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Increased incidence of empyema in Polynesian children

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Abstract

Aim The aim of this study was to review the epidemiology, treatment and outcome of surgically managed empyema in children.

Method A retrospective review was undertaken of all surgically managed empyema at Starship Children's Hospital (Auckland, New Zealand) from 1 July 2003 to 30 June 2008.

Results Of the 93 children diagnosed with empyema, 62 were managed surgically (55 VATS, 7 thoracotomy) and 31 with tube thoracostomy alone. 71% were of Māori or Pacific ethnicity despite making up just 30% of the New Zealand paediatric population ($p<0.0001$). Median duration of chest drainage following VATS was 3 days and postoperative hospital stay 14 days. There was a 5% conversion of VATS to thoracotomy. The VATS complication rate was 16%: one intraoperative cardiorespiratory arrest following rupture of an intrapulmonary abscess into the bronchial tree, two contralateral empyema, one recurrent empyema, four air leaks and a wound infection.

Conclusion For the first time increased incidence of empyema in the Polynesian population has been documented. Severity of empyema may be higher within the Polynesian population affecting treatment outcome.

Empyema in childhood causes significant morbidity and may be increasing in frequency.[1,2] Empyema is classified into three stages:

(1) An early exudative stage,

(2) An intermediate fibrinopurulent stage, and

(3) A late organising stage.

The majority of cases present in the exudative stage and can be effectively managed with tube thoracostomy. Stage 3 empyema often requires open debridement of infective loculations to prevent lung restriction.

The optimal management of fibrinopurulent empyema remains under debate. Two recent randomised controlled trials comparing fibrinolysis with video-assisted thoracoscopic surgery (VATS) in children have shown no significant difference in clinical outcome or length of postoperative hospital stay, but reduced treatment costs with fibrinolysis.[3,4] Several series demonstrate that surgery can be safely avoided in approximately 80–90% of paediatric empyema patients with the use of fibrinolytics.[1,3]

The British Thoracic Society recommends fibrinolysis as first line therapy for empyema.[1] However, Bishay et al recently suggested that the failure rates for VATS can be considerably lower than for fibrinolysis if undertaken at a centre with high levels of thoracoscopic surgical experience.[5]

VATS is minimally invasive and can be undertaken whilst the child is under general anaesthesia for the chest drain, thus allowing early and effective drainage.[6–8]

Starship Children's Hospital (SSH) in Auckland, New Zealand, is a tertiary-referral centre for paediatric surgery. VATS was introduced in 2003 for the primary treatment of fibrinopurulent empyema. The aim of this study is to review the epidemiology, treatment and outcome of surgically-managed empyema in our first 5 years of VATS.

Methods

Study design—A retrospective case-note review was undertaken of all surgically-managed empyemas at SSH over the 5 year period between 1 July 2003 and 30 June 2008. All children (<15 years) who had a diagnosis of empyema on hospital discharge coding data and had undergone surgical management were included in the study.

Surgical intervention (VATS or thoracotomy) was determined from examination of the medical records. Patient demographics, mode of presentation, investigations, timing of illness onset to presentation, surgical intervention, and discharge, duration of chest drainage and complications were recorded. No cases were excluded.

Statistical analysis—Differences between the ethnic distribution in our study and the New Zealand paediatric population were assessed using a goodness of fit test. Differences in surgical timing and chest drainage between those treated by VATS and thoracotomy were assessed using a Wilcoxon 2 sample test.

Surgical technique—Surgery was undertaken by three surgeons at SSH. The precise technique for VATS varied according to surgeon preference. Single lung ventilation with a bronchial blocker or double lumen tube was employed in a minority of cases but with increasing frequency later in the series.

With the patient in the lateral position and the affected hemithorax uppermost, two or three 5 mm ports are placed and carbon dioxide pneumothorax established at 3–5 mmHg. Loculations are lysed, fibrinous peel removed and the thoracic cavity irrigated. One or two chest tubes are left *in situ* and removed on the ward when drainage minimal.

Results

Of 93 children with empyema 62, comprising the study population, were managed surgically (55 VATS, 7 thoracotomy) and 31 with tube thoracostomy alone. No children were managed with fibrinolysis. Of those treated by VATS, 45 (82%) underwent primary VATS and 10 (18%) underwent VATS following prior chest drain insertion. Demographics are listed in Table 1.

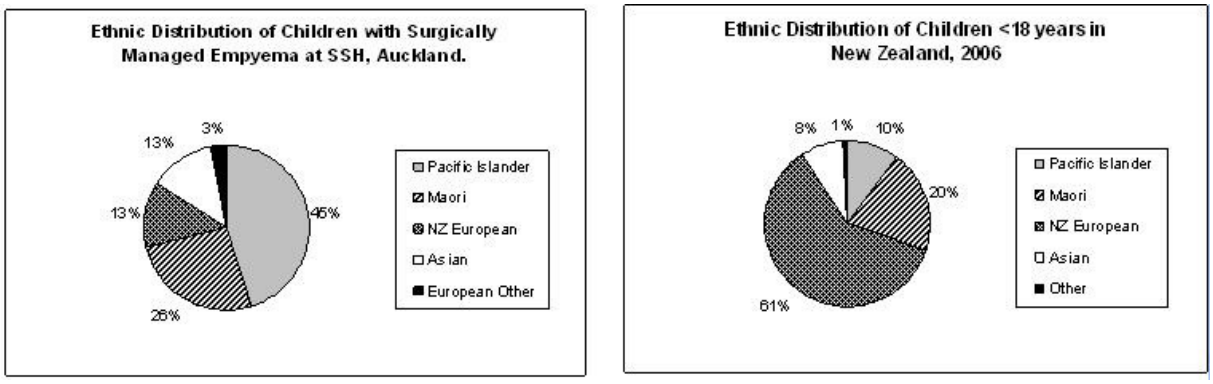
Table 1. Patient characteristics

Variables	VATS* (N=55)	Thoracotomy (N=7)
Mean age in months (range)	38 (4–154)	57 (14–175)
Gender, M:F	27:28	5:2
Ethnicity		
Pacific†	23	5
Māori	16	0
NZ European	6	2
Asian	8	0
Other	2	0

*Video-assisted thoracoscopic surgery; †Mostly of Samoan, Tongan, Niuean, or Cook Islands origin.

Children of Pacific and Māori ethnic origin were over-represented compared to their proportion of the New Zealand paediatric population, p<0.0001 (Figure 1). [9]

Figure 1. Ethnic distribution of the study population and New Zealand paediatric population[9]



The Auckland 2006 Census showed a similar ethnic distribution: 14% Pacific Peoples, 11% Māori, 56% European, 19% Asian, 1% other. [10]

Radiological investigations—54 (87%) were investigated with ultrasonography (US) and 37 (60%) underwent chest computed tomography (CT). All children had either US or CT.

Microbiology (Table 2)—53 (85%) had a blood culture performed. Of these, 19 (36%) had a positive result. All 62 children had a pleural aspirate performed for culture. Of these 25 (40%) resulted in positive culture.

Table 2. Microbiological isolates

Isolates	VATS Total (N=55)	VATS Polynesian Population (N=39)	Thoracotomy Total (N=7)	Thoracotomy Polynesian Population (N=5)
S. aureus	19	13	3	1
S. pneumonia	12	13	1	1
S. pyogenes	6	3	1	1
MRSA	2	2	0	0
Candida albicans	1	1	0	0
Serratia marcescens	1	0	0	0
No isolate	14	7	2	2

MRSA: methicillin-resistant *Staphylococcus aureus.*

Clinical presentation (Table 3)—24 (39%) of patients presented directly to SSH. 38 patients (61%) were transferred to SSH from another hospital; 36 patients from 13 hospitals across the North Island, 1 from the South Island and 1 from a Polynesian Island.

Patients requiring a thoracotomy (43% of which were converted from VATS) had a significantly longer time from presentation at primary hospital to surgery than those treated with VATS (median 17 and 6 days respectively, p=0.007). 10 patients (16%) had intrapulmonary abscesses (7 were Polynesian) and 7 patients (11%) had multi-organ sepsis (5 were Polynesian).

Table 3. Clinical presentation (expressed in median, range)

Clinical presentation	VATS Total (N=55)	VATS Polynesian Population (N=39)	Thoracotomy Total (N=7)	Thoracotomy Polynesian Population (N=5)
Aetiology:				
Pneumonia	55	39	6	4
Costal osteomyelitis	0	0	1	1
Symptom onset to presentation, days	5 (0–28)	5 (0–21)	4 (0–28)	4 (0–7)
Initial presentation to surgery, days	6 (0–28) *	6 (0–28)	17 (3–43) *	17 (7–43)
Interhospital transfer, N (%)	33 (60%)	25 (64%)	5 (71%)	3 (60%)
Duration in primary hospital, days †	3 (0–21)	2 (0–21)	4 (1–23)	4 (1–23)
Arrival at SSH to surgery, days †	2 (0–20)	3 (0–20)	7 (0–17)	9 (0–17)

* p<0.01 †For transferred patients.

Outcome (Table 4)—None of the patients who underwent VATS required a repeat procedure. 3 of those treated by thoracotomy initially underwent VATS but required conversion to an open procedure to allow adequate debridement of infective loculations (5% conversion to thoracotomy). Of those treated by VATS the chest drains remained in situ postoperatively for a median of 3 days.

The total length of hospital stay was significantly longer in those who underwent thoracotomy (34 days) compared to VATS (19 days) (p=0.007). 10 children required PICU admission postoperatively and 1 preoperatively (8 of these were Polynesian).

Table 4. Outcome (expressed in median, range)

Outcome	VATS Total (N=55)	VATS Polynesian Population (N=39)	Thoracotomy Total (N=7)	Thoracotomy Polynesian Population (N=5)
Surgery to chest drain removal, days	3 (1–11) †	3 (1–11) ‡	4 (2–7)	3 (2–6)
Surgery to discharge, days	14 (2–43) ‡	13 (2–43) ‡	25 (9–76)	22 (9–76)
Total length of hospital stay (SSH), days	19 (6–48)* ‡	19.5 (8–48) * ‡	34 (17–119) *	35 (25–119) *
PICU admission, n (%)	9 (16%)	6 (15%); 1 preoperatively	2 (29%)	1 (20%)
PICU days, median (range)	4 (1–12)	6.5 (2–12)	5 (2–8)	8

PICU, Paediatric Intensive Care Unit; * p<0.01; † Two cases not documented. ‡ One case not documented.

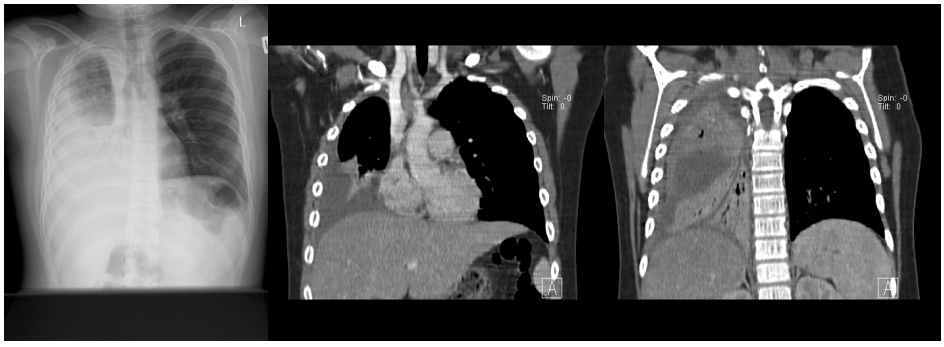
Complications (Table 5)—Complications occurred in 16%. One intraoperative complication occurred. A 14-year-old Māori boy with pre-existing severe bronchiectasis presented with empyema and an intrapulmonary abscess on the right side (figure 2). Whilst on the operating table immediately following an uneventful VATS drainage (without single lung ventilation) he developed cardiorespiratory arrest. Copious pus was suctioned from the endotracheal tube suggesting rupture of the intrapulmonary abscess into the bronchial tree. Septic shock ensued requiring 10 days of ventilatory support in PICU and 33 days inpatient treatment postoperatively.

Table 5. Complications

Variables	VATS Total (N=55)	VATS Polynesian Population (N=39)	Thoracotomy Total (N=7)	Thoracotomy Polynesian Population (N=5)
Intraoperative cardiorespiratory arrest	1	1	0	0
Recurrent empyema (fungal infection)	1	1	0	0
Contralateral empyema *	2	2	0	0
Persisting pneumothorax, including one tension pneumothorax, requiring further chest drain insertion (one secondary to necrotic right middle lobe)	4	2	1	1
Wound infection	0	0	1	1

* In these cases there was no clinical or radiological evidence of contralateral empyema prior to VATS. It may be that infective secretions can be aspirated into the healthy lung by postural drainage intraoperatively when a bronchial blocker is not employed. However, we recognise these cases could reflect extent of disease rather than a complication.

Figure 2. Radiograph and CT scan of empyema with intrapulmonary abscess in a patient with bronchiectasis.



Discussion

Incidence—Empyema is a significant source of childhood morbidity and accounts for approximately 1/1000 paediatric admissions to SSH. This is consistent with previous

reports of empyema incidence, ranging from 0.4–6/1000 paediatric admissions, and highlights the importance of an optimal management strategy for this patient population.[11]

Susceptibility to infection—Children of Māori or Pacific ethnicity represented 71% of children with empyema despite making up just 30% of the NZ paediatric population ($p<0.0001$).[9] There is evidence to suggest that children of Māori and Pacific ethnicity have an increased susceptibility to and severity of certain infections with increased hospitalisation rates for pneumonia compared to children of European descent and more severe pneumonia within hospitalised populations with higher respiratory rates, heart rates, oxygen and intravenous antibiotic requirements and an elevated relative risk for invasive disease and *Staphylococcus aureus* bacteraemia.[12-15]

Possible reasons include genetic factors, for which specific genes have been identified, and lower socioeconomic status associated with increased smoking rates, overcrowding, micronutrient deficiency (with associated immunodeficiency), delayed presentation and reduced access to medical services.[12,16,17]

Investigators elsewhere have shown that indigenous people worldwide have increased rates of pneumococcal disease compared to others within the same geographical region, including North American Indians, Alaskan and Greenland natives and Australian Aborigines.[18-21]

Severity of disease—Despite equal or shorter durations of symptom onset to presentation, time to surgical intervention and chest drainage, Bishay et al, Sonnappa et al and St.Peter et al document considerably shorter median postoperative hospital stays following VATS of 6–7 days compared to 14 days in this study.[4-6]

Chen et al document a similar median time from diagnosis to VATS as this study, but also a similar postoperative length of hospital stay of 13 days.[22] In the latter study there was a high severity of infection indicated by 36.5% of patients having necrotising pneumonia, which they showed through multivariate analyses to be associated with a significantly higher complication rate and postoperative length of stay.

In our study 16% had intrapulmonary abscesses, 11% multi-organ sepsis and 18% required PICU care. There was a high complication rate of 16%, including one life-threatening complication and others requiring further tube thoracostomy. Together these factors resulted in prolonged inpatient treatment. This may have been related to an increased severity of infection within the Polynesian population. Hence, we highlight that severity of empyema and treatment outcome may in part be influenced by ethnicity within a population.

Limitations—The present study is a retrospective series presenting our early experience with VATS for paediatric empyema. Choice of intervention was at the surgeons' discretion, surgical technique was not standardised and evolved throughout the study period.

The majority of patients were referred or presented from the North Island of New Zealand, for which specific paediatric ethnic distribution statistics were not available. However, the Auckland specific population data is highly similar to that of the New Zealand paediatric population data.

We have not drawn conclusions on outcome according to treatment modality in view of the retrospective nature of the study and the numerous prospective studies which have already been published on this subject.

Conclusion—The incidence of paediatric empyema is significantly higher in the Māori and Pacific population than in the other ethnic groups in our region. Severity of empyema may be higher within the Polynesian population affecting treatment outcome; prospective studies using severity scoring systems are required to investigate this.Further research is required to look at the immunological and environmental factors relating to infections and responses in this population. A high level of suspicion for empyema and intrapulmonary abscesses amongst Polynesian children with pneumonia is required to allow swift referral and institution of treatment. The hope is that this will prevent some of the complications related to the disease process and more invasive therapeutic measures.

Competing interests: None.

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