Case reports

Paediatric Empyema: A Case Report and Literature Review

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ABSTRACT

Objective: *To present a case of bilateral parapneumonic effusions in a child with Pneumococcal pneumonia and bacteraemia managed aggressively with early thoracotomies. The literature from peer reviewed journals is summarized and the different management strategies are discussed.*

Methods: *Articles and reviews from peer reviewed journals on the management of empyema in children and adults.*

Results: *Staging of parapneumonic pleural effusions is difficult to assess clinically and radiologically. Most cases can be successfully managed with simple chest tube drainage, plus appropriate antibiotic therapy. However, based on the available evidence for children, thoracotomy with decortication and direct drainage may provide the most effective treatment in terms of length of hospital stay and duration of chest tube insertion, when compared with video assisted thoracoscopic surgery (VATS) or chest tube drainage, with or without intrapleural fibrinolytic therapy.*

Conclusions: *More conservative approaches to treatment of empyema may be appropriate initially to avoid the cosmetic and other disadvantages of thoracotomy. However, delayed surgical drainage increases morbidity and may potentially increase mortality.* (**Critical Care and Resuscitation 2005; 7: 102-106**)

Key words: Empyema, thoracotomy, chest tube, review, management

A case is presented of bilateral parapneumonic effusions in a boy with *Pneumococcal* pneumonia and bacteraemia managed aggressively with early thoracotomies. The literature is reviewed and different management strategies are discussed.

CASE REPORT

A 3 year-old Caucasian boy, with a past history of croup, presented with a three-day history of vomiting and diarrhoea. He was admitted to hospital because of right middle lobe and lower lobe consolidation, neutropenia and a markedly elevated C-reactive protein of 216 mg/L consistent with a diagnosis of pneumonia. Treatment was started with intravenous penicillin and cefotaxime.

On day 3, blood *Streptococcus pneumoniae*, fully sensitive to penicillin, was isolated from blood cultures. By then his fever had settled and treatment was continued with high dose penicillin only. On day 5, his fever recurred. A chest X-ray demonstrated a small right-sided loculated effusion, but an ultrasound revealed only a 1 cm rim of fluid that was deemed 'not drainable'. Cefotaxime was restarted.

By day 10, an ultrasound revealed that the pleural fluid collection on the right side was 3 cm deep and contained particulate matter and septa. Intravenous flucloxacillin was substituted for penicillin. Because the child had clinically deteriorated with worsening fever, tachypnoea and an increasing oxygen requirement, an urgent right thoracotomy, decortication and chest tube

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insertion under general anaesthesia was performed. A left internal jugular central line was inserted at the same time due to problems with peripheral venous access. The pleural fluid drained was seropurulent with many leukocytes, but no organisms were found on culture.

On day 12, the patient again deteriorated and a chest X-ray revealed left sided collapse/consolidation with pleural effusion. An ultrasound revealed a left sided 4 cm loculated pleural fluid collection. A left thoracotomy, decortication and chest tube insertion was performed under general anaesthesia. After consultation with the hospital's infectious diseases service, oral rifampicin was added to the flucloxacillin and cefotaxime antibiotic regimen. Culture of the pleural fluid did not reveal any organisms. Abdominal, cardiac and major vessel ultrasounds did not reveal any other infective sites, thrombosis, or fluid collections. Serum immunoglobulin levels were normal.

Subsequently the child's condition slowly improved. He was discharged home well on day 26.

REVIEW

Empyema in children is usually the result of underlying lung infection with *Staphylococcus aureus* or *Streptococcus pneumoniae*. Several studies report an increase in the incidence of empyema in children, even in developed countries.[1] *Staphylococcal* infections now outnumber *streptococcal* infections as the leading cause in countries where widespread pneumococcal vaccination occurs.[1] *Haemophilus influenzae* infection is now a rare cause of empyema, again due to an effective vaccination strategy. *Mycoplasma pneumoniae* commonly causes a parapneumonic effusion, and is a recognised cause of empyema in children.[2] Mixed infections, including anaerobes, can also occur, especially in adults with underlying illnesses.[3] In developed countries it is now most common for the purulent fluid drained from the pleural cavity to be sterile, due to prolonged and broad-spectrum antibiotic treatment prior to drainage. In the United States of America, initial treatment with vancomycin or clindamycin has been recommended due to the prevalence of resistant *staphylococcal* and *streptococcal* organisms.[1] In Australia severe paediatric pneumonia with effusion is usually treated initially with flucloxacillin and a third generation cephalosporin, with or without a macrolide antibiotic, as resistant pneumococcal disease is rare. Vancomycin is used initially only if meningitis is suspected.[4]

Staging of parapneumonic effusions

An exudative parapneumonic effusion without loculations or septa (Stage 1) has minimal leukocytes in the fluid. The fluid is characterized by an elevated lactate dehydrogenase (LDH), a low pH and low glucose concentration. In the fibrinopurulent stage (Stage 2) these biochemical abnormalities worsen, the leukocyte count remains low, although there still may be extensive fibrinous coating of the pleura and loculations. In Stage 3 disease frank pus develops. Stage 4 disease is characterised by loculated pus. The ideal management strategy for empyema has not been elucidated due to a paucity of properly conducted randomised controlled trails. This situation is compounded by the fact that parapneumonic effusions (Stage 1 and 2 disease) are much more common that true empyema (Stage 3 and 4 disease). Earlier stage disease could be over- or under-represented in the various case series. Staging is also unreliable when based on clinical criteria, e.g. the age of the fluid collection. It is known that Stage 4 disease can occur within 7 days of the initial fluid collection, but the fluid can remain relatively serous for much longer than this.[5] Accurate staging of an empyema can only be done by a combination of computerised tomography and fluid aspiration.

In adults, empyema increases the mortality related to community-acquired pneumonia, usually from overwhelming sepsis, by seven times if bilateral and by more than three times if unilateral.[5] The overall mortality in several series ranges from 1 - 61%.[6] Outcomes are almost certainly influenced by management strategy.

Daily thoracentesis

In a case series from Denmark,[3] adults with empyema had markedly reduced hospital stays (2.3 vs 5 weeks), fewer complications (bronchopleural or pleurocutaneous fistulae) and less need for thoracotomy or rib resection (6 vs 79%), if their empyema was managed by daily needle thoracentesis and lavage with or without intrapleural antibiotic administration versus chest tube drainage. Mortality was equal between the two groups at 8.5%. The two groups of patients were managed by different units (medical and surgical) and may have had different illness severities or other compounding factors. Daily thoracentesis, even if effective, may be impractical in children due to the daily requirement for deep sedation or general anaesthesia.

Initial chest tube drainage

In a series of complex adult patients from Taiwan,[6] with mostly Gram-negative bacterial infections, unsuccessful initial chest tube drainage (defined as incomplete drainage with ongoing signs of sepsis or death) resulted in a significantly higher mortality (47%) and longer hospital stays (28 days vs 16 days) than

immediate thoracotomy and decortication or successful chest tube drainage (6% and 11% mortality respectively). Similar findings have been reported previously.[7] It appears that incomplete drainage with ongoing signs of sepsis heralds a poor prognosis. It is important to note that inflammatory markers such as CRP and ESR can remain elevated for up to 4 weeks despite adequate antibiotic treatment and drainage, although blood leukocyte count and fever falls by one week post drainage.[8] This delayed resolution of inflammatory markers makes assessment of recovery after drainage difficult. The efficacy of pleural fluid drainage thus remains the key to the clinical decision- making process.

A large survey of practice in Britain indicates that only 11% of all paediatric empyemas are managed surgically. Long-term outcome is excellent.[9] Most cases are adequately treated with simple chest tube drainage. In a recent series from Great Ormond Street, later chest drain insertion (8.1 vs 6.3 days after effusion detected) was associated with a trend towards requirement for surgical drainage.[8] Those children requiring surgery had a longer hospital stay (18.6 vs 13.4 days), but surgery was only undertaken if chest tube drainage failed to result in complete drainage and clinical symptoms persisted. The authors felt that inadequate chest tube size contributed to some failures. Chest tube size need not be routinely large, but should be determined by the degree of viscosity of the fluid.[5]

The adult literature reveals a key point, which is that successful complete drainage by chest tube alone can occur even when loculations are evident on ultrasound or computerized tomography scan. However, the presence of loculations makes complete chest tube drainage less likely, with only 40% of loculated effusions drained completely versus 76% of simple effusions.[5] A non-dependent chest tube position does not affect drainage in non-loculated effusions. Truly loculated effusions require ultrasound guidance to achieve the correct tube location. Surprisingly a lower pleural fluid leukocyte count is associated with failure of conservative management.[5]

Fibrinolytic therapy

In adults the addition of fibrinolytic agents to the pleural cavity can improve chest tube drainage impeded by loculations and fibrin debris,[10] and may reduce the need for thoracotomy or video assisted thoracoscopic surgery (VATS).[11,12] In a series of 501 children with multiloculated empyema intrapleural fibrinolytic therapy (IPFT) was successful in avoiding surgery in 81% of cases.[13] In a series of 22 children with complicated parapneumonic effusions from Taiwan, streptokinase resulted in a reduction in requirement for surgery and shorter duration of fever when compared with 20 historical controls.[14] There is one randomised controlled trial from India of routine administration of streptokinase intrapleurally 24 hours after chest tube insertion. No benefit was detected in terms of chest tube drainage rates, duration of illness or development of loculatons.[15] Intrapleural streptokinase may rarely lead to local bleeding complications. This was seen in one child administered 250,000 units of streptokinase.[13] Streptokinase can cause fever, pleural pain, arthralgia, anaphylaxis and the acute respiratory distress syndrome (ARDS).[11] Urokinase may be the safest choice, with no recorded complications at a dose of 100,000 Units intrapleurally used in the Oscelik series[13] and in another series from Israel.[16]

Pigtailed catheters and tissue plasminogen activator (tPA)

Literature regarding the use of intrapleural tissue plasminogen (tPA) activator is limited, with only one report of its use in 12 children[17] until Hawkins *et al*,[18] published a recent report of tPA combined with small bore pigtail catheter drainage of empyema in children. They reported successful management of empyema in 54 of 58 cases with a mean time to catheter removal of 6 days and a mean hospital stay of 9.1 days, using this minimally invasive technique.

Video assisted thoracoscopic surgery (VATS)

Surgical options include a choice between VATS and formal thoracotomy. A study in 1997 of 20 adults compared VATS with chest tube drainage plus IPFT with streptokinase in loculated effusions unresponsive to isolated chest tube drainage only.[19] Ninety one percent of patients undergoing VATS avoided further surgery. However, 44% of the chest tube plus IPFT treated group required further thoracotomy. In another study comparing immediate VATS with VATS after failed chest tube drainage and IPFT in late stage disease,[20] shorter hospital stays (4.5 versus 7.5 days) were demonstrated in the early VATS group. At least two adult studies report VATS debridement to be better than thoracotomy in terms of hospital stay and cosmesis.[21,22]

VATS is reported to be rapidly successful in the majority of paediatric empyema cases with failed chest tube drainage when performed within 7 days of the initial attempt at chest tube drainage.[23,24] VATS also resulted in shorter hospital stays (9 - 13 days) when compared with previous series of children managed with chest tube drainage and delayed thoracotomy. In the recent series of 230 children from the United States of America,[1] children that received very early VATS (within 48 hours of admission), had a shorter hospital

stay (11.5 versus 15.2 days, P = 0.008) than those who had VATS performed later. However, VATS is not widely available, especially for children.

Early thoracotomy

Thoracotomy is traditionally resorted to only after the more conservative management strategies, discussed above, have failed. This surgery is associated with potential anaesthesia difficulties, complications such as pneumothorax, postoperative pain and cosmetic scarring. Some authors have challenged this traditional notion of deferring thoracotomy. Hoff *et al*,[25] in a series of 61 children, reported that resolution of the disease process was more prolonged in patients managed by chest tube alone (16.8 days in hospital) than resolution after thoracotomy (6.7 days, P < 0.001). Carey *et al*, [26] reported a series of 22 children with empyema referred to a paediatric cardiothoracic unit. Those children who had immediate thoracotomy (18 cases) were afebrile and had their chest tubes removed by 2 days. Their mean hospital stay was 4 days. The authors suggested that early thoracotomy remains the benchmark treatment. A similar case series of 44 children undergoing thoracotomy[27] also revealed very short duration of fever (mean 1 day) and an average of 3 days until chest tube removal. Both series authors point out that their mean hospital stays were shorter than series of children managed with VATS.

In summary, the available evidence indicates early and complete drainage of an empyema remains the cornerstone of treatment, however it is achieved. Morbidity and mortality increases with increasing delay in achieving this goal. Most patients can be managed with antibiotics and chest tube drainage only, especially early in the disease process. It is harder to treat late stage disease conservatively. Conservative treatment results in prolonged hospital stays. Intrapleural fibrinolytics, ideally urokinase, may help to avoid surgery. Surgery in the form of VATS or thoracotomy, when done early, appears to result in the most rapid disease resolution, from the limited paediatric evidence available. Thoracotomy may be superior to VATS in terms of length of stay, contrary to the adult literature. The former has significant cosmetic disadvantages; the latter is not as widely available.

CONCLUSION

Empyema in children occurs infrequently in Western societies. The underlying causative organism is usually *Staphylococcus aureus* or *Streptococcus pneumoniae*. Optimal management strategies have not been developed due to a paucity of randomised controlled trials. Staging is difficult to assess clinically and radiologically. Most cases can be successfully managed with simple chest tube drainage, plus appro-riate antibiotic therapy. Based on available evidence, thoracotomy with decortication, in children, may provide the most effective treatment when compared with VATS and chest tube drainage with or without intrapleural fibrinolytic therapy. The more conservative approaches to treatment may be appropriate initially to avoid the cosmetic disadvantages of thoracotomy. However, delayed complete drainage increases morbidity and potentially mortality.

The case presented might have been managed differently. Under general anaesthesia, a pleural tap would have revealed the relatively serous nature of the fluid and chest tube drainage only may well have been successful. However, the loculated nature of the collection and the illness of the child prompted initial thoracotomy. VATS is not available for children in our institution. Our treatment decision is difficult to criticise in light of the available evidence that early thoracotomy leads to the most rapid resolution of the disease process, earlier discharge, and reduced mortality. The major drawback of thoracotomy is the life-long surgical scar. This drawback is not insignificant, but has to be weighed against the potential morbidity and mortality from ongoing infection. In retrospect, it is the authors' view that a less aggressive approach in our case could also have been justified and may have resulted in a better cosmetic result. This approach would be initial chest tube drainage only, under ultrasound guidance, instillation of urokinase on the second day if required, then proceeding to thoracotomy within 48 - 72 hours of initial chest tube insertion if pleural fluid drainage were incomplete.

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