International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

Original Research Article.

Retrospective Study of Surgical Treatment of Thoracic Empyema in Adults

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ABSTRACT

Background: Pleural space infection is common and causes significant morbidity and mortality up to 10%. The proper management of empyema remains controversial, and patients are often seen by a physician after their purulent process has already reached the fibrinopurulent or chronic stage. These patients are often subjected to multiple procedures and long hospitalization before the empyema is successfully treated. Most cases are treated initially using antibiotics with or without repeated thoracentesis or chest tube insertion. Surgical approaches, such as video-assisted thoracic surgery (VATS) or open thoracotomy and decortications, are usually reserved for patients with deteriorated clinical condition following failed conservative treatment, which in turn increase the mortality rate.

Aims and Objective: The aim of our retrospective study is to evaluate our experience with thoracic empyema over a 36-month period with special attention to procedures used, success rate of each procedure and outcome.

Materials & Methods: A retrospective chart analysis on patients in whom thoracic empyema was diagnosed from March 2016 to March 2018 at Civil hospital, BJ Medical college, Ahmedabad, India. was performed. The definition of empyema was selected as any pleural fluid that was grossly purulent, and/or had a positive Gram stain or culture and empyema were classified by etiology and culture results. Charts were reviewed for patients age, symptoms, underlying disease, etiology of empyema, culture results, diagnostic modalities, duration of hospitalization, therapeutic intervention, date of procedures, complications, mortality and long-term outcome.

Results and Conclusion: Empyema thoracis is a cause of high mortality in man and its occurrence is increasing in both children and adults. Two guidelines documents on the management of empyema in adults have been published by the ACCP and the BTS. Although they differ in their approach to management, they agree on that the pleural space should be drained in all patients with exudative PPE with pleural fluid pH < 7.2 and in those who have frank pus in the pleural space. Patients who do not improve should be referred to the surgeon for further management. A large randomized multi-centre trial has shown no survival advantage with the use of intrapleural streptokinase in patients with pleural infection and the use of streptokinase has not prevented surgery in the group of patients studied. However, streptokinase enhances infected pleural fluid drainage and may still be used in patients who have large collection of infected pleural collection causing ventilatory impairment.

Keywords: Empyema, VATS, Decortication, Tube Thoracostomy, Lung Abscess.

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Article History:

Received: 21-04-2019, **Revised:** 16-05-2019, **Accepted:** 28-05-2019

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2019.5.3.068	

INTRODUCTION

Thoracic empyema, an infectious process defined by frank pus in the pleural space, has been recognized since the time of Hippocrates and historically carries a considerably high mortality. Empyema is a complex entity with multifactorial pathogenesis and etiology, and clinicians should be mindful in recognizing different stages of the disease. Rapid diagnosis is essential to successful treatment and patient's survival. Treatment aims at combining medical and surgical interventions that target the source of infection and ensure adequate lung re-expansion.

Risk Factors

A significant proportion of pleural space infection present as complication in community or hospital acquired pneumonia. Other causes include penetrating chest trauma, thoracic surgery, and esophageal rupture.[1,2] Independent risk factors for empyema development include:

- Age under 60 years old
- Poor oral hygiene
- IV drug misuse

- Disorders with a predisposition to aspiration (seizure, alcoholism, central nervous system disease)
- Diabetes
- Cardiovascular disease
- Liver cirrhosis
- Other immunocompromised states (HIV infection, malignancy)

Bacteriology

Aerobic *Staphylococcus* and *Streptococcus* species and Gram-negative bacteria including *Escherichia coli*, *Haemophilus influenzae*, and *Klebsiella pneumoniae* were the predominant microorganisms in community-acquired empyema. However, recent literature suggests have that anaerobes and staphylococcal species have replaced *S. pneumoniae* as the major pathogen in surgically treated empyema. Also, anaerobic isolates were found in higher incidence in CAP than previously reported. Methicillin-resistant *Staphylococcus aureus* (MRSA) and gram negatives including *Pseudomonas* and *Enterobacteriaceae*, are pathogens commonly seen in hospital-acquired empyema. Anaerobes are slow growing organisms that notoriously yield negative culture media. Therefore, broad-spectrum antibiotic coverage with anaerobic coverage is warranted.

Fungal empyema is a clinical entity that is rare but carries a high mortality. The majority of these cases were nosocomial infections or had concomitant fungemia.

Pathophysiology

The American Thoracic Society first described the evolution of empyema as a continuous process that subdivides into three stages.

Exudative Stage: Initial bacterial infection causes an acute inflammatory response between the pulmonary parenchyma and visceral pleural.[2,3] Proinflammatory cytokines cause increased capillary permeability leading to an influx of neutrophil-rich fluid into the pleural space. This exudative fluid is usually free-flowing, resolves with appropriate antibiotic treatment, and does not warrant any invasive drainage.

Fibrinopurulent and Loculated Stage: In the absence of appropriate treatment, the effusion can become complicated via deposition of fibrin clots and membranes resulting in isolated collections of fluid in the pleural space. At this stage, bacteriology usually becomes positive, and the effusion warrants antimicrobials and drainage.

Chronic Organizational Stage: If not drained, fibroblasts coalesce to form a thick pleural peel between the visceral and parietal pleura.[4] This peel can ultimately encase the underlying lung parenchyma and can complicate the clinical course via inhibition of adequate gas exchange, trapped lung or chronic forms of empyema.

EVALUATION

Imaging

Chest imaging is a fundamental step in the diagnosis and management of empyema. Despite advances in imaging modalities, plain radiographs still serve as a great screening tool for pleural effusions in patients with pneumonia. Typically, a unilateral, markedly asymmetric pleural effusion with blunting of the costophrenic angle can be appreciated. Smaller volume effusions are detectable with a lateral view X-ray. Decubitus views can be obtained to assess for layering and help quantify an existing effusion.[5,6] Ultrasonography and computed tomography (CT) scanning, however, have greater sensitivity for fluid detection and provide additional information for determining the extent and nature of the pleural infection. Ultrasound is useful in providing an accessible, radiation-free method of visualizing free versus loculated pleural effusions. CT scan with intravenous contrast is optimal and has high diagnostic yield for empyema. The “split pleura” sign is a radiologic finding that has high diagnostic value for empyema. Enhancement and thickening of both the visceral and parietal pleura on CT scan with separation by pleural fluid over 30mm is highly suggestive of a complicated parapneumonic effusion amenable to drainage.

MANAGEMENT

Thoracentesis

The recommendation is for diagnostic fluid sampling via thoracentesis in all patients with pleural effusions with greater than 2 cm depth on lateral decubitus film or computed tomography, associated with a pneumonic illness, recent chest trauma, surgery or features of ongoing sepsis.[6-8] Frank pus in the pleural space invariably necessitates surgical drainage. However, if there is uncertainty whether a turbid fluid is infected, a pH less than 7.2 measured via a blood gas analyser warrants an invasive procedure for drainage. Polymorphonucleocyte predominance, low glucose, and LDH over 1000 on biochemical analysis of pleural fluid support the diagnosis of empyema. Furthermore, fluid culture data should be used to guide appropriate antimicrobial therapy. Research shows that culture yield can be increased significantly if the pleural fluid gets injected into blood culture bottles immediately after aspiration.[8,9]

Management

In 2000, the American College of Chest Physicians (ACCP) published clinical practice guidelines on the medical and surgical approach effusions and empyema. The risk of poor outcome was directly related to the following three variables: pleural space anatomy, pleural fluid bacteriology, and pleural fluid chemistry. Per ACCP consensus, categories 1 and 2 involve effusions in the exudative stage, are free-flowing, and carry the lowest risk for adverse outcomes.[10,11] Category 3 defines complicated effusions in the fibrinopurulent stage and can be larger, free-flowing or loculated, and carry a moderate risk for poor outcomes. Empyema, category 4, carries the highest risk for poor outcome. Goals of therapy for empyema include eradication of the infection via antimicrobials and pleural drainage via tube thoracostomy with or without adjuvant intrapleural medications, video-assisted thoracoscopic surgery (VATS) or by open thoracostomy and decortication.

Antimicrobials

For most patients with suspected or confirmed empyema, empiric broad-spectrum antibiotics are necessary. Initiation should not delay pending diagnostic procedures. Antimicrobials should be tailored to target pathogens based on geographic epidemiology, antibiotic resistance patterns, mode of acquisition (aspiration, trauma), and whether the affected patient presents from a community versus a healthcare setting.[6,8]

- Community-acquired empyema - Antibiotic regimen should target common pathogens of the oropharynx, including aerobic Staphylococcus and Streptococcus species and anaerobes. Appropriate antibiotics would include third-

generation cephalosporins plus metronidazole or a beta-lactam/beta-lactamase inhibitor combination.

- Hospital-acquired empyema - As well as covering for typical organisms and anaerobes, antimicrobial therapy should be directed at providing coverage for MRSA and Pseudomonas. Reasonable options include Vancomycin plus Metronidazole and an antipseudomonal cephalosporin. Vancomycin plus piperacillin/tazobactam, a broad-spectrum beta-lactam/beta-lactamase inhibitor, provides both anaerobic and antipseudomonal activity.[6,12]

Caution should be taken with the use of aminoglycosides due to poor pleural penetration and therefore are not the recommendation in the treatment of empyema. Duration of antibiotics is generally recommended for 2 to 6 weeks (intravenous followed by oral) depending on the degree of infection, and clinical response to therapy.

Tube Thoracostomy

Chest tube placement, under radiologic guidance, is the least invasive and most common non-surgical modality for empyema. Optimal thoracostomy tube size has been a controversial topic amongst chest physicians. The traditional dogma was a large bore (greater than 22 French) thoracostomy tube was more suitable for draining the viscous purulent fluid of empyema. However, recent literature has shown no significant mortality benefit or delay in surgery between large bore (greater than 20 French) versus small-bore chest tubes (less than 20 French). Clinically, the location of the chest tube is more relevant than its size as mal-positioning is often the cause of treatment failure. Confirmation of adequate positioning should be via plain film or chest CT within the first 24 hours. Most chest tubes are left in place until the drainage is less than 50 ml in 24 hours or if there is proof of lung re-expansion on chest radiography.[2]

The use of adjunctive intrapleural medications is controversial. The data regarding isolated use of fibrinolytic drugs (streptokinase, tissue plasminogen activator (TPA), and urokinase) has been underwhelming and has shown no profound benefit in patient outcomes or need for surgical intervention. In contrast, combination therapy of fibrinolytic agents and mucolytics, particularly TPA–DNase therapy, improved fluid drainage for patients with pleural infection and reduced the frequency of surgical referral and the duration of the hospital stay. Despite such positive outcomes, there was no change in mortality.[4,9]

Recently, a new intrapleural irrigation approach using saline lavage has reported benefits for patients with empyema. The Pleural Irrigation Trial (PIT) found radiographic improvement after three days in empyema patients receiving saline irrigation via tube thoracostomy vs. standard of care. A smaller retrospective study comparing saline flushes plus urokinase versus saline alone found decreased chest tube duration and use of fibrinolytics. Although researchers noted no mortality benefit, more extensive randomized studies are needed to confirm the benefits of this inexpensive, well-tolerated therapy.

VATS

Surgical consultation should be a consideration when drainage via tube thoracostomy fails or in multi-loculated empyema. Video-assisted thoracoscopic surgery (VATS) is a minimally invasive surgical technique that allows for direct visualization and evacuation of the infected pleural space. Although appropriate timing of VATS is unclear, it has been documented to have superior outcomes when compared to tube thoracostomy for the treatment of advanced stage empyema in terms of postoperative morbidity, complications, and length of hospital stay.[10]

Open Thoracostomy & Decortication

Persistent empyema refractory to standard therapies, including VATS, should be considered for open window thoracostomy (OWT) with prolonged chest tube drainage or decortication. Acute empyema can have long term consequences despite adequate therapeutic interventions. Pleural scarring and fibrosis can lead to adhesions, decreased lung compliance, and a restrictive lung disease pattern. A decortication is an option for lung re-expansion if symptoms persistent 6 months after empyema resolution.[12]

AIMS AND OBJECTIVES

1. To identify the pathological causes of empyema.
2. To study the morbidity and mortality in surgical management of empyema.
3. To study the various complication in patients operated for empyema.

MATERIALS AND METHODS

The Study consist of 200 cases of empyema treated in cardiovascular and thoracic surgery department civil hospital, BJ medical college, Ahmedabad from march 2017 to march 2019. These patients are direct admission from the OPD of department as well as those referred from the departments of Paediatrics, Medicine, Surgery. Ethical clearance was obtained from institutional review committee.

Inclusion Criteria

All Empyema treated with operative intervention.

Exclusion Criteria

Conservatively managed meningioma.

Table 1: Epidemiology

Age	Male	Female
0-9	9	4
10-19	16	12
20-29	47	26
30-39	32	10
40-49	19	09
50-59	06	02
60-69	07	00
70-79	02	00

Table 2: Pathology of empyema

Sr. no	Causes	Number
1	**Tuberculosis**	88
2	**Post pneumonia**	69
3	**Oesophageal Surgery**	11
4	**Blunt injury**	15
5	**Penetrating injury**	11
6	**Acid ingestion**	04
7	**Miscellaneous**	02

Table 3: Management

Procedure	Number
Tube Thoracostomy	71
VATS	29
Decortication	93
Open thoracostomy	07

Table 4: Complication

Sr no.	Numbers
Post op Bronchopleural fistula	07
Lung collapse	08
Wound infection	04
Diaphragmatic paralysis	01
Upper limb neuropraxia	11
Post thoracotomy pain	24
Chylothorax	01
Arrythmia	03
Atelactasis	17

Table 5: Further operative procedure after decortication

Procedure	Numbers
Thoracoplasty	07
Bronchoalveolar lavage	09
Open thoracostomy	02

Table 6: Results

Procedure	Full expansion of lung	Require further management
Tube Thoracostomy	48	23
VATS	23	05
Decortication	93	16
Open thoracostomy	05	02

RESULTS

Table 1 shows that it is most common in third and fourth decade of life. In above study 36.5 % population involve third decade and 21% population involve in forth decade. Cases are much less after fifth decade of life.

In this study tuberculosis is most common cause for empyema accounting for 44% of patients. Second most common cause is post pneumonia accounting for 34.5% of the patients.

In this study 46.5% patients required operative intervention. And 35.5% patients managed by tube thoracostomy.

In this study most common complication is post op atelectasis and upper limb neuropraxia. Third most common cause is Broncho pleural fistula.

In this study 4.5% patients require second operative intervention due to bronchopleural fistula.

In this study patients undergoing decortication and VATS having good post op results.

DISCUSSION

The high incidence of empyema in the productive age group of 21-40 years in this study is consistent with the findings in the earlier study by Behra and Tandon.[5,6] This may be due to the common occurrence of pulmonary tuberculosis in this age group, particularly in the developing countries with a high prevalence of tuberculosis. Two other studies show the incidence of empyema to be higher after the age of 40.[17,18] This may be attributed to the fact that the above studies were carried out in the developed countries, where the overall prevalence of tuberculosis is relatively low; in contrast to the present study, which was undertaken in India.

In the present study, males outnumbered female patients in the ratio of 3.4:1.0. Males in general are more prone to mechanical stresses due to their tall stature and strenuous work. Smoking is a more frequent habit, and tuberculosis and COPD are more frequent in males.

The study done by Kamat reported cough (94%) to be the most common symptom. This was followed by fever (76%), chest pain (75%) and dyspnoea (53%).[9] The prevalence of cough (92.5%), chest pain (80%) matches that of the study by Kamat, whereas dyspnoea (92.5%), fever (87.5%) and constitutional symptoms (62.5%) were encountered more frequently in our patients. The clinical manifestations of an empyema can vary widely, depending on both the nature of the infecting organism and the competence of the patient's immune system. The spectrum ranges from an almost complete absence of symptoms to a severe illness with systemic toxicity.[10] In general, anaerobic and tubercular empyema usually present with a subacute illness, whereas aerobic bacterial infections of the pleural space present with an acute illness.

In the present study, infectious etiology is more common because this study was carried out in a TB and chest diseases ward and patients of posttraumatic and postsurgical empyema were excluded from the study. In 88 patients (44%) the empyema was tubercular in etiology. In 69 patients (34.5%) the empyema developed as a complication of bacterial pneumonia.

Prior to the availability of antibiotics, streptococcus pneumoniae and streptococcus pyogenes accounted for most empyema. After the discovery and widespread use of penicillin in the 1940s, staphylococcus aureus succeeded *S. pneumoniae* and *S. pyogenes* as the major cause of empyema. Since the advent of β-lactamase resistant semisynthetic penicillin in the early 1960s, the incidence of staphylococcal empyema has decreased, and infections due to anaerobic bacteria (Bacteroides, Pepto streptococci and Fusobacteria) and aerobic gram-negative bacilli (*E. coli,* Pseudomonas, Proteus, Klebsiella) have increased markedly. Approximately 75% of patients with empyema have multiple infecting organisms, averaging three bacterial species per patient. The pus is found to be sterile in only one-third of cases.[11]

The pathogen isolated in empyema also depends on presence or absence of certain predisposing factors like community-acquired pneumonia (*S. pneumoniae*), h/o aspiration (anaerobes), subdiaphragmatic infections (aerobic gram-negative enteric bacilli), external trauma and haemothorax (*Staphylococcus aureus*) and immunosuppression (*Staphylococcus aureus, Mycobacteria, fungi*). Age is also an important deciding factor. Whereas coagulase-positive *Staphylococcus aureus* is common in childhood, gram-negative organisms other than Hemophilus influenza are relatively unusual causes of empyema in children;

anaerobic organisms are rare in patients younger than 18 years.[18] In the present study, a positive culture was obtained in 54 patients (26%). Gram-negative organisms were cultured most frequently 55 (27.5%). This is in concurrence with the reports of various workers who have emphasized the emergence of gram-negative bacilli as predominant pathogen.[7,8] In our series pleural fluid was sterile in 47% cases. This high negative culture report, compared to the previous studies, correlated with the high number of tuberculous empyema thoracis in the present study.

A good proportion of cases of tubercular empyema can be diagnosed by isolation of AFB in sputum and/or pleural pus. In addition, a smaller number were diagnosed on basis of past history, symptomatology, radiological lesions and therapeutic response to anti-tuberculous treatment.

There are two basic principles for the successful management of thoracic empyema – namely, the control of infection with appropriate antimicrobial therapy and the adequate drainage of pus.

The initial choice of antibiotics depends on the results of Gram's stain of pleural fluid and sputum. This is then modified as per the clinical response of the patient and the result of culture and sensitivity. As a rule, antibiotics are continued until (1) the patient is afebrile and the white blood cell count is normal, (2) the tube thoracostomy drainage yields <50 ml of fluid daily, (3) the radiograph shows considerable clearing. Typically, antibiotics are required for 3 to 6 weeks.[11]

The choice of the method used to drain the empyema depends on the stage of the empyema. The pleural fluid in the first stage, i.e., *the exudative stage,* is small in volume, sterile and free flowing. It is characterized by a low white blood cell count and lactic acid dehydrogenase (LDH) and a normal glucose level and ph. An empyema detected at such an early stage can be managed by antibiotics plus serial thoracentesis.[10,12]

The second stage, viz., *the fibrinopurulent stage,* is characterized by an increase in the volume of pleural fluid, which is then turbid in appearance due to the presence of a large number of polymorphonuclear leukocytes, bacteria, fibrin and cellular debris. The pleural fluid pH and glucose progressively decline and the LDH level progressively increases. Septations form in the pleural cavity to contain the infection and prevent the extension of the empyema.[13,14] Management of this stage of empyema necessitates the use of chest tubes. Successful closed-tube drainage is evidenced by improvement in the clinical and radiologic status within 48 h. If the patient fails to improve clinically and radiographically within 48 h, ultrasonic or CT examination of the pleural space is performed to detect undrained loculated fluid. In patients with inadequate drainage, the choices are 1. image (CT/ultrasound) guided placement of additional chest tubes; 2. suction therapy, i.e., the use of negative suction to break loculations; 3. use of intrapleural fibrinolytic agents like streptokinase and urokinase; 4. video-assisted thoracoscopic surgery with breakdown of adhesions; 5. thoracotomy with digital lysis of adhesions and operative placement of chest tubes with or without decortication.[21]

The formation of a fibrinous inelastic membrane on the surface of both the pleura – variously referred to in literature as the pleural cortex, the rind, peel – encases the lung, rendering it functionless; these are features of the third stage of empyema, or *the organizational stage*.[10,13] This stage of empyema requires surgical intervention, which usually takes the form of decortication. Decortication is an elective surgical procedure in which the fibrous wall of the empyema cavity – the cortex, rind or peel – is stripped of the adjacent visceral and parietal pleura along with the evacuation of pus, blood clots and fibrin material from pleural cavity. This eliminates the pleural sepsis and allows the underlying lung to expand.[2,10,13]

The mortality from empyema ranges from 11 to 50%. A good outcome demands prompt recognition, appropriate antibiotic therapy and adequate pleural drainage. Pleural fluid of pH <7.2, glucose <40 mg/dl and LDH >1,000 IU/L indicates a patient with increased risk of needing pleural drainage.

However, in practice such criterion may not always be readily available to guide treatment decisions. Hence, we propose that in absence of the above, size of the effusion and thickness of aspirated fluid may be used to guide the need for a chest tube placement. Cases failed by repeated thoracentesis, all cases of simple empyema with thick pus and with moderate to large size of empyema and all cases of empyema with bronchopleural fistula (BPF) should be managed by intercostal drainage tube connected to water seal.

CONCLUSION

Empyema thoracis is a cause of high mortality in man and its occurrence is increasing in both children and adults. Two guidelines documents on the management of empyema in adults have been published by the ACCP and the BTS.[15,16]

Although they differ in their approach to management, they agree on that the pleural space should be drained in all patients with exudative PPE with pleural fluid pH < 7.2 and in those who have frank pus in the pleural space. Patients who do not improve should be referred to the surgeon for further management. A large randomized multi-centre trial has shown no survival advantage with the use of intrapleural streptokinase in patients with pleural infection and the use of streptokinase has not prevented surgery in the group of patients studied. However, streptokinase enhances infected pleural fluid drainage and may still be used in patients who have large collection of infected pleural collection causing ventilatory impairment.

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Source of Support: Nil.

Conflict of Interest: None Declared.

Cite this article as: Tushar Sharma, Bhupesh Shah. Retrospective Study of Surgical Treatment of Thoracic Empyema in Adults. Int J Med Res Prof. 2019 May; 5(3):294-99.
DOI:10.21276/ijmrp.2019.5.3.068