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August 2014

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## Recommended Citation

Saleem, A. F., Shaikh, A. S., Khan, R. S., Khan, F., Faruque, A. V., Khan, M. M. (2014). Empyema thoracis in children: clinical presentation, management and complications. *JCPSP: Journal of the College of Physicians and Surgeons Pakistan*, 24(8), 573-576.  
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# Empyema Thoracis in Children: Clinical Presentation, Management and Complications

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## ABSTRACT

**Objective:** To determine the etiology, clinical manifestation, management (medical and surgical) and complications of children with empyema thoracis in a tertiary care hospital from Karachi, Pakistan.

**Study Design:** Descriptive, analytical study.

**Place and Duration of Study:** Department of Surgery, The Aga Khan University Hospital, Karachi, from January 1996 to December 2010.

**Methodology:** Medical records of admitted children aged > a month to 15 years with discharge diagnosis of empyema thoracis and data was collected on demographic features, clinical manifestation, management and complications. Children managed medically were compared with those managed surgically by using interquartile range and median comparison. Mann-Whitney U test was used to compare age in months, weight (kg) and length of stay in days and presenting complaint, duration of illness; chi-square test was used to compare thrombocytosis in between groups and p-value was calculated.

**Results:** Among the 112 patients, 59 (53%) were younger than 5 years of age. Males (n=83, 74%) were predominant. Fifty (45%) children were admitted in winter. Thirty (27%) children found unvaccinated and one fourth (n=27; 24%) were severely malnourished. Fever, cough, and dyspnea were the major presenting symptoms. Sixty-six (59%) were on some antibiotics prior to admission. *Staphylococcus aureus* (n=13) and *Streptococcus pneumoniae* (n=5) were the commonest organism isolated from blood and pleural fluid cultures. Majority of the children required some surgical intervention (n=86). Surgically managed children were younger (p=0.01); had less weight (p=0.01) and prolonged fever (p=0.02); and stayed longer in hospital (p < 0.001) as compared to medically managed children. Requiring readmission (n=8), subcutaneous emphysema (n=5) and recollection of pus (n=5) were the major complications.

**Conclusion:** *Staphylococcus aureus* was the major organism associated with paediatric empyema thoracis. Early identification and empiric antibiotic as per local data is essential to prevent short and long-term complications. Younger, lower weight children with prolonged fever required surgical management.

**Key Words:** *Empyema in children. Tube thoracostomy. Decortication.*

## INTRODUCTION

Empyema thoracis (ET) is a serious infection of the pleural space. Despite the availability of broad spectrum antibacterial, improved vaccination coverage and availability along with better diagnostic tools; ET remains associated with high morbidity worldwide.<sup>1</sup> Pathologically, empyema develops in three stages; exudative, fibrinopurulent stage and organized stage.<sup>2,3</sup> The incidence of childhood ET has increased since last two decades while childhood pneumonia leading to empyema accounts for 0.6%.<sup>4,5</sup> There is a rise in the incidence of ET, partly because of multi-drug resistant pathogenic microorganism.<sup>5</sup> Delay in early diagnosis, failure to institute appropriate antimicrobial therapy, multi-

drug resistant organisms, malnutrition, comorbidities, poor health seeking behavior and high treatment cost burden contribute to increased morbidity in children.<sup>1,4-7</sup>

*Staphylococcus aureus* outnumber *Streptococcus pneumoniae* and *Haemophilus influenzae* (Hib) because of effective vaccine in developed countries.<sup>5,8</sup> Hib vaccine was included into Pakistan expanded programme on immunization (EPI) in 2008. This vaccine is highly effective and has enormous impact of Hib infection worldwide. At the time of writing this paper *Pneumococcus* vaccine was approved in the current vaccination schedule for all Pakistani children. Impact of vaccine after introduction would take at least 5 years. Among the top causes of ET in children, *Pneumococcus* and *Staphylococcus aureus* outnumber *Mycobacterium tuberculosis* and other gram negative bacteria.<sup>7</sup> It is essential to have microbiological diagnosis for the optimal management in empyema patients even though the low microbiological yield of pleural fluid,<sup>3</sup> that has led to increasing use of molecular methods for the detection of microorganisms by using polymerase chain reaction (PCR) technique.<sup>8</sup>

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Received: April 16, 2012; Accepted: April 22, 2014.

Optimal management of pediatric empyema is still controversial and the best management option is still not clear.<sup>9</sup> The available treatment options include intravenous broad spectrum antibiotics either alone or in combination with surgical procedure (thoracocentesis, chest tube drainage, fibrinolytic therapy, decortications with video assisted thoracoscopic surgery (VATS) and open drainage.<sup>10</sup>

There is dearth of knowledge regarding empyema or parapneumonic effusion (PPE) in Pakistan. There are very few centres with VATS availabilities and expertise in children. The aim of this study was to describe the clinical characteristics, bacterial etiology, management and complications in children with discharge diagnosis of PPE and empyema at The Aga Khan University Hospital, Karachi.

### METHODOLOGY

Medical records of all children (aged 1 month - 15 years) with discharge diagnosis of PPE and/or empyema at The Aga Khan University Hospital, Karachi, during the period from January 1996 to December 2010, were retrospectively reviewed.

Cases were selected by searching coded discharge records for the terminologies parapneumonic effusion and empyema with International Classification of disease (ICD-9) 510 and 511.9 respectively. Medical records were also retrieved by using ICD-9 procedure category for decortication and chest wall procedure (tube thoracostomy) 34.28 and 34.51.

Patients who were chronically ill, immunocompromised, underlying malignancy or on PPE/empyema treatment or had surgical procedure at the time of admission were excluded. Patients with non-infectious etiologies leading to pleural effusion and having chest tube thoracostomy or thoracotomy were also excluded. Data including medical record number, age in months, gender, vaccination status, antibiotic therapy prior to hospitalization, weight for age, presenting complaints, laboratory investigations (anemia,<sup>11</sup> leukocytosis (WBC > 10,000), thrombocytosis (platelet count > 400)); site of PPE (right, left or both), management procedure (surgical or medical management), isolated microorganism (bacterial cultures from blood and/or pleural fluid), duration of antibiotic and disease or procedure related complications were recorded. All patients received antibiotic therapy.

Statistical analysis was performed by using Statistical Package for Social Sciences (SPSS) version 19. Continuous variables including age (in months), weight on admission (kg), duration of presenting illness (i.e., duration of fever and cough), duration of hospital stay, duration of chest drain placement were mentioned in mean and standard deviation; however, categorical variables i.e., (gender, vaccination status, site of chest

involvement, laboratory parameters, presence of loculation, complications, follow-up duration and discharge disposition) were mentioned in frequency and percentages. Normality assumption was checked of the study parameters. Age, weight, presenting complaints (fever and cough) and length of stay were computed for interquartile range and median comparison. Mann-Whitney U test was used to compare age in months, weight (kg), and length of stay in days and presenting complaint, duration of illness; chi-square test was used for comparing thrombocytosis in between groups and p-value was calculated. P-value < 0.05 were taken as significant.

### RESULTS

A total of 112 children were discharged with diagnosis of empyema thoracis or parapneumonic effusion during 1996 to 2010. Mean age was  $71 \pm 54$  months (median 53 mon); 59 (53%) were five years or younger. Males were predominant (n=83; 74%); majority of them were admitted during winter season (n=50; 45%). Fever (n=106, 95%), cough (n=77, 69%) and shortness of breath (n=52, 46%) were the major presenting complaints. Thirty (27%) children did not receive any vaccination, while 27 (24%) were severely malnourished. Sixty-six (58%) were on some antibiotics when presented. Right side of chest was involved in 54% (n=61), left side in 41% (n=47) while 3% (n=4) patients had bilateral chest involvement on chest X-ray. Multi-loculated empyema was seen in 46 (41%) of patients. Blood and pleural fluid culture yield is shown in Table I. *Staphylococcus aureus* was the most common isolated organism (n=13). Six children had tuberculosis and on its treatment before admission; later on two pleural fluid cultures were positive for *Mycobacterium tuberculosis*.

Eighty-six (77%) children were managed surgically {(chest drain only (n=25; 29%); chest drain and decortication (n=59; 69%); chest drain, decortication and pneumonectomy (n=2; 2%)} while rests were managed with antibiotics and supportive treatment only. Surgically managed children were younger (p=0.01); had prolonged history of fever (p=0.02); had more cough and less weight (p=0.01) as compared to the children managed medically. Table II shows the differences in both groups. Children managed medically has shorter length of stay (p = < 0.001) and less thrombocytosis (p=0.06) compared to children managed surgically. Forty-one (37%) patients were discharged with chest drain, and total duration of chest drain was  $12 \pm 11$  days. Eight patients were readmitted within 72 hours of discharge. Fifteen patients developed complications {subcutaneous emphysema (n=5); recollection of pus (n=5); rib osteomyelitis (n=2); bronchopulmonary fistulae (n=2); and pneumatocele (n=1)}. Most of the patients (80%) were followed-up in the clinic for 4 - 6 weeks.

**Table I:** Isolated from bacterial blood and pleural fluid culture.

Microorganism	Pleural fluid (n)	Blood (n)
<i>Staphylococcus aureus</i>	11	2
<i>Staphylococcus epidermidis</i>	3	2
<i>Streptococcus pneumoniae</i>	3	2
<i>Pseudomonas aeruginosa</i>	3	1
<i>Klebsiella pneumoniae</i>	1	2
<i>Haemophilus influenzae</i>	--	3
<i>Enterobacter species</i>	--	2
<i>Mycobacterium tuberculosis</i>	2	--
<i>Salmonella typhi</i>	1	--
<i>Acinetobacter species</i>	1	--
<i>Enterococcus species</i>	1	--

(n) number of patients.

**Table II:** Comparison of medical and surgically managed children.

	Only managed medically (n = 26)	Surgically intervention (n = 86)	p-value**
Age (mo.)*	96 (107.3)	45 (79)	0.01
Weight (kg)*	24 (18)	14 (13.2)	0.01
Presenting complaint (days)*			
Fever	6 (12.8)	15 (20.3)	0.02
Cough	14.5 (94)	15 (93)	0.80
Thrombocytosis (%)***	9 (36.4%)	49 (56.9.3%)	0.06
Length of stay (days)*	5 (6.3)	9 (7)	< 0.001

\* Median (inter quartile range); (n) number of patients; \*\* Mann-Whitney U-test for age, weight and length of stay, days with presenting complaints; \*\*\* Chi-square test for thrombocytosis.

**Table III:** Children with PPE complications (n=112).

Readmission	8 (7%)
Subcutaneous emphysema	5 (4%)
Recollection of pus	5 (4%)
Bronchopulmonary fistulae	2 (2%)
Rib osteomyelitis	2 (2%)
Pneumatocele	1 (1%)

Three patients died; 2 admitted with severe pneumonia and empyema and respiratory failure, found to be necrotizing pneumonitis and one with severe sepsis, and disseminated intravascular coagulation.

## DISCUSSION

Parapneumonic effusion (PPE) and empyema thoracic (ET) are the sequels of pneumonia and occurred mostly with inappropriate management of pneumonia (inappropriate antimicrobial choice, dosing and interval; delayed treatment strategy); or/and with poor host response against virulent organism (i.e., immunosuppressed patients).<sup>2</sup> In most of the developing countries including Pakistan problematic functional infrastructure (primary health care services and basic health units), unsatisfactory vaccination coverage, high tuberculous prevalence along with high chronic malnutrition might increase the chance for empyema.<sup>12</sup>

The incidence of ET ranges between 0.6 - 0.8% in subcontinent region;<sup>13</sup> however, there is lack of literature regarding ET incidence and/or prevalence in Pakistani

children. Infants and children, because of certain features, tend to develop ET more as compared to older children.<sup>5,13,14</sup> This holds true for our study population, where younger children developed more disease as compared to elder. The disease is more prevalent in winter season.<sup>5</sup> Males were predominant in our study as also mentioned elsewhere.<sup>5,14</sup> Certain factors i.e., severe malnutrition (stunting and undernutrition), unvaccinated child, inappropriately managed pneumonia, immunodeficiency, overcrowding and poverty are associated with ET in children.<sup>3,9,13,15,16</sup> Severely malnourished children predisposed to recurrent pathogenic microbial infections of respiratory and gastrointestinal tract of varying intensity compared to normal to moderately malnourished children.<sup>12</sup> One of the major predisposing factors of ET in our study population could be severe malnutrition, which has been observed in the previous studies.<sup>13,15</sup>

EPI-Pakistan has introduced the *Haemophilus influenzae* vaccination in 2008 and *pneumococcal* vaccination is now able to make its place in the current vaccination. At the time of writing this manuscript, a majority of Pakistani population has access to EPI available pneumococcal (PCV 10) vaccine. Two-third of this study population were unvaccinated and majority of them were found unvaccinated for *H. influenzae*. Both *H. influenzae* and *pneumococcus* culture yield was very low, therefore it is difficult to estimate the disease burden on the basis of culture positivity.

Culture yield for pleural fluid was very low (ranging 3 - 33%).<sup>17,18</sup> The pleural fluid culture yield was 29% (Table I). Poor yield could possibly be because of prior antimicrobial therapy and/or less bacterial inoculum in the collected sample. *Staphylococcus aureus* and *Streptococcus pneumoniae* remains the major bacterial etiologic microorganisms reported worldwide.<sup>5,8,19</sup> *Staphylococcus aureus* has been the most isolated bacteria in this study cohort. Five patients' cultures were positive for *Streptococcus pneumoniae*. Serotyping could not be done, however, the data suggest that serotype 1, 14 and 3 are the commonest serotypes.<sup>14</sup> *Mycobacterium tuberculosis* is endemic in Pakistan. Every year many children and adults are infected with this slow growing but highly morbid microorganism which causes empyema in adults as well as in children.<sup>7</sup> Six patients had tuberculosis. Almost all patients were symptomatic 2 weeks before developing empyema and were on antituberculous therapy.

Most of the children were managed surgically in our study cohort. Clinical features like lethargy, persistent spiking of fever with increased respiratory distress, along with progressive fluid accumulation on Radiology despite broad spectrum antibiotic cover warrants immediate evacuation of pleural content and also to re-expand the lung.<sup>3</sup> Children who are younger and having

symptoms for a longer duration were managed with surgical intervention along with medical management in this study cohort with significant statistical value (Table II). Unfortunately, there is no definite point at which one should proceed for surgical drainage; however, one should consider the above-mentioned measures as to proceed for surgery. It is reported that only 10% of patients with PPE required needle or tube drainage, but it is also important not to delay this as it can become loculated or organized and then difficult to drain.<sup>8</sup> Children who required surgical intervention may be because of wrong antibacterial drug and/or dosage, their poor response to initial antibacterial therapy and/or virulence of microorganism. Children managed surgically found to be younger in our study cohort. VATS is far better than conventional open drainage in children.<sup>20</sup> The possible reason might be that they were sicker and needed immediate surgical intervention.

There were certain limitations of this study. It was one center study therefore; results should be generalized with caution. Because of retrospective nature of chart review, authors were dependent on the physicians' documentations. There were certain missing information; however, all the possible measures were taken to collect the information.

### CONCLUSION

Paediatric empyema thoracis is associated with increased morbidity. Early recognition is the key leading to optimum management, which depends upon the stage at presentation. Every case of pneumonia should be managed with high index suspicion and should be followed.

**Acknowledgement:** Dr. Ali Faisal Saleem received research training support from the National Institute of Health's Fogarty International Center (1 D43 TW007585-01).

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