Pleural Effusion and Empyema Thoracis in Children - Bacterial Profile and Treatment Outcome

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ABSTRACT

BACKGROUND

Pleural effusions, parapneumonic effusions and empyema thoracis are known complications of bacterial pneumonia Underlying disorders as well as treatment approaches dramatically reduce the rate of morbidity and mortality in children.

METHODS

Forty-six children below 12 years of age admitted with pleural effusions or empyema thoracis between October 2016 and May 2019 were prospectively analysed. Thoracocentesis and pleural fluid specimens were checked within 30 minutes of collection, for anaerobic organisms. Daily thoracocentesis, intercostal tube drainage (ICD), open thoracotomy and decortication were performed among appropriate patients.

RESULTS

Patient required thoracocentesis in 14 (30.4%) cases with thin pleural fluid and tube drainage in 32 (69.6%) patients with frank pus. Four of fourteen children (28.5%) on serial thoracocentesis underwent ICD for failure of resolution. 4 of 32 (12.5%) cases on ICD required decortication. Median length of stay was 12.4 days for patients treated with serial thoracocentesis, 18.6 days for patients treated with ICD and 29.2 days for operated patients.

CONCLUSIONS

Conservative management (with either thoracentesis or tube thoracostomy) of pleural effusions or empyema thoracis with antibiotics covering *S. aureus* and *S. pneumoniae* along with ICD is safe and effective without the need for prolonged hospital stay. Surgical intervention is needed only when conservative approach fails.

KEYWORDS

Pleural Effusion, Empyema Thoracis, Decortications, Intercostal Tube Drainage

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DOI: 10.18410/jebmh/2020/50

Financial or Other Competing Interests: None.

How to Cite This Article:
Thokchom C, Laitonjam C, Nongmaithem MS. Pleural effusion and empyema thoracis in children- bacterial profile and treatment outcome. J. Evid. Based Med. Healthc. 2020; 7(5), 237-240. DOI: 10.18410/jebmh/2020/50

Submission 18-01-2020,
Peer Review 20-01-2020,
Acceptance 27-01-2020,
Published 03-02-2020.

BACKGROUND

Pleural effusions and empyema thoracis are known complications of bacterial pneumonia. Pleural effusions occur in approximately 40% of bacterial pneumonias with up to 60% of effusions progressing to empyema thoracis.[1,2] In recent years, there has been an increase in the incidence of childhood empyema thoracis and pleural effusions complicating pneumonia.[3,4,5,6] Staphylococcus aureus (*S. aureus*) and Streptococcus pneumoniae (*S. pneumoniae*) have been identified as the dominant causative organisms causing empyema thoracis in children.[7,8,9,10,11] The optimal management of pleural effusions and empyema thoracis in children remains controversial.[10,11] It is highly dependent on individual experience. In view of the above facts, the present study was undertaken to study the bacteriological outcome of pleural effusions and empyema thoracis in a teaching hospital of north eastern India. Poor yield on routine pleural fluid culture has also been reported.[12,13]

METHODS

A prospective study of 46 children below 12 years of age admitted with the diagnosis of pleural effusions or empyema thoracis was undertaken in the Cardiovascular and Thoracic Surgery unit, Regional Institute of Medical Sciences Hospital, Manipur, between October 2016 and May 2019. For the study purpose, pleural effusions or empyema thoracis was diagnosed if pleural fluid or thoracocentesis fulfilled at least one of the following criteria: a) frank pus, b) bacteria on Gram-stained smear, c) culture positive, d) polymorphonuclear cell predominance with glucose level <40 mg/dl and lactate dehydrogenase (LDH) level >1000 IU/L secondary to pneumonia.[14] Exclusion criteria included neonates, immunosuppressed children (HIV/AIDS), empyema thoracis secondary to other causes (tuberculosis, chest injuries, post-thoracotomy), patient demographics, presenting symptoms, duration of illness prior to admission, prior antibiotic therapy and clinical findings were studied. Nutritional status was classified according to weight for age as per Indian Academy of Paediatrics recommendation.[15]

In all the cases the following investigations were done-complete blood count, blood culture, chest radiography, pleural fluid analysis including Gram staining and culture. Ultrasonography (USG) and CT scan of the chest were done as and when required. Thoracocentesis was done in all the cases and pleural fluid specimen were transported immediately to the laboratory in closed syringes and inoculated on appropriate culture media within 30 minutes of collection for aerobic and anaerobic organisms. Drug sensitivity was tested in Disc diffusion method (Kirby Bauer). After thoracocentesis, all patients received parenteral ceftriaxone empirically. The antibiotics were subsequently changed depending on culture/sensitivity reports and/or clinical response.

Patients with thin pleural fluid were managed with daily thoracocentesis while those with frank pus were managed with intercostal tube drainage (ICD). Open thoracotomy and decortication was performed in those cases not responding to ICD. Patients were advised for follow-up at 1 month and 3 months after discharged for assessment of clinical and radiological improvement.

Statistical analysis was done using chi-square test and 'p' value of 0.05 was considered statistically significant. All the data were entered in a specially designed proforma.

RESULTS

During the study period 46 cases of pleural effusions or empyema thoracis were encountered constituting 0.82% of total paediatric admissions. Commonest age group involved was 1-3 years (52.2%) and the youngest patient was a 7-month old boy. Male to female ratio was 1.7:1 (Table 1). Approximately 89% of patients had significant symptoms for >2 weeks at the time of presentation. In 72% of cases various combinations of oral and/or parenteral antibiotics were administered but none underwent thoracocentesis prior to admission. Nearly two-thirds (69.6%) of patients hailed from rural areas. Among the presenting features, fever and dyspnoea were present in all the cases while cough and chest pain were present in 91.3% and 26% respectively. One six year old boy presented with left lateral chest wall bulging with systemic toxicity in addition to the above symptoms (Figure 1).

Various grades of protein energy malnutrition (PEM) Grade I-III were observed in 76.1% of cases but none had Grade IV. Chest radiograph revealed effusion occupying more than half of the hemithorax in all cases with a right sided predominance in 69.6% of cases. None had bilateral involvement. USG chest performed in 20 (43.4%) cases revealed multiple loculations in 4 cases of which two patients underwent CT scan of chest for confirmation.

Haemogram revealed mild to moderate anaemia. (Haemoglobin ranging from 7-11 g/dl) in 39 (84.6%) cases while three cases developed severe anaemia (Haemoglobin <7 gm/dl) during their hospital stay. Peripheral blood polymorphonuclear leucocytosis was present in 30 (65.2%) cases. Blood cultures were sterile in all cases. Thoracocentesis yielded frank pus in 32 (69.6%) cases which was putrid in 1 case. Glucose level of pleural fluid was <40 mg% in all cases while LDH level was >1000 IU/L in 39 (84.8%) case. Gram stained smears of pleural fluid revealed organisms in 7 (15.2%) cases while culture was positive in 4 (8.7%) cases. The dominant pathogen identified was *S. aureus* (Table 2).

Of the bacterial isolates, *S. pneumoniae* was resistant to ceftriaxone (empirically used antibiotic) while *S. aureus* was sensitive (Table 3). Owing to the poor culture yield all patients subsequently received ampicillin and cloxacillin combination in addition to ceftriaxone, were given empirically, due to non-availability of oral cloxacillin formulations. Only one patient failed to respond to the above antibiotic regimen but responded to piperacillin and tazobactam combination.

Initial therapeutic intervention undertaken was serial thoracocentesis in 14 (30.4%) cases with thin pleural fluid and ICD in 32 (69.6%) patients with frank pus. Four of fourteen children (28.5%) on serial thoracocentesis underwent ICD for failure of resolution of symptoms. Further 4 of 32 (12.5%) cases on ICD were subjected to open thoracotomy and decortication. Median length of stay in the hospital was 12.4 days (range 10-15 days, n=10) for patients treated with serial thoracocentesis; 18.6 days (range 14-25 days, n=32) for patients treated with ICD and 29.2 days (range 20-52 days, n=4) for patients who underwent open thoracotomy and decortication. One 6 year old boy died within 24 hours of admission before ICD could be instituted.

After discharge 37 (80.4%) patients came for follow-up at 1 month and 3 months of whom 34 were clinically well with complete radiological resolution while 3 patients had pleural thickening.

Age (Years)	Male		Female		Total	
	No.	%	No.	%	No.	%
< 1 yr.	4	8.7	2	4.3	6	13.0
1-3 yrs.	15	32.6	9	19.6	24	52.2
4-6 yrs.	7	15.2	5	10.9	12	26.1
7-9 yrs.	2	4.3	1	2.2	3	6.5
10-12 yrs.	1	2.2	-	-	1	2.2
Total	29	63.0	17	37.0	46	100

Table 1. Distribution of Empyema Thoracis Cases According to Age and Sex (n=46)

$\chi 2 = 0.75$; df = 4; P-value < 0.944

Gram Stain, Organism	No. of Cases	%
Staphylococcus aureus	3	6.5
Streptococcus pneumoniae	1	2.2
No growth	42	91.3
Total	46	100

Table 2. Profile of Bacteriological Isolates of Pleural Fluid by Culture (n=46)

Bacteria	Amikacin	Ceftriaxone	Ceftazidime	Cloxacillin	Gentamycin
S. aureus	S	S	S	S	R
S. pneumoniae	S	R	S	S	R

Table 3. Distribution of Drug Sensitivity Pattern of Culture Positive Bacteria

S = Sensitive; R = Resistant

Figure 1. Photograph Showing Empyema Thoracis Necessitatis (Left Chest Wall)

DISCUSSION

Despite advances in diagnostic facilities and availability of newer antibiotics, pleural effusions and empyema thoracis still remains a common source of morbidity in children in developing countries.[7,8,9] Incidence of pleural effusions or empyema thoracis in the present series was 0.82% which is consistent with a case series by Satpathy et al.[16] Nearly half of (52.2%) of the cases in our study were in the age group 1-3 years while a higher incidence (70.7%) in children below 2 years of age is reported.[8] Predominance of male children being affected in the present study is consistent with other studies.[8,10,13] Among the presenting symptoms, the most striking was chest wall bulging in a 6 year old boy which later was confirmed to be empyema thoracis necessitates.

Empyema thoracis necessitatis is a rare complication of empyema thoracis characterized by spontaneous dissection of pus from the pleural space into the chest wall.[17] Most cases result from inadequate or delayed treatment of empyema thoracis. Empyema thoracis necessitates due to S. pneumonia in a boy has been reported.[17] Majority (89%) of children in our series had significant symptoms for >2 weeks before presentation and 72% had received prior antibiotics which explains the poor yield on routine pleural fluid and blood cultures. Despite the poor yield majority of our cases responded to ceftriaxone and ampicillin/cloxacillin combination. The only exception was the patient with empyema thoracis necessitatis who developed fulminant sepsis despite ICD in addition to the above antibiotic regimen. Suspecting mixed infections on account of the putrid pleural fluid (on thoracocentesis), parenteral piperacillin and tazobactam combination was used which resulted in a dramatic response within 12 hours of initial medication.

While *S. aureus* and *S. pneumoniae* continue to be the dominant causative organism responsible for pleural effusion and empyema thoracis in children, anaerobic and mixed infections are also important aetiological agents.[7,8,9,10,11,18] Mainstay of therapy for childhood empyema thoracis is control of infection with appropriate antibiotics and adequate drainage of pleural fluid to facilitate lung expansion. Several treatment modalities are available for the management of pleural effusion and empyema thoracis depending upon the stage of the disease but optimal management of the paediatric empyema thoracis remains controversial.[19] Patients with thin pleural fluid can be managed with antibiotics and thoracocentesis, those with pleural exudates/frank pus needs ICD.[10,14] In our study, 32 (69.6%) were successfully managed with thoracocentesis and antibiotics while 10 (21.7%) cases responded to serial thoracocentesis. Early open thoracotomy and decortication has been suggested for childhood empyema thoracis to shorten hospital stay, minimize the long term use of antibiotics and prolonged chest tube drainage.[20] However it is a major surgical procedure and difficulties are often encountered in persuading patients to undergo surgery.[21]

The safety and efficacy of intrapleural fibrinolysis for pleural effusions and empyema thoracis in children is reported but financial constraints limits its use in developing countries.[9,11,22] In recent years, video assisted thoracoscopic surgery has been suggested as an effective and safe procedure with shorter hospital stay but its use may not be applicable in resource-poor settings with limited facilities.[23,24]

CONCLUSIONS

In the treatment of pneumonia, the possibility of pleural effusion and empyema thoracis must always be kept in mind. Conservative management of pleural effusions or empyema thoracis with antibiotics covering *S. aureus* and *S. pneumoniae* along with ICD is safe and effective without the need for prolonged hospital stay. Surgical intervention is needed only when conservative approach fails. In cases yielding frank pus with putrid odour, mixed infection is a possibility.

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