Parapneumonic empyema in children: conservative approach

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Forty-nine patients, aged 3 months to 13 years, were studied to determine the clinical presentation, bacteriology, treatment and outcome of empyema complicating pneumonia in children. There were 28 (57.2%) males and 21 (42.8%) females in the study, with a male/female ratio of 1.3/1. We found malnutrition in 15 (30.6%) patients. The most common symptoms at presentation were fever (93.8%) and cough (85.7%). Radiography demonstrated minimal effusions (6 patients, 12.2%), moderate effusions (23 patients, 46.9%), and massive effusions (20 patients, 40.9%). The pleural fluid was on the right side in 26 (53.1%) cases, the left side in 17 (34.6%) cases, and bilateral in 6 (12.3%) cases. Staphylococcus aureus was the most frequently isolated microorganism in pleural fluid. No organism was recovered in 33 (67.3%) patients. Most cases were treated with a combination of intravenous antibiotics and chest tube drainage. Decortication was carried out in only two patients. The hospitalization period was 28.02±10.18 days (11 to 57 days). There was one death due to widespread Staphylococcus aureus septicemia. All patients who were followed-up showed complete or near complete resolution of the chest radiography at six months, regardless of severity of disease or treatment modality. Children with pleural empyema can be successfully treated with appropriate antimicrobial therapy and adequate closed chest tube drainage. Further surgical intervention is rarely required.

Key words: parapneumonic empyema, chest tube drainage.

Pleural empyema is the presence of grossly purulent fluid in the pleural space. It is usually a result of an antecedent bacterial pneumonia. However, other etiologies including esophageal rupture, mediastinal or subdiaphragmatic disease, neoplasm, bacteriemia, chest trauma, thoracic surgery, collagen vascular disease, and immunodeficiency disorders should be considered[1]. Three distinct stages of progression of an empyema have been described. The first stage (stage I) is exudative and is characterized by free-flowing fluid that can easily be drained. The second stage (stage II) is fibrinopurulent with the formation of septations and loculations. Tube drainage would be very difficult in this stage. The final stage (stage III) is organization in which surgical debridement is considered by some to be the only treatment option[2,3].

Recent advances in imaging and instrumentation have facilitated the recognition and management of bacterial empyema[2,4,5]. Despite such rapid advances in diagnosis and therapy, it is still possible for an empyema to remain undetected unless the risks of this complication are appreciated and appropriate diagnostic measures are used. Although currently available antimicrobial agents can control some of the systemic manifestations of empyema, the morbidity and mortality caused by undrained pleural pus are still high[6-9]. Therapeutic decisions are made more difficult by wide variations in the disease spectrum, perhaps resulting from variables such as virulence of infecting organism, host resistance and timing of presentation for treatment[10].

In this study, we reviewed medical records of children with pleural empyema to examine the spectrum of the disease and to evaluate the role of surgical and nonsurgical management.

Material and Methods

The medical records of 49 children who had been discharged with the diagnosis of pleural empyema between January 1990 and January

2000 were reviewed. In the clinical setting of pneumonia, empyema was defined as pleural fluid demonstrated on chest radiography that contained >1000, white blood cells (WBC) count µl or from which an organism could be cultured.

After detailed history was obtained, physical examination was performed in all patients. The patients whose weights according to age were below 90th percentile were accepted as malnutrition[11]. Routine laboratory studies were performed for all patients including WBC count, sedimentation and blood cultures. C-reactive protein (CRP) was available in 42 (85.7%) patients. Fifteen patients were tested for the presence of IgM against Mycoplasma pneumoniae with ELISA (R-Biopharm GmbH, Darmstadt, Germany). Pleural fluid was analyzed for WBC count, glucose, protein and lactate dehydrogenase (LDH) concentrations and pH. Routine bacteriologic studies were also performed in pleural fluid. Anteroposterior and lateral chest radiographs were obtained. The degree of pleural involvement was classified into one of the following three categories: 1. Minimal: some costophrenic angle blunting or slight pleural thickening, 2. Moderate: opacity involving up to half of the hemithorax, or 3. Massive: opacity over more than half of the hemithorax[12]. Chest ultrasound was performed in 26 patients and computerized tomography (CT) in 18 patients. Most of the patients who had ultrasonography (USG) and/or CT admitted after 1995.

Data regarding hospital course included fever curve, total number of invasive procedures, duration of chest tubes, length of stay and complications. Statistical analysis was performed using Student's t test. A p valuve <.05 was considered significant.

Results

Of the 49 patients, 28 (57.2%) were boys, 21 (42.8%) were girls, and the ages of the patients ranged from 3 months to 13 years (mean age 4.5±3.4 years). The peak incidence was in the 0-4 years age group. The majority of patients were healthy children before the onset of their acute illness. We found malnutrition in 15 (30.6%) patients. Five patients had mild, six patients had moderate and four patients had severe malnutrition. Fourteen patients admitted directly to this hospital and 35 patients were transferred from other hospitals after a period of five to 15 days (mean 7.8±3.7 days). Children were ill on average for 8.3±2.1 days before hospital admission.

The most common symptoms at clinical presentation were acute illness with fever (93.8%) and cough (85.7%). Abdominal pain was seen in five (10.2%) patients and explained the misdiagnosis of an acute abdomen made for three of our patients. Dyspnea and tachypnea were found in 36 (73.4%) patients.

The mean peripheral WBC count was above 15,000/mm^3 in 31 (63.2%) patients. A moderate-to-marked degree of anemia was found in 24 (48.9%) patients. Increased erythrocyte sedimentation rate was present in all patients. Elevated values of CRP were found in 39 (92.8%) of 452 patients. Protein concentrations in pleural fluids obtained from patients ranged from 3.9 to 5.4 g/dl (4.7±0.8 g/dl). Glucose concentrations in pleural fluids ranged from 11 to 78 mg/dl (34.4±17.2 mg/dl), and LDH concentrations ranged from 450 to 1595 IU/L (710±230 IU/L). Total WBC counts in pleural fluids varied from 500/mm^3 to 26,000/mm^3 (12,500±4100/mm^3).

The effusions seen on initial chest X-rays were minimal in six patients (12.2%), moderate in 23 patients (46.9%) and massive in 20 patients (40.9 %). Right-sided effusions were most common. Empyema was right-sided in 26 (53.1%) children, left-sided in 17 (34.6%), and bilateral in six (12.3%). Four children had associated cardiomegaly. Chest USG revealed the following: non-loculated collections (n=19), pleural thickening (n=8), and loculated fluid (n=7). Computerized tomography showed non-loculated fluid (n=13), pleural thickening (n=5), loculated fluid (n=5), and lobar cavitation (n=3).

Gram strains of pleural fluid were positive in 13 (26.5%) patients. Eight of these were also culture positive. The most common bacterium isolated from the pleural aspirate was Staphylococcus aureus (Table I). The blood cultures were sterile in only three patients. In four of the patients with bilateral empyema, Staphylococcus aureus was isolated, and in two patients there was no microorganism in pleural fluid. Streptococcus pneumoniae was isolated from the blood cultures in two patients and Staphylococcus aureus was in one of the patients as well. Three patients had Mycobacterium tuberculosis. One patient had positive Mycoplasma pneumoniae serology. All patients whose pleural fluid and blood cultures were sterile had received antibiotics prior to thoracentesis.

Table I. Bacteriologic results in patients with pleural empyema

Organism	No. patients (%)
Staphylococcus aureus	6 (12.24)
Streptococcus pneumoniae	4 (8.16)
Mycobacterium tuberculosis	3 (6.12)
Staphylococcus epidermidis	1 (2.04)
Pseudomonas aeruginosa	1 (2.04)
Mycoplasma pneumoniae (serology)	1 (2.04)

All patients were treated intravenously with systemic antibiotics. A third generation cephalosporin or a ureidopenicillin with an aminoglycoside was the most frequently used combination in the patients. Three patients were treated successfully with antibiotics alone. These patients had minimal effusions on initial chest X-rays. Forty-six patients had chest tubes placed through a closed thoracotomy within one day of admission. The chest tubes functioned for 3 to 11 days (mean 7.1±2.4 days) and were removed after 6 to 19 days (mean 12.2±1.9 days). Only two patients required drainage beyond five weeks. WBC count decreased by the end of the first week. Inflammatory markers such as CRP and erythrocyte sedimentation rate remained elevated for up to three weeks despite treatment in four patients. They had persistent fever requiring a prolonged hospital stay. Two patients had decortication of thickened pleura, which prevented lung expansion. One patent underwent decortication on the 42nd day of admission and the other on the 45th day.

Hospitalization ranged from 11 days to 57 days (mean 28.02±10.18) days). The massive and moderate effusions presented earlier than minimal and, as might be expected, massive effusions led to longer hospitalization (Table II). There was a statistically significant difference in duration of hospitalization between patients with massive effusion and patients with minimal effusion ($p<0.001$). In seven patients who had loculated fluid demonstrated in the pleural cavity by USG and CT, the duration of hospitalization was also prolonged (mean 34.1±5.6 days).

Table II. Parapneumonic effusions data

Size of effusions	No.	Mean hospital stays (days)
Minimal	6	13±1.79
Moderate	23	27.91±7.04
Massive	20	32.65±10.47*

* $P<0.001$.

One patient with empyema with Staphylococcus aureus had broncho-pleural fistula and two patients had wound infections at the exit site of the chest tube. Only one patient died due to widespread Staphylococcus aureus septicemia. The patient had purulent pericarditis and renal abscess as well. Thirty-nine (81.25%) of 48 survivors were seen after discharge. Follow-up ranged from one month to three years (mean 1 year). Chest X-rays, performed at 3rd month after hospital discharge, were normal in only five patients. All patients showed complete or near-complete resolution of abnormalities related to the empyema in the 6th month after discharge in chest radiography, regardless of severity of disease or treatment option.

Discussion

Despite the availability of broad-spectrum antibiotics, empyema remains a significant problem in pediatrics[13]. Pleural empyema continues to contribute significantly to the mortality rates among the poor in developing countries[14]. In this study the maximum incidence of this disease was in the age group of 0.4 years. This agrees with the findings of the other authors[14-15]. The predominance of males has been described previously[12,16]. Our study also demonstrated predominance of the male gender.

The peripheral WBC count was elevated in most patients on admission. Increased erythrocyte sedimentation rate were observed in all patients. Increased CRP concentrations were found in 39 (92.8%) patients. These results agree with the findings of other studies[10,14,17].

Classically Staphylococcus aureus has accounted for the greatest proportion of cases of pediatric empyema[14,16,18]. Nelson[19] reported that 54% of the empyemas in children <6 months of age were caused by Staphylococcus aureus. Staphylococcus aureus was the most common organism isolated from the pus obtained at thoracentesis in our patients. Empyema resulting from pulmonary tuberculosis was found in three patients, and they were treated with antituberculous drugs. Purulent tuberculous empyema is rare and usually follows a long history of unsuccessful medical and/or surgical therapies[6]. Three patients with tuberculous empyema had malnutrition and had been managed with unsuccessful medical therapies before hospital admission. Protein-energy malnutrition is seen as associated

illness[20,21]. Ghosh et al.[22] described that a large majority of children with empyema were victims of malnutrition (73.2%) and mortality was high (17.1%). Malnutrition was detected in 30.6% of our patients.

Prior antibiotic therapy reduces the frequency of positive cultures[6]. Hoff and co-workers[10] reported that 71% of patients with sterile empyemas had received antibiotics before cultures were performed. Our results supported their findings.

When empyema is suspected, it is necessary to characterize the size and extent of the fluid collection and determine whether loculations and septations are present. Ultrasonography is more sensitive in characterizing the fluid density and detecting the presence of septations and loculations[1,2,6]. Computerized tomographic scanning has been shown to be invaluable in the evaluation of parapneumonic empyema[23-25]. In our study, we used CT if the patient's clinical condition failed to improve despite adequate therapy for a reasonable length of time (two weeks).

Appropriate antibiotics and closed tube drainage was the regimen most commonly used in the management of these patients[13,14,26]. Only three patients were successfully managed with antibiotics alone. These patients had minimal effusions on initial chest X-rays. The remaining 46 patients were treated with antibiotics, thoracentesis and closed-chest drainage. Two patients had decortication for thickened pleura. Tuberculosis-related pleural effusions respond well to the usual antituberculous regimens[6]. The pleura is usually quite thick, and often has high concentrations of mycobacteria. Tube drainage should be avoided in order to prevent secondary bacterial infection of a tuberculous empyema[27]. In this study, all patients with tuberculous empyema were managed with closed-tube drainage. But the chest tubes had been inserted within one day from the appearance of pleural effusion on chest X-ray. Tuberculosis was diagnosed by follow-up in these patients. Demonstration of high adenosine deaminase levels (>70 U/L) in pleural fluid supports the diagnosis of tuberculosis. However, we could not apply this.

The average duration of hospitalization in our study was 28.02±10.18 days. This is concordant with other reports[13,18]. In our series, the length of hospital stay increased with the size of effusion. Munglani and Kenney[12] confirmed this finding. Although resolution occurs in the majority of children with fibropurulent empyema, the hospitalization is prolonged[28]. and this is consistent with our results.

Fibrinolytic therapy has been useful and safe adjunctive tool to facilitate the drainage of pus in some children with pleural empyema[29,30]. Experience with intrapleural fibrinolytic therapy in children with empyema has been limited, and further studies are needed before these agents are routinely used[1,17]. Intrapleural fibrinolytic therapy was not used in this study.

Failure of medical management is often seen with pleural empyema that becomes organized, forming thickened pleural peels and loculation, for which chest drainage will most likely fail[17]. If the disease has presented with, or progressed to, the formation of multiloculated collections and fibropurulent exudates (stage II), video-assisted thoracoscopic adhesiolysis, or open surgery, should be considered. When stage III disease has developed, adhesiolysis has no role. Open surgery should be undertaken with confidence that meticulous technique results in early drain removal, rapid recovery, prompt hospital discharge, and complete resolution[31,32]. In the present study, two patients underwent decortication. The decision to operate was made on the basis of both the CT findings of a loculated collection and a pelural thickening, and failure to improve clinically despite appropriate antibiotic and tube drainage.

The morbidity and mortality associated with pleural empyema are affected by the microbial etiology, host defence defects, severity and duration of infection, and adequacy of antibiotic therapy and drainage[6]. Patients with nosocomial infections complicating severe underlying disease may die at rates in the range of 40%-70%[33]. Among otherwise healthy patients, mortality rates are 2%-15%, depending o n the duration and the severity of their infection[19]. In the present study, the mortality rate was 2%. In the patient who died, Staphylococcus aureus septicemia contributed to the fatal outcome.

We conclude that appropriate antibiotics with early closed-chest tube drainage is adequate to achieve clinical and physiologic resolution. A few patients may require further surgical intervention. The long-term prognosis is excellent.

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