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CME ARTICLE

Interventional radiology treatment of empyema and lung abscesses

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EDUCATIONAL AIMS

- To discuss the known complications of pneumonia in children.
- To list the treatments for empyema in children.
- To discuss novel treatments for empyema in children.
- To show the role of imaging in children with complicated pneumonias.
- To list the indications for image guided drainage of lung abscesses in children.

KEYWORDS
paediatrics;
child;
empyema;
pneumonia;
lung abscess;
radiology;
interventional

Summary Pneumonias in children can be complicated by pleural effusions, empyema and abscesses. The incidence of these complications is increasing, correlated to an increased virulence of the pneumococcal bacterium. These complications may prolong morbidity and lead to decreased pulmonary function. Traditionally, patients were treated medically with antibiotics, and refractory complications were treated surgically with large bore chest tube placement and thoracotomy. Improvements included instilling fibrinolytics into the chest tubes and video-assisted thoracoscopic surgery, which expedited recovery and improved outcomes. Image guided techniques from interventional radiology have been developed as an alternative to treat these patients with minimal invasiveness. These therapies have achieved high success and low complication rates, and are the preferred first-line procedures when available.

INTRODUCTION

Pneumonia in children is quite common and usually responds either to oral or intravenous antibiotics. However, in a subset of patients, the pneumonia can be complicated by pleural effusion, empyema or necrotization progressing to pneumatoceles or abscesses. These children often require additional interventional therapies to resolve their primary illness, with a secondary goal of preserving lung function.[1] These complications are most likely related to the virulence of the pathogen, with *Streptococcus pneumoniae* being the most common bacterium.[2–5] The incidence of complicated pneumonia due to pneumoccocal disease is increasing.[2,3]

It is well established that appropriate treatment of empyema will help control sepsis, restore pulmonary function and prevent lung entrapment from the fibrous peel.[2,6,7]

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Traditionally, pleural collections were treated with large bore catheters inserted by a surgeon. If this failed to completely drain the pleural space, surgical intervention with a decortication was performed. Later developments included instilling a fibrinolytic into the chest tube in an attempt to break up loculations and video-assisted thoracoscopic surgery (VATS).[1,8–11] Interventional radiologists originally had a limited role in the management of these patients, with image guided procedures indicated if residual loculated collections remained after surgical therapy. However, after successful treatment of these post-surgical patients, image guided interventional techniques were adapted for primary treatment of patients with pleural collections, as they were better tolerated than surgery, avoided general anaesthesia, had a high clinical success and were without significant complications.

Abscess and pneumatocele complications from pneumonia occur less often than does pleural infection, and while most commonly due to pneumococcal disease, polymicrobial infection or other pathogens have a higher incidence than with empyema. In addition, congenital malformations such as sequestration or congenital cystic adenomatoid malformation may present as pulmonary abscesses.[12] In the majority of patients, the abscess spontaneously drains via the airways and prolonged antibiotic therapy is sufficient. Spontaneous drainage is less common is patients younger than 7 years old, with up to 21% failing medical treatment.[13] Similar to pleural disease, this problem was traditionally managed surgically and usually required a partial or complete lobectomy, with the potential of reducing later pulmonary function. Interventional radiology is the preferred treatment modality for abscesses in most other areas of the body. These same techniques have been adapted to treating intrapulmonary collections, with a high degree of success.

The purpose of the article is to describe image guided techniques for treating complicated pneumonias and to evaluate the role of these techniques in the care of paediatric patients.

INTERVENTIONAL RADIOLOGY TECHNIQUES

Empyema

Imaging

Chest radiographs are usually the first imaging to be done in a patient with pneumonia (Fig. 1a). Advanced imaging may not be needed, but is often helpful. The amount of pleural fluid is often not apparent on the chest film as an opaque hemithorax may have little fluid or the entire lung may be collapsed by a large empyema.[14]

A CT scan will show all areas of pleural disease and can direct tube placement; however, CT is poor at distinguishing the character of the fluid (transudate versus exudate) or the presence of loculations[2,14–16] (Fig. 1b).

Ultrasound imaging can verify or exclude the presence of fluid. It also grades the fluid, depending on the identification of loculations.[2] Stage I is anechoic fluid, Stage II has loculations and Stage III is identified to be a solid peel.[17] However, ultrasound is a directed study and distant sites of disease may be missed[14] (Fig. 1c).

Procedure

Almost all patients will require some form of sedation or anaesthesia. Standard sedation protocols are followed. We typically use a combination of pentobarbital and fentanyl intravenously in children younger than 12 years old, with midazolam substituting for pentobarbital in older patients. General anaesthesia or other medications may be used as well, when available.

While some advocate serial thoracentesis for thin effusions,[7] we only perform thoracentesis for diagnosis of the pathogen. If a patient has fever or oxygen requirement, we always place a tube. This eliminates the need for multiple sedations and it is easier to remove the tube than to perform the procedure again. The patient is placed supine or with the affected side slightly elevated. The arm is either raised over the head or placed across the anterior chest. Pre-procedural ultrasound scanning is performed to determine the best site for access, the most appropriate transducer and the character of the fluid. Typically, we use an 8 MHz curvilinear transducer with a small footprint as it easily fits into the small imaging window between the ribs. A standard sterile prep and drape are performed.

The goal is to place the tube in a posterior location as the fluid is dependent. The mid-axillary line is usually chosen as it allows for posterior tube placement without the patient having to lie on the tube. For isolated collections, the most appropriate access to the empyema is chosen based on imaging findings. Local anaesthesia is provided, and with direct ultrasonographic guidance, a sheathed needle is directed posteriorly and over the rib to avoid the intercostal vessels. A small sample of fluid is taken and sent to the laboratory.

The remainder of the procedure is performed with fluoroscopic guidance. A guidewire with a floppy tip is advanced and directed posteriorly. Over the wire, the tract is dilated and a pigtail catheter placed. We generally use 12-French catheters, although the size may be decreased in smaller children or increased if the ultrasound characteristics suggest thick fluid. Alternatively, other catheters may be used. The wire or catheter can be manipulated through the pleural space to try and break up adhesions; however, this may lead to wire or catheter kinking and does not usually result is a large amount of additional drainage compared to the use of fibrinolytics. The catheter is secured to the patient and is attached to a standard chest drain with 20 cmH_2O suction.