

Case Series

Pediatric empyema thoracis: our surgical experience

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ABSTRACT

Incidence of empyema is increasing despite various treatment modalities available. Management of pediatric empyema remains a challenge due to factors like malnutrition, poverty, TB, delay in early intervention and incomplete treatment course. It is necessary to address these issues at ground level. A short 2-year prospective study was carried out at a tertiary care teaching hospital where 17 consecutive cases of pediatric empyema were managed. Among 17 cases, all patients intercostal tube drainage (ICD) was required. Six patients underwent surgical interventions [2 video-assisted thoracoscopic surgery (VATS) and 4 open thoracotomies] while 11 were managed on ICD and antibiotics. Fibrinolytic therapy was not administered in any case. Follow-up showed good lung expansion with apparent rib crowding in 3 cases and no mortality. Majority of empyema in children are post pneumonic. Chest tube drainage, antibiotics along with intrapleural fibrinolytic is a safe and effective method of treating empyema thoracis in children in resource- poor settings and can reduce the need for invasive interventions.

Keywords: Empyema thoracis, Pediatric empyema, VATS, Decortication, Open thoracotomy, Fibrinolytic therapy, Intercostal chest tube

INTRODUCTION

Empyema thoracis is defined as pus in the pleural space. It commonly develops as a complication of bacterial pneumonia in 5-10% of children. The diagnosis and surgical treatment of empyema by was described by Hippocrates in around 600 B.C, where it was said that a person with empyema shall die on the 14th day unless something favourable supervenes.^{1,2}

The empyema is usually the result of pneumonia, traumatic, spread of infection from mediastinum, retropharyngeal, paravertebral space infection, tuberculous processes or after a thoracic surgery. With developing surgical practice, thoracotomy became a common procedure, and a new aetiology called postsurgical empyema was added which constitutes 20%

of all empyema cases.² The management of pediatric empyema is a challenge to paediatrician and surgeons as various modalities of treatment like antibiotics, intrapleural instillation of Fibrinolytic drugs, ICD, breakdown of loculations by VATS or thoracotomy decortication for open drainage are at disposal for its treatment. Early initiation of intravenous antibiotics along with chest tube insertion promotes lung expansion and early recovery in up to 86% of cases.³

Incidence of empyema is increasing in spite of various treatment modalities available. We believe poverty, ignorance, malnutrition, prevalence of tuberculosis, delay in initiating treatment or inadequate/inappropriate treatment of bacterial pneumonia, non-evacuation of pleural space and delayed referral might be some factors for its increasing incidence.⁴⁻⁶

CASE SERIES

This case series study, analysing presentations and management of empyema thoracis in pediatric patients was performed from January 2018 to January 2020 (24-month duration) on patients admitted at the department of pediatric surgery, NKP Salve institute of medical sciences and research centre, Nagpur. Children (0-12 years of age) with clinical and radiological evidences of empyema thoracis were included in the study.

Empyema thoracis was diagnosed by clinical (chest auscultation and percussion), radiological and after aspiration of pus from pleural cavity. Detailed history, clinical examination was noted in a pre-structured proforma. Routine blood workup, chest X-ray, ultrasonography and if needed CT scan of thorax, echocardiography (to detect pericardial effusion) was performed. Diagnostic aspiration was done under radiological guidance. Patients were started on empirical IV antibiotics till culture reports were obtained. Supportive treatment in the form of painkillers, IV fluids, antipyretics, oxygen supplementation was given on case-to-case basis.

ICD insertion was done in patients who had respiratory distress or patients who had persistent fever even after IV antibiotics for 48 hours. Chest X-ray and ultrasonography was done beforehand to decide need for unilateral or bilateral ICD insertion. Chest X-ray was repeated post ICD insertion for checking correct placement of intercostal tube to ensure an effective drainage. Serial radiographs were taken according to patient's response. Quantity of drainage, its colour, odour, frothing and column movement was recorded daily. In non-responsive patients' high-resolution CT of thorax was performed to look for loculations, effusion, crowding of ribs, thick pus and pleural thickening on chest X-ray were considered for operative intervention.

Patients who were considered for therapeutic decortication or VATS were shifted to pediatric surgery ward and after pre-anaesthetic check-up operative intervention was planned. All patients received general anaesthesia and controlled ventilation. Lateral decubitus position was used with affected side up. Two lung ventilation was used. Intraoperative findings were noted. Ease of operability, difficulty in debridement and drainage along with lung expansion was noted. Postoperative chest tubes were kept and serial observations were made. Outcomes of various procedures were evaluated.

Well informed consent from parents and institutional ethics committee approval for the study was obtained beforehand. The data obtained on descriptive statistics was presented in tabular format with mean, standard deviation and percentage. For analytical statistics, categorical variables were expressed in actual numbers.

Appropriate statistical tests were applied wherever necessary.

Findings

A total of 17 cases were analysed in the two-year duration. All patients with underwent some sort of intervention, be it ICD insertion, VATS or open thoracotomy.

Out of 17 patients, 12 were male and 5 females with M:F = 2.4:1. Maximum number of patients were in the age group of 2-4 years. Mean age of children was 3.47 ± 1.79 years. Five (29.41%) children were malnourished, while remaining 12 (70.58%) children had normal weight. Beside malnutrition no other specific comorbidities were present.

Table 1: Age and gender distribution of children.

| Age (year) | Male | Female | Total |
|--------------|------|--------|-------|
| 0-2 | 2 | 1 | 3 |
| 2-4 | 7 | 3 | 10 |
| 4-6 | 2 | 1 | 3 |
| >6 | 1 | 0 | 1 |
| Total | 12 | 5 | 17 |

Symptomatological analysis showed children presented with cough and breathlessness in all the cases. Fever was third most common symptom which was seen in 14 patients. Majority 10 (58.8%) of the patients sought medical care within 7 days, while 3 cases presented between 7-14 days and 4 cases presented to us after 2 weeks. Of these 4 patients who visited us after 2 weeks, 2 cases already had intercostal drainage tube *in situ*.

Table 2: Common symptoms present in study.

| Symptoms | No. of cases | Percentage (%) |
|----------------------------------|--------------|----------------|
| Cough | 17 | 100 |
| Breathlessness | 17 | 100 |
| Fever | 14 | 82.35 |
| Chest pain | 10 | 85.82 |
| Abdominal pain/distention | 8 | 47.05 |

Most of the patients, 11 (64.7%) recovered with antibiotics and ICD insertion alone. There was dramatic improvement in patients after ICD insertion which was evident on clinical improvement and reduced supplemental oxygen requirement.

The average ICD duration was around 2 weeks 15.23 ± 5.48 days. Three patients had prolonged ICD drainage (2 showed delayed response while one developed leakage which resolved on conservative management). Of the 11 (64.7%) patients which were managed purely on ICD, 3 cases required bilateral chest tubes as clinical features and loculations were assessed on

both sides on chest X-ray. One patient had developed pericardial effusion which was managed conservatively. Total hospital stay in our study was 17±5.62 days.

Of the 17 cases, 6 (35.29%) required surgical intervention. Four patients underwent open thoracotomy decortication while 2 patients underwent VATS. These cases showed little response to ICD drainage. On High resolution CT horax organised fluid, loculations with pleural thickening was seen in nonresponsive patients. One case had developed consolidation of the affected lung and another one patient had developed lung collapse. In two cases VATS was performed, while 4 (23.52%) required open decortication, this included the patient who had delayed presentation and had ICD before admission (prolonged ICD failure). 1 patient developed minor air leak postoperatively which was managed conservatively. Pulmonary resection was not required in any patient. In open decortication patients' satisfactory lung expansion was obtained only after removal of thick fibrous peel and stripping of pleura. Postoperative antibiotics, epidural and IV analgesics, nebulization, chest physiotherapy and incentive spirometry played a vital role in lung expansion and recovery.

All patients at the time of discharge were asymptomatic. In some patients pleural thickening and overcrowding of ribs was observed on chest X-ray just before discharge. After a 3-month follow-up, clinical examination of 15 the cases were absolutely normal. Rib crowding was apparent in 3 cases without any chest deformity. None of the cases expired. The five malnourished children were given proper nutrition, two of them required blood transfusion and were discharged only after gaining weight. Of 17 cases, 15 were evaluated and 2 were lost to 3-month follow-up.

DISCUSSION

This case series on empyema thoracis in children at a tertiary care centre shows good pulmonary outcome. The age of presentation and male predominance, found in this series seems similar to studies in the literature. A higher incidence of empyema, with prolonged hospital stay has been reported in undernourished children.⁷

The characteristic three stages of empyema are shown in the Table 3 below.

Table 3: Different stages of empyema.

| Stage | Time after onset | Fluid characteristics | Treatment |
|------------------------|------------------|---|--|
| Exudative | 24-72 hours | Thin watery fluid, few cells | Drainage (needle/chest tube) |
| Fibrinopurulent | 5-10 days | Fibrinous debris, loculated septations, many polymorphonuclear leukocytes cells | Fibrinolysis/thoracoscopic debridement |
| Organizing | 2-4 weeks | Thick visceral and parietal pleura | Decortication/pleurectomy |

The progression in empyema is divided into three stages: exudative stage (1-3 days), fibrinopurulent stage (5 to 10 days) and organizational stage (after 14 days lasting 2-4 weeks). Treatment of empyema is determined after assessing the stage of empyema. Many times, it is difficult to exactly determine the stage of empyema before treatment. Judgement based on history; clinical examination and preliminary radiological analysis (chest X-ray and ultrasonography) assists in initiating empirical therapy.

Pleural fluid analysis plays an important role in management of children with empyema. Pleural fluid is obtained by thoracentesis under ultrasonography guidance. Fluid examination helps differentiate between exudate and transudate, identification of organism, staging and assessment of prognosis. Pleural fluid pH<7.2, LDH >1000 IU/L, glucose <40 mg/dL suggests that effusion is unlikely to resolve with antibiotics alone. *Staphylococcus aureus* is usually the most common pathogen isolated from pleural empyema.⁸

Historically for early parapneumonic effusions antibiotics and thoracentesis/chest tube drainage is considered adequate. Close monitoring of babies with detailed blood work, radiological evaluation, thoracentesis and analysis

of pleural fluid aspirate for microscopy, biochemistry, CBNAAT (cartridge based nucleic acid amplification test), LDH (lactate dehydrogenase) are useful.

Empirical antibiotic coverage (3rd generation cephalosporin, glycopeptide, beta lactams, carbapenems aminoglycosides, monobactam etc.), based on local antimicrobial policy, is initiated right from admission. It should be personalised to the patient based on age, nutritional status, renal and hepatic functions. Subsequently antibiotics are changed as per culture sensitivity pattern.

Conventional X-ray chest is usually the first line radiological investigation to detect effusion and pleural space infections, however it must be combined with additional imaging. Ultrasound is better for estimating volume of effusion and is an ideal tool for safe and effective diagnostic thoracentesis. High resolution CT of thorax helps in diagnosis, identification of pus pockets, pleural fluid thickness, quantity of undrained fluid, extent of parietal and visceral pleura thickening, loss of lung volume and its consolidation. The presence of air bubbles within the pleural effusion in the absence of preceding pleural intervention, is specific for a pleural space infection and may suggest resistance to chest tube

drainage alone. There is no evidence that direct administration of antibiotics into the pleural space increases microbial clearance or outcomes in comparison with systemic antibiotics alone.^{8,9}

Fibrinolytic therapy is useful only when the disease is limited to the early fibrinopurulent phase, although many times it is difficult to exactly differentiate the stages of empyema where presence of loculations, thick pus and fibrinous adhesions limits use of fibrinolytic therapy and successful drainage. Moreover, there is insufficient evidence to support routine use of this therapy for all patients as long-term outcomes (pulmonary reserve) are still not studied.¹⁰ We did not use fibrinolytics in any patient because of financial constraints.

In our case series study, of the 17 cases, 11 patients with antibiotics and ICD insertion showed complete clinical and radiological resolution of empyema and re-expansion of the lung without the need for surgical intervention. Of the 6 patients who underwent surgical procedures in our study VATS was done in 2 cases while 4 were subjected to open thoracotomy. Two patients who had ICD before admission were assessed and directly taken for open decortication as they presented late had history of delayed insertion of ICD tube, with inadequate drainage and incomplete antibiotic course.

Intraoperatively there were organised pockets of thick turbid pus with thickened pleura. Debridement of pus infected tissue was done. In prolonged empyema cases, thorax was contracted with mediastinal shift on the affected side due to fibrosis. After decortication intercostal drains were kept after thorough wash and suction. Postoperative pain was managed with epidural catheter. Patients were discharged after increase in weight and improvement of air entry.

Patients were followed up for clinical improvement, increased lung expansion, ambulation decreased total counts and absence of fever. Overall general well-being of the patient was assessed. Of 17 patients, 15 had 3 months follow up while 2 patients were lost to follow-up.

Under the care of a dedicated pediatric surgeon, a thoracoscopic (VATS) or open surgical intervention remains the gold standard for empyema. VATS provides multiple benefits over open thoracotomy, however patients not tolerating one lung ventilation and coagulopathy contradicts use of VATS. Besides drawbacks of VATS include increased operative time, increased cost, steeper learning curve, and incomplete therapy which may further require additional procedures.

Avansino et al conducted a meta-analysis and suggested that primary operative therapy of empyema is associated with lower mortality rate and morbidity as compared to conservative management whereas McLaughlin and Gocmen et al emphasized that most children with loculated empyema can be treated with antibiotics and

chest tube drainage and surgery is required in few cases only.¹¹⁻¹³

In the study done by Baranwal et al success rate of medical management over surgery was 79%, while Satpathy et al reported a success rate of 90.5% with conservative management which is higher than present study.^{14,15} We believe that, this difference was because majority of the patients in our study had presented late and the incidence of complications was higher in this study.

Pleural fluid analysis remains the single most important predictor of clinical outcome, besides it septations, associated disease and serial chest X-rays help in anticipating disease prognosis. However, various centers that have facilities for VATS may prefer to use the same over fibrinolytics. Thoracotomy and decortication are 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 with less chances of recurrence.

Detailed clinical history, local antibiotic resistance patterns, antibiotic stewardship, precise selection of antibiotics based on patient characteristics, overall duration of disease, organism grown, adequate source control and judgement of clinical response are some determining factors. Some features like sensitivity of organism, adequate drainage (ICD/surgical drainage), response to therapy decide the end result. Goal of the therapy in empyema patient is drainage of infected material from collected space with adequate lung expansion.

CONCLUSION

Majority of cases of empyema in children are post-pneumonic. Hence morbidity and mortality can be reduced by adequate treatment of bacterial pneumonia. In all patients with loculations except those with a broncho pleural fistula, fibrinolytic therapy should be tried. Chest tube drainage, antibiotics along with intrapleural fibrinolytic is a safe and effective method of treating empyema thoracis in children in resource-poor settings and can reduce the need for invasive interventions. However, early identification of warning signs and clinical deterioration should be immediately dealt with operative interventions such as thoracoscopic debridement or open surgery.

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