

Original Research Article

Empyema thoracis in children: analysis from a tertiary care center

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ABSTRACT

Background: Empyema thoracis refers to infection and pus formation within the pleural space in the thorax. It is estimated that 0.6% of childhood pneumonia's progress to empyema, affecting 3.3 per 100000 children. The purpose of this study was to analyse the clinical and bacteriological profile, outcome of empyema in children with reference to intercostal drainage/tube thoracostomy (ICD/TT) and video assisted thoracoscopic surgery (VATS).

Methods: A hospital based prospective comparative study was conducted on 61 children diagnosed with empyema thoracis according to ICD-10 code J869 between 6 months to 18 years of age admitted to K. G. P. children hospital, Vadodara over a period of 20 months from September 2018 to May 2020.

Results: Most of patients (63.9%) were seen in age group of 1-5 years. Fever (100%), cough (99%) and breathlessness (85%) were the commonest presenting features. Pleural fluid culture was positive in (28%) of patients and *Staphylococcus aureus* (11.5%) was the most frequent organism isolated from pleural fluid. The mean duration of ICU stays, the mean duration of hospital stays and time taken for removal of ICD was less VATS group with statistically significant difference.

Conclusions: Empyema in children causes significant morbidity which can be reduced by appropriate treatment of bacterial pneumonia. ICD and antibiotics are effective method to facilitate drainage and resolution of empyema in resource poor settings. VATS is effective treatment for empyema when presented with stage 2 and stage 3 empyema having multiple loculation, which decreases duration of hospital treatment.

Keywords: Empyema thoracis, Tube thoracostomy, Video assisted thoracoscopic surgery

INTRODUCTION

Empyema is a collection of pus within a naturally occurring anatomical space. The term itself is a compound Greek word consisting of empyein meaning pus producing (suppurate). Empyema thoracis refers to infection and pus formation within the pleural space in the thorax. It is usually caused by local spread of infection from pneumonia, tuberculosis or lung abscess but may be caused by organism brought to pleural space via blood or lymphatics or abscess extending upward from below the diaphragm or as a consequence of infection at other sites distant from lung. The formation of empyema has been arbitrarily divided into three phases

that are not sharply distinct but gradually one phase merges into another with progression depending largely on the infecting organism.¹⁻³

Three phases of empyema formation

Exudative stage 1 -3 days (fluid accumulation)

This is the immediate response and the cellular content of the exudates is relatively low with normal pH and glucose levels.

Fibro purulent stage 4-14 days (fibrin deposition and loculation)

In this stage a large number of poly-morphonuclear leukocytes and fibrin accumulate in the effusion. Pleural fluid pH and glucose level fall while LDH rises. With continued accumulation of neutrophils and fibrin, effusion becomes purulent leading to development of empyema.

Organization stage: >14 days (fibrin proliferation and scar formation)

Fibroblasts grow into exudates on both the visceral and parietal pleural surfaces, producing an inelastic membrane, the peel, which can restrict lung movement.

It is estimated that 0.6% of childhood pneumonia's progress to empyema, affecting 3.3 per 100000 children.⁴ Studies reporting conservative management have become less common as management has become strategies using fibrinolytics and VATS evolved. The availability of local resources and cost particularly in case of surgical technique limits the surgical option.⁵ The management of empyema thoracic in children till date has largely lacked evidence-based approach. This prospective study was done to analyse the clinical and bacteriological profile, outcome of empyema in children with reference to ICD/TT and VATS.

METHODS

This study was conducted after approval from the ethics committee and scientific committee of K. G. P. children hospital, Vadodara, Gujarat. This study was hospital based prospective comparative study conducted on children between 6 months to 18 years of age admitted to K. G. P. children hospital over a period of 20 months from September 2018 to May 2020 where 61 patients fulfilling the inclusion criterion were included after written informed consent from parents or relatives.

Inclusion criteria

The children who were diagnosed as empyema according to ICD-10 code J869, between 6 months to 18 years of age, with their written informed consent before their inclusion in the study.⁶

Exclusion criteria

Infant with empyema less 6 months of age, cases of effusion other than empyema (like chylothorax, haemothorax), children with empyema thoracis secondary to trauma/thoracic surgery/oesophageal rupture had been excluded.

Methodology

Patients were evaluated as per the history of presenting illness and examined thoroughly for their general and systemic examination including vital signs and anthropometry. The patients were subjected for

investigations complete blood count (CBC), ESR, chest X-ray (CXR), ultrasonography (USG) of chest was done.

In all clinically suspected cases diagnostic thoracentesis was performed under local anaesthesia and collected pleural fluid sent for cytology, biochemistry for pleural fluid pH, LDH, glucose, microbiology for gram stain and culture sensitivity.

When USG suggestive of pleural fluid with significant amount without septation or loculations were managed with TT/ICD in combination with intravenous antibiotics. ICD procedure was done with all aseptic precautions with prior consent in 5th intercostal space in mid axillary line, outer end of the tube was connected to an underwater seal kept in sterile condition.⁴ VATS was done as primary treatment modality who presented with septation and multiple loculated empyema on ultrasonography. VATS was done by pediatric surgeon, adherent peel was removed completely from the pleural surfaces and pleural space was irrigated with antibiotic solution and a chest tube was placed.⁷

CXR was taken after ICD insertion to confirm the exact position of the tube, to see residual collection subsequently and to see lung expansion. Appropriate antibiotics were given for a minimum of 4-6 weeks depending on the clinical condition of the patient and organism isolated in culture sensitivity. Outcome of empyema was measured in terms of duration of ICU stays, duration of hospital stays, time taken to become afebrile and time taken for removal of ICD.

Statistical methods

Frequency and percentage were taken out in all patients. For comparison of TT and VATS, Chi square test was used for categorical data and unpaired t test was used for continuous data.

Statistical software

STATA/IC-13, Texas, USA was applied and if p value was less than 0.05 then there was statistically significant difference and highly dependent (correlated) with the outcome of empyema.

RESULTS

During the study period, 61 children were diagnosed as empyema thoracis out of which 32 (52.5%) were males and 29 (47.5%) were females. Incidence of empyema was more common in 1 to 5 years 39 (63.9%) patients, 5 (8.2%) patients were seen in infancy and 17 (27.9%) patients were seen above 5 years. All the patients had fever and cough, respiratory distress (RD) was seen in 52 (85%) patients, chest pain was present in 11 (18%) patients whereas other symptoms (abdominal pain, vomiting) were present in 7 (11.5%) patients. Out of 61 patients, 58/61 (95%) patients had chest retractions and

55/61 (92%) patients had mediastinal shift and decreased breath sound on right side in 34 (55.7%) patients whereas in left side it was 27 (44.3%) patients. TT was done in 38/61 (62.3%) patients whereas VATS in 23/61 (37.7%) patients with p value of 0.006 suggestive of statistically significant difference between two treatment modalities.

CXR done at time of hospitalization in present study group of 61 patients which were showing right costophrenic angle blunting (RCPB) in 34 (56%) patients

whereas left costophrenic angle blunting (LCPB) in 27 (44%) patients with p value of 0.006 suggestive of statistically significant difference. USG of chest which had shown LPE (left pleural effusion without loculation) in 22 (36%) patients, RPE (right pleural effusion without loculation) in 16 (26%) patients, LML (left multiloculation) in 5 (8%) patients and RML (right multiloculation) in 18 (30%) patients with p value of <0.001 suggestive of statistically significant difference.

Table 1: CXR and empyema (N=61).

CXR and empyema		Treatment		Total (N=61)	
		TT	VATS		
CXR	LCPB	N	22	5	27
		%	57.9	21.7	44.3
	RCPB	N	16	18	34
		%	42.1	78.3	55.7
Total	N	38	23	61	
	%	100.0	100.0	100.0	

Table 2: PF culture yield in empyema (N=61).

PF culture	Frequency (N=61)	Percentage (%)
<i>S. aureus</i>	7	11.5
<i>Pseudomonas</i>	3	4.9
<i>Stenotrophomonas</i>	3	4.9
<i>S. pneumoniae</i>	2	3.3
<i>Burkholderia capacia</i>	2	3.3
Negative	44	72

Table 3: Comparison of outcome of empyema between TT and VATS.

Outcomes	Treatment	Frequency (N)	Mean	Standard deviation	t value	P value
Duration of ICU stay	TT	38	5.1053	1.68923	1.700	0.094
	VATS	23	4.3913	1.40580		
Duration of hospital stay	TT	38	7.4737	2.29849	2.391	0.020
	VATS	23	6.2174	1.31275		
Time taken for removal of ICD	TT	38	4.5526	1.81134	2.060	0.044
	VATS	23	3.6957	1.06322		
Time taken to become afebrile	TT	38	5.3421	2.32816	1.700	0.094
	VATS	23	4.4783	0.89796		

All patients were subjected to pleural fluid routine microscopy and pleural fluid culture sensitivity (PF C/S), with mean of pleural fluid (PF) glucose was 45.5 mg/dl with standard deviation of 13.9, mean of pleural fluid LDH was 930 U/l. CRP was elevated in all patients with mean value of 43.1 mg/l and mean value of ESR was 24.7 mm/1sthr. Blood C/S were positive for *S. aureus* (2.6%). PF bacteriological growth was seen in 17 (28%) patients in which *S. aureus* (11.5%) followed by *Pseudomonas* (4.9%) and *Stenotrophomonas* (4.9%). Most of cultural growth were sensitive to vancomycin followed by ceftriaxone and meropenem.

Empyema more occurred on the right side 34 (56%) patients compared to left side 27 (44%) patients. Out of 61 patients, 38 (62%) patients were managed with TT and antibiotics and 23 (38%) patients were managed with VATS and antibiotics.

The mean duration of ICU stay in TT group was 5.1±1.7 days and the mean duration of hospital stay in TT group was 7.5±2.3 days whereas the mean duration of ICU stay in VATS group was 4.4±1.4 days and the mean duration of hospital stay in VATS group was 6.2±1.3days. There was significance difference between VATS versus TT in

terms of duration of hospital stay ($t=2.39$, $p=0.02$) which suggested duration of hospital stay was less in VATS group. Time taken for removal of ICD in TT group was 4.5 ± 1.8 days whereas time taken for removal of ICD in VATS group was 3.7 ± 1.1 days with p value of 0.04 suggest that there was statistically significant difference between two treatment modalities and time taken for removal of ICD was less in VATS group. The mean time taken to become afebrile in TT group was 5.3 ± 2.3 days while in VATS group was 4.5 ± 0.9 days with p value of 0.09 suggest that there was no statistically significant difference between two treatment modalities.

DISCUSSION

PE is usually secondary to bacterial pneumonia which progresses to empyema thoracis due to many predisposing factors such as malnutrition, poverty, immunodeficiency, delay in initiation of treatment and poor compliance.⁴ The optimal management of empyema thoracis in pediatric age group has limited evidence and currently, there were insufficient data to give a clear guidance for therapy of parapneumonic effusion and empyema.^{4,8}

In present study of 61 patients, 39 (63.9%) patients were between 1 to 5 years, 5 (8.2%) patients were seen in infancy. Langley et al have found 3 to 5 years to be the commonly affected group.⁶ The higher incidence in children aged 1 to 4 years can be partly explained due to the increased susceptibility to *Staphylococcal* and *Streptococcal pneumonia*, which were the common cause of empyema. In study done by Sharma et al showing 2-3 years being the commonly affected group.¹⁰ In study done by Rao et al have found 1 to 5 years (58.3%) to be the commonly affected group.⁹

All the patients had fever and cough, respiratory distress was seen in 52 (85%) patients, chest pain was present in 11 (18%) patients whereas other symptoms (abdominal pain, vomiting) were present in 7 (11.5%) patients in present study. In study done by Gun et al fever (92%), cough (88%), chest pain (38%), dyspnea (64%) were present and in Kosar et al fever (87%), cough (79%), chest pain (46%), dyspnea (58%), abdominal pain (24%) was present.^{11,12} Empyema occurred more frequently on the right side 34 (55.7%) than the left 27 (44.3%) and bilateral empyema was not seen in the present study. In study done by Sharma et al, Mangete et al, Gun et al and Kosar et al showed similar results of more occurrence of empyema on right side.¹⁰⁻¹³

PF bacteriological growth was seen in 17 (28%) patients and *S. aureus* (11.5%) was the commonest organism cultured followed by *Pseudomonas* (4.9%) and *Stenotrophomonas* (4.9%) in this study. In study done by Barnes et al PF bacteriological growth was seen in 21% with commonest organism *S. pneumonia* and in study by Kosar et al PF bacteriological growth was seen in 49.5% with commonest organism being the *S. aureus*.^{12,14}

Similar results were also found in study done by Goyal et al showed PF bacteriological growth of *S. aureus* (34%) and in study by Rao et al showed PF bacteriological growth of *S. aureus* (17%).^{8,9} This high percentage of culture negativity was probably due to the prior treatment with antibiotics.

Out of 61 patients, 38 (62%) patients were managed with TT/ICD and antibiotics and 23 (38%) patients were managed with VATS and antibiotics. In study by Rao et al, 58 (80.5%) cases were treated by intercostals tube drainage and 7 (9.72%) cases were treated by ICT drainage and decortication and 8 cases was treated by aspiration due to the presence of small amount of pus.⁹ Chest tube drainage and intravenous antibiotic therapy might be adequate for stage 1 empyema. However, this approach was rarely effective in patients with stage 2 or 3 disease. Although there might be clinical improvement with drainage of the pleural space and antibiotic therapy, re-expansion of the entrapped lung was unlikely to occur in a significant number of cases and this ultimately led to surgical intervention.¹⁵

In present study, the mean duration of ICU stay in TT group was 5.1 ± 1.7 days and the mean duration of hospital stay in TT group was 7.5 ± 2.3 days where as the mean duration of ICU stay in VATS group was 4.4 ± 1.4 days and the mean duration of hospital stay in VATS group was 6.2 ± 1.3 days. There was significance difference between VATS versus TT in terms of duration of hospital stay ($t=2.39$, $p=0.02$) which suggested duration of hospital stay was less in VATS group. In a study by Cohen et al the median duration of stay was 15.4 days in patients treated with antibiotics and chest tube drainage and 7.5 days in VATS group where as in study by Sharma et al the mean duration of ICU stay in TT group was 16 ± 4.5 days and in VATS group was 9.3 ± 3.5 days.^{10,15}

Time taken for removal of ICD in TT group was 4.5 ± 1.8 days whereas time taken for removal of ICD in VATS group was 3.7 ± 1.1 days with p value of 0.04 suggested that there was statistically significant difference between two treatment modalities and time taken for removal of ICD was less in VATS group. In study done by department of pediatric surgery, Seth G. S. medical college and KEM hospital, Mumbai (2017), mean time of ICD was 5 to 7 days in VATS group and in study by Rao et al mean time of ICD was 11.9 days in TT group.^{7,9} The mean time taken to become afebrile in TT group was 5.3 ± 2.3 days while in VATS group was 4.5 ± 0.9 days with p value of 0.09 suggest that there was no statistically significant difference between two treatment modalities. In study done by Peter et al days to become afebrile after intervention in VATS group was 3.1 ± 2.7 while in ICD group was 3.8 ± 2.9 days; $p=0.46$ and in study by Sharma et al the mean time taken to become afebrile in TT group was 9.385 ± 3.477 days while in VATS group was 4.059 ± 1.638 days.^{10,16}

Limitations

The sample size was limited to make comparisons and to draw conclusions for the general population due to ongoing COVID-19 pandemic, logistics and time frame of the study. Study was conducted in a tertiary pediatric hospital where cases referred from other hospitals mostly with complications, so this population does not match with general population. CT scan of chest was not done in all the cases due to financial constraint as most of patients were belong to lower socioeconomic class.

CONCLUSION

Empyema is disease of young children, PF culture and sensitivity forms an important investigation tool in assessment of children with empyema and *S. aureus* was the commonest organism isolated and responded well with vancomycin. USG is better modality in cases of empyema to assess for fibrinous septa in PF and to differentiate free fluid from loculated fluid, estimate the amount of fluid and can readily distinguish PF from pleural thickening. ICD and antibiotics are effective method to facilitate drainage and resolution of empyema in resource poor settings. VATS is effective treatment for empyema when presented with stage 2 and stage 3 empyema having multiple loculation and hidden pockets and thickened pleura, which decreases duration of hospital treatment.

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