Journal of Pediatric Surgery 51 (2016) 588–591

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

'Less may be best'—Pediatric parapneumonic effusion and empyema management: Lessons from a UK center

Anna-May Long [a], Jonathan Smith-Williams [b], Sarah Mayell [c], Jon Couriel [c], Matthew O. Jones [a], Paul D. Losty [a,d,*]

[a] Department of Paediatric Surgery, Alder Hey Children's Hospital NHS Foundation Trust, Liverpool, UK
[b] Medical School University of Liverpool, Liverpool, UK
[c] Department of Respiratory Medicine, Alder Hey Children's Hospital NHS Foundation Trust, Liverpool, UK
[d] Academic Department of Paediatric Surgery, University of Liverpool, Liverpool, UK

ARTICLE INFO

Article history:
Received 12 May 2015
Received in revised form 31 July 2015
Accepted 31 July 2015

Key words:
Empyema
Parapneumonic effusion
Urokinase
Antibiotics
Thoracic surgery
Clinical trials

ABSTRACT

Background: Children with empyema are managed at our center using a protocol-driven clinical care pathway. Chemical fibrinolysis is deployed as first-line management for significant pleural disease. We therefore examined clinical outcome(s) to benchmark standards of care while analyzing disease severity with introduction of the pneumococcal conjugate vaccine.

Methods: Medical case-records of children managed at a UK pediatric center were surveyed from Jan 2006 to Dec 2012. Binary logistic regression was utilized to study failure of fibrinolytic therapy. The effects of age, comorbidity, number of days of intravenous antibiotics prior to drainage and whether initial imaging showed evidence of necrotizing disease were also studied.

Results: A total of 239 children were treated [age range 4 months–19 years; median 4 years]. A decreasing number of patients presenting year-on-year since 2006 with complicated pleural infections was observed. The majority of children were successfully managed without surgery using antibiotics alone (27%) or a fine-bore chest-drain and urokinase (71%). Only 2% of cases required primary thoracotomy. 14.7% cases failed fibrinolysis and required a second intervention. The only factor predictive of failure and need for surgery was suspicion of necrotizing disease on initial imaging ($P = 0.002$, OR 8.69).

Conclusion: Pediatric patients with pleural empyema have good outcomes when clinical care is led by a multidisciplinary team and protocol driven care pathway. Using a 'less is best' approach few children require surgery.

Pleural empyema is a lung disease occurring in children where parenchymal infection is complicated by parapneumonic effusion. Exudative fluid accumulates in the pleural cavity and deposition of fibrin occurs. Over time pleural surfaces are coated with an inelastic 'peel' inhibiting lung expansion [1]. Where this is causing significant physiological compromise to patients expedient drainage of the effusion and debridement of fibrin peel using either mechanical or chemical methods may be required [2,3].

Chemical fibrinolysis is encouraged as first line therapy for complicated disease [2,3]. Randomized controlled trials show equivalent outcome(s) comparing (I) decortication by thoracoscopy (VATS) versus (II) chemical fibrinolyis—with significant cost savings with the latter [4,5]. To this end, guidelines have been developed by the British Thoracic Society (BTS) and the American Pediatric Surgical Association (APSA).

This study analyzes and reports patient outcomes from a major UK pediatric center against the background of developing a protocol driven integrated clinical care pathway for empyema. We have examined the progress of all children treated at our center focusing on (I) length of hospital stay, (II) readmission rate(s), and (III) need for second intervention(s). Factors potentially related to outcome such as (I) age, (II) comorbidity, and (III) infecting organism(s) were examined in detail. Any feature(s) relating to failure of chemical fibrinolysis was also scrutinized with the aim of identifying patient subgroups unsuitable for fibrinolysis as primary therapy.

In September 2006, the seven valent pneumococcal conjugate vaccine (PCV7) was added to routine childhood immunization protocols in the UK [6]. In March 2010 the vaccine was replaced by a thirteen valent pneumococcal conjugate vaccine after public health concerns were raised regarding a growing predominance of invasive serotypes not covered by PCV7 [7]. This study therefore also reports microbiology findings and outcome metrics in the postvaccination era.

At our center after a diagnosis of empyema is confirmed by ultrasound all children are then managed by a multidisciplinary (MDT) team led by pediatric respiratory physicians and surgeons. CT chest scans are not a routinely deployed investigation in 'work up'. Here CT is reserved only for patients where a bronchopleural fistula is suspected or an underlying congenital lung lesion, eg, congenital cystic adenomatoid malformation (CCAM). CT is further used in patient care

* Corresponding author at: Alder Hey Children's Hospital NHS Foundation Trust, University of Liverpool, Liverpool, UK. Tel.: +44 151 228 4811.
E-mail address: paul.losty@liv.ac.uk (P.D. Losty).

http://dx.doi.org/10.1016/j.jpedsurg.2015.07.022
0022-3468/

Table 1
Population characteristics.

Characteristic	*n* (%)	
Sex:		
Male	122 (51)	
Female	117 (49)	
Median age (IQR)	4 years, (2–8 years)	
Age range	4 months–19 years	
Severe comorbidity		
No	209 (87)	
Yes	30 (13)	
ICU/HDU Admission		
No	187 (78)	
Yes	52 (21)	
Causative organism		
S. pneumoniae	112 (56)	
Not identified	61 (26)	
Group A Strep.	19 (8)	
S. aureus	4 (2)	
Others[a]	5 (2)	
Primary management strategy		Failed primary treatment (required second procedure)
IV antibiotics alone	66 (27)	2[b] (3)
Chest drain and urokinase	169 (71)	25 (14.7)
Primary thoracotomy	4 (2)	0
Total	239	27 (11.3)

[a] *Mycobacterium tuberculosis* 1, *Enterococcus faecium* 1, *Streptococcus intermedius* 3.
[b] Readmitted and required thoracotomy.

plans when a primary or rescue thoracotomy is considered. Clinically stable patients with small pleural collections seen on ultrasound imaging are therefore managed with antibiotics and active observation. Cefuroxime is employed as a first-line antibiotic and oral clarithromycin added in patients >5 years. Blood cultures, serology, Anti-streptolysin O titre (ASOT), and blood pneumococcal PCR are obtained on all patients at first presentation with pleural fluid routinely sent to the laboratory(s) for microscopy, culture and sensitivity including pneumococcal PCR.

Patients with persistently high fever and significant pleural collections are then managed with an 8 Fr chest drain inserted under general anesthesia using the Seldinger technique with instillation of intrapleural urokinase. Six doses of urokinase are administered at 12 hourly intervals (10,000 IU diluted in 10 ml of 0.9% saline was used for children <10 kg and 40,000 IU diluted in 40 ml of 09.9% saline for children >10 kg). Primary thoracotomy is reserved for children with a suspicion of bronchopleural fistula(e) and severe necrotizing lung disease with severe systemic illness or in cases with a suspected lung lesion.

Methods

This clinical study was Institutional Review Board (IRB) approved by Alder Hey Childrens Hospital (in accordance with the Declaration of Helsinki 1964). Medical case records were analyzed on patients admitted to our center with a diagnosis of empyema during the era(s) January 2006–December 2012. All patients were managed using the protocol driven MDT care pathway. Data examined were (I) demographics (II), patient comorbidity (III) infecting organism[s], (IV) radiology, and (V) antibiotic therapy. Length of hospital stay, admission to the intensive care unit (ICU) or high dependency (HDU), hospital readmission and need for second intervention(s) were examined. Data on readmission and postprocedural length of stay were fully available from 2007 onward.

The influence of severe patient comorbidity(s) and microorganism(s) on hospital stay and admission to ICU or HDU was analyzed with Mann–Whitney U, Chi χ^2 and Fishers Exact tests. Factors linked to fibrinolytic failure were identified prospectively: (I) patient age, (II) significant comorbidity, (III) duration of intravenous antibiotic[s] prior to drainage, and (IV) suspicion of necrotizing disease on initial chest imaging. Covariates were selected *a priori* based on clinical hypotheses. Significant comorbidity included (a) chromosomal anomaly, (b) neurological disability, (c) congenital heart disease, (d) connective tissue disorders, and (e) immune deficiency states. Necrotizing disease on initial imaging was defined as evidence of parenchymal destruction, suppuration or air in the pleural space with chest x-ray, ultrasound or CT. The influence of these factors was further assessed with binary logistic regression to undertake univariate analysis. All statistical analyses were performed using SPSS 20 (with $P < 0.05$ equals significant).

Results

A total of 239 patients were admitted to our hospital with empyema in the era(s) 2006–2012. Table 1 shows the demographics with primary management strategies for the cohort (age range 4 months–19 years: median 4 years). The proportion of those who had significant

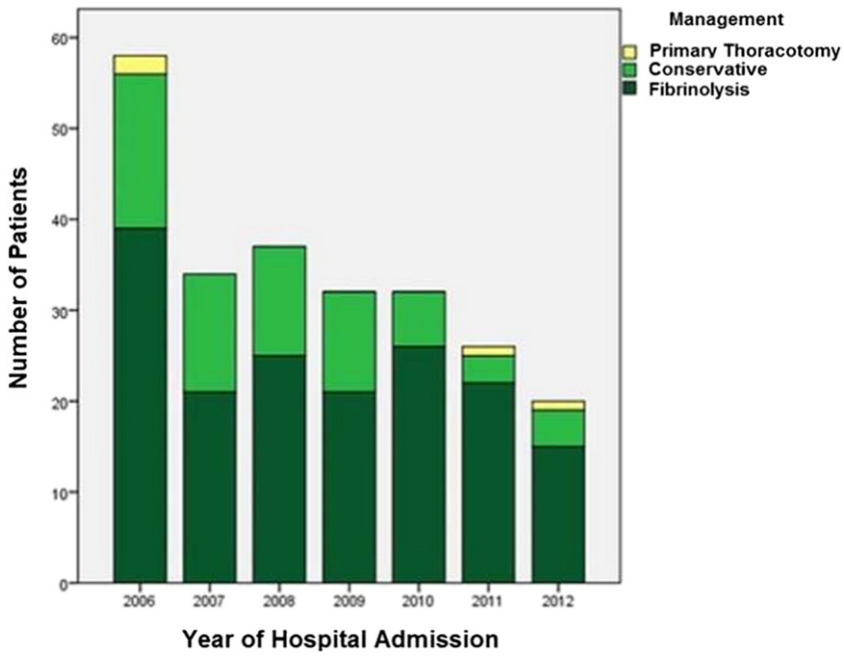

Fig. 1. Bar chart illustrating empyema hospital admissions per year and management.