

Original Research Article

Risk factors associated with adverse outcome in empyema thoracis children aged 1 month-12 years in a tertiary care centre: a nested case control study

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ABSTRACT

Background: Empyema thoracis (ET) is serious complication of pneumonia in children, treatment outcome depends upon many risk factors. Empyema thoracis is a serious infection of the pleural space. Despite the availability of broad spectrum antibacterial, improved vaccination coverage and better diagnostic tools, ET remains associated with high morbidity worldwide. This study was undertaken to identify risk factors associated with poor outcome and to describe etiological agents.

Methods: This nested case control study was conducted at Institute of Child Health and Hospital for Children, Egmore, and Chennai from January 2011 to October 2012 in age group from 1 month to 12 years attending with clinical/radiological evidence of empyema. Cases children with complications and controls without complications. Basic investigations, ultrasonogram chest, pleural fluid gram stain/ culture and blood culture done. Antibiotics started empirically and changed based on culture and sensitivity. Intercostal drainage (ICD) was inserted with an underwater seal. Demographic data and other variables analysed were haemoglobin, persistent positive CRP, serum albumin level, pleural fluid gram stain, culture and sensitivity, imaging like ultra-sonogram, CECT, X-ray chest after ICD insertion.

Results: Of 90 empyema cases, 26 recovered without complication, 56 recovered with complication, 8 died. Logistic regression uses to find association between variables and complications. Risk factors significantly associated with complications were persistent positive CRP, pleural fluid gram stain, imaging ultra-sonogram chest showing loculations, CECT scan showing pleural thickening and X-ray chest after ICD insertion.

Conclusions: Independent risk factors associated with complications were X-ray chest after ICD insertion showing non-resolution, ultrasonogram revealing loculations and septations. Early diagnosis, appropriate antibiotics and timely intervention helps in reduction of empyema and complications.

Keywords: Complications, Empyema, Risk factors, Ultrasonogram, X-ray chest

INTRODUCTION

Empyema thoracis (ET) is a serious infection of the pleural space. Despite the availability of broad spectrum antibacterial, improved vaccination coverage and better

diagnostic tools, ET remains associated with high morbidity worldwide. Pathologically, empyema develops in three stages; exudative, fibrinopurulent stage and organized stage.¹ The rise in the incidence of ET, is because of multi-drug resistant pathogenic

microorganism. Delay in early diagnosis, failure to institute appropriate antimicrobial therapy, multidrug resistant organisms, malnutrition, comorbidities, poor health seeking behavior and high treatment cost burden contribute to increased morbidity in children. Optimal management of pediatric empyema is still controversial and best management option is still not clear. 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.² There is dearth of knowledge regarding risk factors and etiological agent's causative of empyema in south India. The aim of this study was to identify the risk factors associated with poor outcome and also to describe the etiological agents in children. The aim of the study was to study the risk factor and etiological agents associated with empyema in children with aged 1 month-12 years and their outcome.

METHODS

The study was conducted at the Institute of Child Health and Hospital for Children, Egmore, Chennai from January 2011 to October 2012 and our study design is nested case control study. IRB approval from Madras Medical College was obtained. Children were enrolled in the study after obtaining informed consent from the parents.

Inclusion criteria was children aged 1 month-12 years with clinical, radiological evidence suggestive of empyema with or without complications and confirmed by the presence of frank pus on thoracocentesis have been included in the study. Exclusion criteria were care givers who did not give consent.

Detailed history including age, sex, diet, demographic features and clinical features were elicited and thorough clinical examination was done. Investigations- CBC, Blood sugar, RFT, LFT, CRP, ESR, Chest X-ray, ultrasound chest, Mantoux, blood culture, pleural fluid analysis with gram stain, AFB, and cultures were done.

Chest x-ray helps in identification of significant amount of pleural fluid. Ultrasonography can be used to localize fluid for a thoracocentesis. Fluid appears dark or black on ultrasound images, and most bedside ultrasonography devices permit measurement of the depth of location from the chest wall. CT scanning of the chest with contrast enhances the pleural surface and assists in delineating the pleural fluid loculations.³ Thus imaging studies plays a major role in identification of empyema and its complications.

Antibiotics were started in all cases initially depending upon suspected etiological agent. Antibiotics were changed based on blood or pus culture reports. ICD tube drainage done with an appropriate sized mallecot tube

with an underwater seal placed in the most dependant position, at the point of maximum dullness on percussion was inserted for patients with empyema related complications. ICD was kept in situ till the drainage is less than 30-50 ml per day and the cavity is less than 50 ml in size.

Cases that showed multiseptation, bronchopleural fistula or non-improvement with this treatment were subjected to thoracotomy or decortication surgery. Patient was discharged after clinical recovery with oral antibiotics for two weeks. Recovery of empyema is total clearance of pus with satisfactory lung expansion necessitating the removal of ICD tube. Complications of empyema include prolonged drainage of pus, bacteraemia, unsatisfactory lung expansion, pleural thickening or fibrosis, Scoliosis, thoracotomy, decortications, bronchopleural fistula and death.

Statistical analysis

Chi square test was used to identify the relation between each of the factors with empyema (p -value <0.05). Univariate analysis was used to study the association between risk factors and complications. Multivariate analysis was used to adjust for the confounders. Logistic regression was used to identify significant factors associated with complications.

RESULTS

Total number of patients admitted in the hospital during the study period was 65056. Number of empyema patients participated in the study was 90. Of which 26 recovered without complications and 56 recovered with complications and 8 patients died.

The number of patients admitted for empyema were 68.2% in less than 3 years but complications were more in age group >3 years with 79.2% in our study. Statistically no significant difference was noted in socioeconomic status and nutritional status in our study (Table 1).

Empyema related complications was more noted in hemoglobin <10 gm (74%) but no statistical significance was observed in present study. No statistical significance was noted in serum albumin levels in our study (Table 2). Strong statistical significance was noted in persistent positive CRP ($p<0.001$) and gram stain ($p=0.02$) variable in present study.

Though Pleural fluid culture positive growth was seen in 34 children compared to 56 children who showed no growth but 73.5% showed positive growth in empyema associated with complications with no statistical significance (p value=0.6) (Table 3).

Empyema patients who did not improve in chest X-ray after ICD insertion developed more complications

(83.3%) with statistical significance ($p < 0.0001$). Highly statistical significance was noted in imaging studies USG

chest showing loculation ($p < 0.001$) and CECT chest revealing pleural thickening ($p < 0.000$) (Table 4).

Table 1: Demographic factors.

Variables	Category	Complication status n (%)		χ^2	Odds ratio (95% CI)	p value
		With complication	Without complication			
Age	<3 years	45 (68.2)	21 (31.8)	1.03	0.56 (0.18 to 1.71)	0.31
	>3 years	19 (79.2)	5 (20.8)			
Socio-economic status	Lower [¥]	36 (70.5)	15 (29.5)	0.02	0.94 (0.37 to 2.36)	0.9
	Other than lower	28 (71.8)	11 (28.2)			
Nutritional status	Under nourished [©]	29 (70.7)	12 (29.3)	0.01	0.96 (0.38 to 2.4)	0.9
	Not undernourished	35 (71.4)	14 (28.6)			

[¥] = Lower socio-economic status included class IV/V of Kuppuswami scale; [©] = Undernutrition is classified according to WHO classification

Table 2: Investigations.

Variables	Category	Complication status n (%)		χ^2	Odds ratio (95% CI)	p value
		With complication	Without complication			
Hemoglobin level(gm/dl)	<10	54(74.0)	19(26.0)	0.9	1.98 (0.6 to 5.96)	0.21
	>10	10(58.8)	7(41.2)			
Serum Albumin	<2.5 gm	27(71.1)	11(28.9)	0.05	0.99 (0.39 to 2.5)	0.9
	>2.5 gm	37(71.2)	15(28.8)			

Table 3: Microbiological pattern.

Variables	Category	Complication status n (%)		χ^2	Odds ratio (95% CI)	p value
		With complication	Without complication			
Persistent Positive CRP	Yes	29 (96.7)	1 (3.3)	14.30	20.71 (2.6 to 162.2)	<0.001 HS
	No	35 (58.3)	25 (41.7)			
Gram Stain	Positive	32 (61.5)	20 (38.5)	5.49	0.3 (0.1 to 0.8)	0.02 HS
	Negative	32 (84.2)	6 (15.8)			
Pleural Fluid Culture	Positive growth	25 (73.5)	9 (26.5)	0.16	1.2 (0.46 to 3.13)	0.6
	No growth	39 (69.6)	17 (30.4)			

Table 4: Imaging.

Variables	Category	Complication status n (%)		χ^2	Odds ratio (95% CI)	p value
		With complication	Without complication			
X ray chest after ICD tube	Not Improved	60 (83.3%)	12 (16.7%)	26.17	17.5 (4.9 to 62.4)	<0.0001
	Improved	4 (22.2%)	14 (77.8%)			
USG Chest	Loculation	59 (92.2)	5 (7.8)	47.9	49.6 (13.03 to 188.5)	<0.001 HS
	No loculation	5 (19.2)	21(80.8)			
CECT Chest	Pleural thickening	52 (96.3)	2 (3.7)	52.03	130 (22.0 to 766.28)	<0.0001 HS
	No pleural thickening	4 (16.7)	20 (83.3)			

From the logistic regression model, that was identified persistent positive CRP, gram stain, USG chest, CT scan chest and X ray chest post ICD as risk factors for complication in empyema patients (Table 5). These factors were subjected to multivariate logistic

regression, and USG Chest showing loculations, septations and X-ray Post ICD revealing nonresolution of empyema were identified as predictors for identification of complications in empyema.

Table 5: Predictors of complications in empyema-multivariate logistic regression analysis.

Variables	Odds Ratio		95% Confidence interval	p value
	Crude	Adjusted		
Persistent Positive CRP	20.7	2.852	0.288 to 28.28	0.371
USG Chest	49.5	30.787	5.228 to 181.311	<0.0001
Gram stain	0.3	0.182	0.030 to 1.094	0.063
CT Chest	130	0.181	0.015 to 2.124	0.174
X ray Post ICD	17.5	12.883	1.156 to 143.582	0.038

DISCUSSION

This study was conducted at a tertiary hospital where cases are referred from various district hospitals. The optimal management of empyema thoracis in paediatric age group is controversial and British thoracic surgery came out with guidelines for management of empyema.⁴ This study was done to find out the risk factors and etiological agents associated with bad outcome in empyema.

Of the 90 patients included in the study were age groups between 1 month-12 yrs. The number of patients admitted for empyema with complications were 68.2% in less than 3 years but complications were more in age group >3 years with 79.2% in our study which was unusual compared with the studies done by S.K.Sathpathy ,et al and Muhammad Salim et al.^{5,6}

70.5% of children belong to lower socioeconomic class in complications group compared to 71.8% in other than low socioeconomic class probably due to increased referral from private hospitals due to better existing infrastructure in government hospital to anticipate and treat the complications arising compared to studies done by Sathpathy et al.

Not undernourished (71.4%) was more in present study compared to undernourished probably due to WHO criteria taken for assessment of undernutrition as mentioned in inclusion criteria age group was 1 months to 12 years compared to studies Menon et al and Shah et al.^{7,8}

Anemia (HB<10mg/dl) was significantly associated with complication related to empyema indicating their poor nutritional status compared to other studies done by Menon et al.⁷ Persistent positive CRP was defined as CRP persisting >6 mg even after initiation of antibiotics 96.7% were significantly positive even after 1 week thus

helps in prognosticating complications and adequacy of treatment compared to study done by Embyia et al.⁹ Plasma CRP level is a sensitive marker not only in the diagnosis of parapneumonic empyema, but also in the management of treatment response.¹⁰

Gram stain was negative in 84.2% of patients compared to 61.5% gram positive patients in empyema associated with complications due to early initiation of antibiotics outside before referral to hospital.

Though Pleural fluid culture positive growth was seen in 34 children compared to 56 children who showed no growth but 73.5% showed positive growth in empyema associated with complications with no statistical significance (p=0.6) due to partial/inadequately treated pneumonia outside where pleural fluid culture plays a major role in identification of organism.¹¹ In present study, the most common organism isolated was Staphylococcus aureus and it was more in <3 years and common in low socioeconomic status compared to study done by Dass et al where streptococcus pneumonia was the predominant organism.¹² Immunisation plays a major role in reduction of empyema and its complications compared to study done by Karen D Schultz et al where staphylococcus was the most predominant organism and pneumococcal vaccination heled in preventing complications.¹³

Chest X-ray helps in identification of significant amount of pleural fluid. Ultrasonography can be used to localize fluid for a thoracentesis. Fluid appears dark or black on ultrasound images, and most bedside ultrasonography devices permit measurement of the depth of location from the chest wall. CT scanning of the chest with contrast enhances the pleural surface and assists in delineating the pleural fluid loculations. Thus, imaging studies plays a major role in identification of empyema and complications of empyema. Empyema patients which did not improve after ICD insertion developed more

complications (83.3%) with high statistical significance (p value <0.0001) suggesting nonresolution of empyema and its complications. Highly statistical significance was noted in imaging studies USG chest (p value <0.001) and CECT chest (p value <0.000) compared to studies done by Givan et al and Aquino et al.^{14,15}

From the logistic regression model, we identified persistent positive CRP, gram stain, USG chest, CT scan chest and X-ray chest post ICD as risk factors for complication in empyema patients (Table 5). These factors were subjected to multivariate logistic regression, and USG Chest showing loculations and X-ray Chest Post ICD revealing nonresolution of empyema were identified as independent risk factors for complications.

Limitations

In present study, smaller sample size which could not be generalized to general population. This study was done in a tertiary institute where cases have been referred mostly with complications. Anaerobic culture and latex agglutination were not done in current study.

CONCLUSION

Out of 90 empyema cases, 26 children improved without complications and 64 had complications like death, decortication, pleural thickening and bronchopleural fistula. *Staphylococcus aureus* was the most common organism isolated. Ultrasonogram showing loculations and X ray chest post ICD showing non-resolution of empyema and its complications are predicted as independent risk factors. Thus, early identification of risk factors and etiological agents associated with empyema helps in early diagnosis and aid in proper treatment of pneumonia so chances of empyema and their complications are minimised.

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Ethical approval: The study was approved by the Institutional Ethics Committee of IRB, Madras Medical College

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