Original Article

Scoring System for Empyema Thoracis and Help in Management

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Abstract. ***Objective :*** To evaluate the implications of a newly defined severity scoring of empyema in children for the prediction of surgical management and to compare the length of hospitalization as an outcome measure of patients treated using medical therapy, salvage video-assisted thoracoscopic surgery (VATS) *vs* early elective VATS. ***Methods :*** A retrospective chart review of parapneumonic empyema of patients below 18 years of age admitted to a tertiary children's hospital in northern Taiwan from April 1993 to December 2002 was performed. Patients were categorized into a medical group who received antibiotic therapy, needle aspirations with/without tube thoracostomy; a salvage VATS group when the patients required surgery for the relief of persistent fever > 38°C, chest pains or dyspneic respirations despite initial medical therapy; an early VATS group when the patients received elective surgery early after admission. The demographic data, clinical features, laboratory findings, and duration of hospitalization were compared using a severity score of empyema (SSE). ***Results :*** *Streptococcus pneumoniae* was the most common infecting organism, followed by *Staphylococcus aureus*, *Pseudomonas aeruginosa*. No organisms were recovered in 39% of patients. A pleural pH < 7.1 increases the odds of requiring surgical intervention by 6 times among this cohort. Children who required decortication of empyema had a higher severity score (mean 4.8 *vs* 3.0, $p < 0.005$). The duration of hospitalization for patients having early VATS showed a shortening stay (mean 18 *vs* 28 days) as compared to salvage VATS. ***Conclusion :*** A pleural pH < 7.1 and a newly designed clinical severity score of empyema ≥ 4 are two predictors of surgical intervention for fibrinopurulent empyema in the present study. Early elective VATS may be adopted not later than 7 days after failure of appropriate antibiotic therapy and adequate drainage of empyema to decrease the length of stay and minimize morbidity. **[Indian J Pediatr 2005; 72 (12) : 1025-1028]** *E-mail: pchest@adm.cgmh.org.tw*

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The optimal management of empyema remains controversial.[1-3] Some investigators advocate antibiotics in combination with tube thoracostomy and/or intrapleural thrombolytics,[4-7] while others advocate the use of early surgical intervention such as video thoracoscopy and pleural debridement.[8-10] Although prognostic factors of mortality for severe community-acquired pneumonia and pleural fluid analysis have been validated to direct therapy for parapneumonic empyema in adults,[11-13] there is no published data on the utility of clinical severity scoring to predict the prognosis of empyema in children.[8] The aims of the study were to (1) compare the clinical characteristics and laboratory findings of the patients who were successfully and conservatively and those who required surgical intervention; (2) determine whether a newly defined severity scoring of empyema can predict the necessity of surgical intervention for fibrinopurulent empyema in children; (3) to compare the length of hospitalization between medically treated patients, patients who required salvage video-assisted thoracoscopic surgery (VATS) and early VATS.

MATERIALS AND METHODS

Charts of patients aged less than 18 years identified by a computer search for the discharge diagnosis of empyema thoracis in Chang Gung Children's Hospital (CGCH) between April 1993 and December 2002 were reviewed. CGCH is a university-affiliated hospital which serves both as a primary and tertiary referral center in northern Taiwan. Patients were excluded from the analysis if they had received parenteral antibiotics for > 5 days or had a thoracostomy tube insertion prior to admission into CGCH. Patients with underlying diseases (congenital heart disease, cerebral palsy, postoperative empyema) or known immunodeficiencies were also excluded.

Demographic data were collected including the presenting symptoms and laboratory findings of the patients; comparisons were made between patients who had medical therapy (antibiotics with/without chest tube drainage), salvage VATS group of patients who had persistent fever, chest pain or dyspnea despite conservative treatment for > 7 days,[14] and early VATS

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group for those patients who had VATS ≤ 7 days of conservative treatment. The microbiology profile obtained isolated from blood or pleural aspirates was identified and the susceptibility to antimicrobials was determined. Severity scoring of empyema (SSE) was assessed in each case 3-5 days after admission and scored according to the criteria: 1 point was assigned to each of the following entries regarding clinical features, laboratory findings and radiographic features (Table 1). The maximal SSE in each case was 20.

The complications and morbidity of patients during hospitalization were recorded and analyzed. The length of stay was defined as the duration of hospitalization after admission into CGCH.

Statistics

Statistical analysis was performed using the SPSS software, version 10. The student's t test was used for comparing differences of continuous values; percentages were compared using the chi-square test or Fisher Exact test. When more than two groups were compared, the Kruskal-Wallis test was used for non-parametric data but one-way analysis of variance (ANOVA) was used for comparison of means for continuous values between 3 groups. A 2-tailed p value < 0.05 was considered significant.

TABLE 1. The Entries of Severity Scoring of Empyema (SSE)

Clinical features
Fever > 39°C
Days prior to admission > 7 days
Tachycardia > 140/min
Tachypnea > 40/min
Abdominal pain
Required parenteral fluid infusion for volume expansion
Inotropic infusion for stablization of vital signs
Respiratory failure requiring intubation and mechanical ventilation
Laboratory findings
White blood cell counts < 4.0 × 10^9/L
Platelet counts < 100 × 10^9/L
Prothrombin time > 15 seconds
Blood urea nitrogen > 8.0 μmol/L
Blood creatinine > 110 mmol/L
Pleural pH < 7.1
Gross pus of pleural aspirates
Radiographic manifestations
Bilateral involvement
Thickness of empyema > 3 cm mantle by chest CT scan in lying position
Multiple loculated effusions
Extent of empyema > 1/3 hemi-thorax
Presence of air-fluid level in CT scans

RESULTS

Patient Demographics, Clinical Characteristics, Laboratory Findings

A total of 81 patients were included in the study. The average age of the patients was 37.9 ±26.0 months (mean ±SD) with a range of 6 weeks to 15 years. The male to female ratio was 1.25:1 (45 boys and 36 girls). The most common presenting symptoms were fever, cough, dyspnea and decreased activity (Table 2). Laboratory analysis showed that a significant higher percentage of patients had pleural pH < 7.1 for those who had undergone surgery (Table 3). Microbiological examination revealed a diverse group of organisms as shown in table 4. For *Streptococcus pneumoniae* isolated, 23.3% were susceptible to penicillin (MIC ≤0.06 μg/mL), 43.3% were intermediate resistant (MIC 0.12 – 1.0 μg/mL) and 13.3 % were highly resistant to penicillin (MIC ≥2 μg/mL).

Severity Scoring of Empyema and Clinical Course

Patients with an SSE of ≥ 4 have 4.6 times chance of requiring surgery intervention than those with SSE of <4 in parapneumonic empyema in the present study (Table 3). The patients in the medical group also stayed for significantly shorter period of time as compared to the patients who had VATS. In order to study the outcome of therapy and the time of surgical intervention, the patients who had undergone surgery were further sub-categorized into a salvage VATS or an early VATS group. SSE for salvage VATS *vs* early VATS was not different,

TABLE 2. Demographic Data and Presenting Symptoms of Empyema

Group	Surgery (n = 49)	Medical (n = 32)	p	Odds Ratio
Age, months	39.4 ± 30.3	36.1 ± 19.2	0.56	
Sex (M/F)	27/22	17/15	0.85	1.08 (0.44-2.65)
Days prior to admission	7.9 ± 4.9	6.1 ± 2.8	0.04	
Fever	43/44 (98)*	31/31 (100)	0.4	-
Cough	37/43 (86)	19/25 (76)	0.3	1.90 (0.55-6.86)ℵ
Shortness of breath	20/30 (67)	16/22 (73)	0.64	0.75 (0.22-2.51)
Lethargy	12/21 (57)	9/14 (64)	0.67	0.74 (0.18-2.98)
Decrease appetite	13/23 (57)	8/13 (62)	0.77	0.81 (0.20-3.26)
Abdominal pain	8/11 (73)	6/21 (29)	0.02	2.04 (0.78-5.33)
Chest pain	3/20 (15)	2/20 (10)	0.73	1.59 (0.24-10.7)
Decrease urine output	1/17 (6)	2/8 (25)	0.17	0.19 (0.01-2.47)

*Numbers in parentheses, percent.
ℵNumbers in brackets, 95% confidence intervals

Table 3. Laboratory Data and Severity Score of Empyema – Medical *vs* Surgery Groups

Group	Surgery (n =49)	Medical (n = 32)	p	Odds Ratio
CRP, mg/L	260 ± 107*	253 ± 118	0.79	
WBC, × 10^9/L	2.1312 ± 2.5808	1.7969 ± 1.2255	0.45	
Platelet, × 10^9/L	355 ± 203	310 ± 196	0.36	
Segmented neutrophils(%)	77.2 ± 14.0	79.0 ± 9.9	0.52	
Effusion pH < 7.1	12/16 (75)+	4/12 (33)	0.03	6.0 (1.15 -31.23)?
Effusion glucose < 40 mg/dL	15/18 (83)	11/16 (69)	0.32	2.27 (0.45-11.59)
Effusion LDH ≥ 2000 U/L	15/20 (75)	7/15 (47)	0.09	3.43 (0.82-14.37)
Penicillin susceptibility (MIC < 0.06 μg/mL)	4/18 (22)	3/12 (25)	0.83	0.86 (0.15-4.76)
Fever subsided, days	12.4 ± 6.2	10.6 ± 5.7	0.17	
Mean severity score	4.5 ± 1.7	3.3 ± 1.9	0.0025	
Severity score ≥ 4	36/49 (73)	12/32 (38)	0.001	4.62 (1.77-12.0)
Length of stay, days	27.4 ± 6.6	23.7 ± 8.1	0.03	

*mean ± standard deviation
+Number in parentheses, percent
?Numbers in brackets, 95% confidence intervals; CRP – C reactive protein; LDH – lactic dehydrogenase; MIC – minimal inhibitory concentration

Table 4. Isolation of Bacteria from Blood or Pleural Empyema

	Blood	Pleural fluid
S. pneumoniae	18	19
S. aureus	1	6
P. aeruginosa	2	
H. influenzae	1	2
S. viridans		2
V. parvula		1
S. pyogenes		1
B. catarrhalis		1
E. fetalis		1

but the duration of hospitalization was significantly shorter (mean 18.0 *vs* 27.9 days) for the patients who had early VATS than the salvage group. The patients having conservative treatment had a mean SSE of 3.0 which was significantly lower than the surgical group of patients having a score of 4.8 (Table 5).

DISCUSSION

In this retrospective review of children with empyema it has been found that children with an SSE of 4 or above had a 4.6 times chance of requiring surgical intervention than medical therapy. The optimal therapy of parapneumonic empyema remains controversial with a multiplicity of available options. Some authors advocate conservative treatment of empyema using solely appropriate antibiotic therapy and/or closed tube drainage because children seem to have a greater capacity to resorb thickened pleura effectively as compared to adults.[4] With the advance of thoracic computed scanning, increasing number of necrotizing pneumonitis in complicated pneumonia has been recognized,[14] however, it must be emphasized that the decision to perform decortication on patients should be persistent sepsis, rather than reliance on the roentgenographic appearance.[15,16]

Recently, the use of fibrinolytic agents or decortication in patients with loculations and septation during sonographic examinations has been shown to reduce morbidity and shorten hospital stay.[8,17-20] However, Chan and colleagues in a 26-year retrospective review of fibrinopurulent empyema from Montreal Children's Hospital demonstrated that complete drainage was achieved in 7 (18%) of 39 patients, and although 25 (64%) patients had persistent loculations after tube drainage, only 7 patients required decortication.[5] Till date there is only one randomized trial comparing the use of intrapleural urokinase *versus* saline in children, but the selection of the patients may not be qualified as truly fibrinopurulent empyema in these 60 children,[6,21]

Table 5. Clinical Outcome of 81 Children with Parapneumonic Empyema

Group	Medical (n=32) mean ± SD	Salvage VATS (n=44) mean ± SD	Early VATS (n=5) Mean ± SD	p
SSE	3.0 ± 1.48	4.8 ± 1.99	4.0 ± 1.22	<0.005
LOS	23.7 ± 1.4	27.9 ± 1.0	18.0 ± 1.1	<0.003

SSE – severity score of empyema
LOS – length of stay
VATS – video-assisted thoracoscopic surgery
Kruskal-Wallis test was used among three groups, p values was significant when < 0.05; for differences between two groups, tested with Mann-Whitney U test.

Therefore, solid evidence supporting the routine use of intrapleural fibrinolytic therapy in the treatment of parapneumonic empyema in children is still lacking.[7,22-24]

In the present study, the authors used clinical features, laboratory findings and radiographic features on thoracic computed tomographic scans for the prediction of success empyema when medically treated. The average duration of fever was 10.6 days in the medical group *vs* 12.4 days in patients who had surgery; these patients had an average stay of 23.7 and 27.4 days respectively. The longer stay in patients who had undergone surgery signified the initial selection of patients who failed to response to conservative therapy exclusively.

In the past decades, video-assisted thoracoscopic surgery had been advocated more frequently for decreasing morbidity and shortening length of stay in complicated parapneumonic empyema in adults and children.[2,3,8-10,23] The present data suggest that pleural pH < 7.1 and SSE ≥ 4 are two predictors for the necessity of surgical intervention in fibrinopurulent stage of empyema (Table 3). The course of conservative management was usually prolonged with a mean stay of 23.7±8.1 days using antibiotic therapy and pleural drainage only. For patients with refractory fever, dyspneic respirations and chest pain despite adequate medical therapy and early elective VATS revealed a shorter length of hospitalization as compared to salvage VATS (Table 4). If children with SSE ≥ 4 are subjected to early VATS, it may be possible to curtail the length of stay in hospital for patients and apply a sequential oral home medication, more aggressive to comply a more modern trend of therapy to achieve shorter hospitalization stay. Finally, multicenter randomized prospective studies are urgently needed to determine the optimal therapy of parapneumonic empyema in children.

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