Community acquired pneumonia in children

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This article is designed to provide a practical introduction for junior medical staff to paediatric pneumonia. It is not exhaustive but will hopefully supplement other resources and provide some background detail to current recommendations.

What is pneumonia?

Pneumonia involves an acute respiratory infection involving the lower respiratory tract (distal bronchi and alveoli). The host-pathogen interactions and ensuing inflammatory response lead to the accumulation of oedema and purulent secretions within the airspaces, these changes are central to the pathogenesis of pneumonia (Figure 2).

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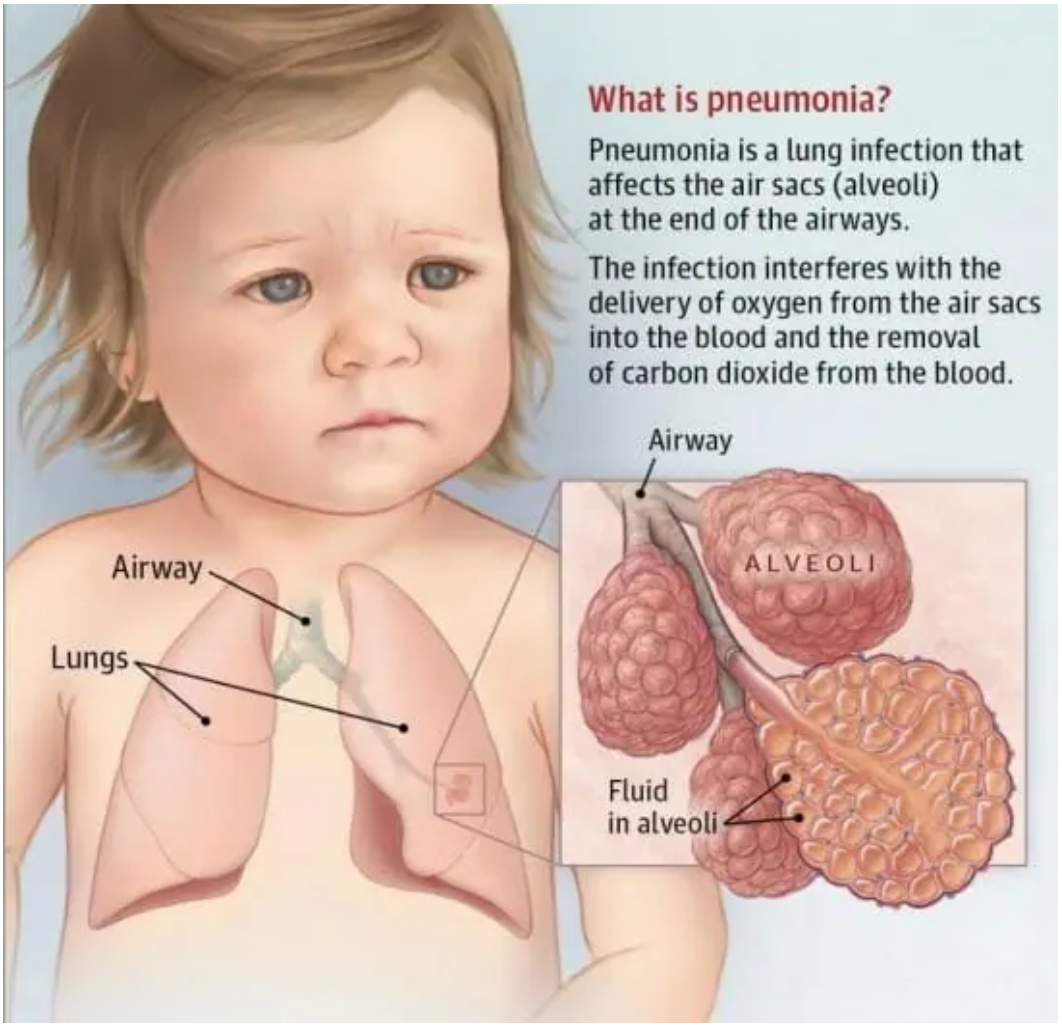

Figure 1. What is

pneumonia? This graphic demonstrates the disease process within the distal bronchi and alveoli.[/caption]

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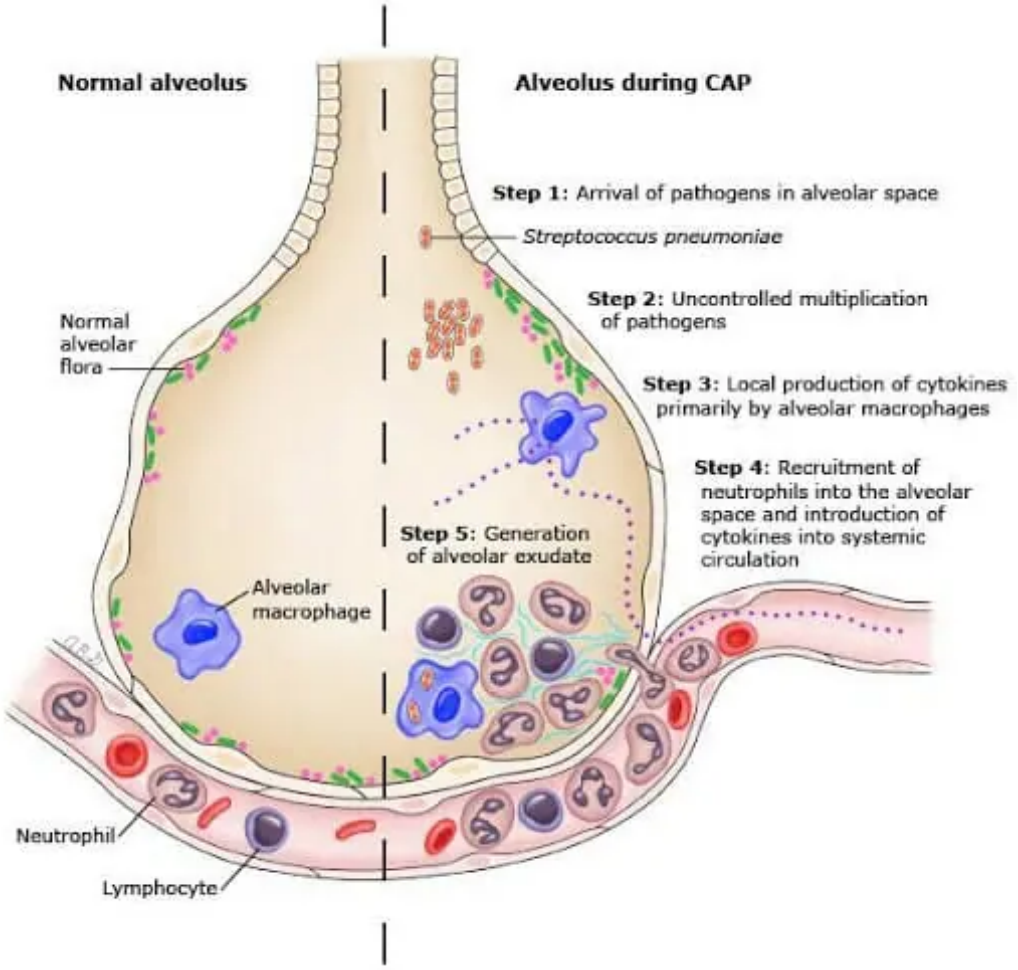

Figure 2.

Pathophysiology of community-acquired pneumonia.[/caption]

What are the most useful clinical signs of community acquired pneumonia in children?

Children commonly present to the emergency department with fever. An Australian cohort study of febrile children aged under 5 years presenting to a tertiary children's hospital emergency department reported community acquired pneumonia to represent 3.4 % of cases [1].

Clinical presentation can vary widely and no presenting sign is pathognomic for paediatric CAP.

A large systematic review included 23 prospective cohort studies and correlated the most useful clinical examination findings with the presence of radiographically confirmed pneumonia. The strongest positive examination findings with confirmed

radiographic pneumonia were: chest pain, fever (temperature above 37.5°C), tachypnoea, hypoxaemia (SaO2 <96%) and increased work of breathing. The presence of wheeze and normal oxygen saturations (SaO2 >96%) decreased the likelihood of radiographic pneumonia [2].

Complicated pneumonia presents with similar clinical features to uncomplicated pneumonia or as a more severe disease, with persisting fevers despite antibiotic treatment and/or acute respiratory compromise. Pleurisy may present as acute chest or abdominal pain. Advanced disease may present as sepsis or toxic shock syndrome.

Neonates and infants often present without localising symptoms and signs. At this age the presentation may only be significant for poor feeding, increased work of breathing and temperatures above/below the normal range.

The differential diagnoses for children presenting with tachypnoea are broad. Important diagnoses to consider include; decompensated cardiac disease, airway foreign body, diabetic ketoacidosis and sepsis.

When community acquired pneumonia is suspected, which tests are necessary for which patients?

It is important to consider the value of performing a test. As clinicians we strive to be rational with our investigations. A test should be performed if the result will change a patient's management.

Chest radiograph

Features of chest radiographs suggestive of CAP include:

- **Airspace opacification with lobar or segmental disease patterns.**
- **Air Bronchograms: the silhouette of bronchi against the opacified airspaces. Except for the presence of air-bronchograms, airspace pneumonia is usually homogenous in density.**
- **Blunting or fluid collections (air-fluid) level at the costophrenic angles. Note infants with radiographs taken in a supine position may have a veiled appearance suggesting a pleural effusion rather than a dependent collection.**
- **Viral or Atypical pathogens (Mycoplasma pneumoniae, Bordetella pertussis, Chlamydia pneumoniae) tend to involve airway walls and alveolar septa and give a widespread, fine reticular pattern.**
- **Thoracic scoliosis (concave toward the lesion) is often associated with empyema and may reflect pain.**
- **Necrotising pneumonia may be evident on radiographs as cavitating chest lesions or fluid filled abscesses, however, these changes are better appreciated on chest CT.**

When describing pulmonary infiltrates, it is helpful to consider the size, site, and character of the infiltrates, and the presence of a pleural effusion, cavitation, or air leak.

Chest radiographs have limitations

These include:

- **A poor correlation between clinical signs and chest radiography,**
- **There is significant inter-observer variability in the interpretation of chest radiographs, and**
- **Chest radiographs are not able to distinguish aetiology i.e. they poorly discriminate between viral and bacterial pneumonia.**

The British Thoracic Society (BTS) and the Infectious Disease Society of America (IDSA) suggest reserving chest radiograph for patients requiring hospitalisation, i.e. those more likely to have severe or complicated disease. Children with suspected pneumonia who do not require hospitalisation do not require a chest radiograph [3, 4].

Chest radiographs of a 2-year-old taken 48hrs apart, after representing with persisting fevers despite appropriate oral antibiotics. Left; right upper zone opacification, multiple air bronchograms seen. Right; more extensive right upper and middle zone opacification, no mediastinal deviation, lentiform opacity at right lateral aspect and loss of costophrenic angle consistent with a right sided empyema (confirmed on US).)

Blood cultures

The yield of blood cultures in paediatric pneumonia is less than in adults with pneumonia. In children presenting to the emergency department with CAP the rates of bacteraemia are reported as 1-3% of cases [5]. The rates of bacteraemia increase with more severe disease and may be as high as 8-10% in complicated pneumonia [6, 7].

The current recommendations from the BTS and IDSA is for blood cultures to be collected in hospitalised patients. The NSW health guidelines recommended a blood culture is collected in patients requiring hospitalisation and/or those with moderate to severe disease.

Inflammatory markers

Non-specific inflammatory markers include white cell count, C reactive protein (CRP), erythrocyte sedimentation rate (ESR) and procalcitonin. These measures have been shown useful in sepsis or bacteraemic infections. The limitation of inflammatory markers in pneumonia is the inability to distinguish between viral and bacterial pneumonia. When all or most of these markers are elevated bacterial aetiology is highly probable but low values do not rule out serious bacterial infection [8].

Other investigations

Other investigations to be considered in severe disease include;

Chest ultrasound

This is a non-invasive and safe imaging modality that can quantify and characterise pleural fluid or peripheral parenchymal lesions such as suspected lung abscesses. Chest ultrasound is considered in patients with chest radiograph findings suggestive of parapneumonic effusion, empyema or lung abscess either failing to respond to empiric antibiotic treatment or with indications for operative intervention.

Chest CT scan

Chest computed tomography provide detailed evaluation of airway and parenchymal architecture. The use of contrast allows enhancement of vascular and pleural structures and is helpful in defining pulmonary abscess, necrotising or cavitating tissue. The information provided is balanced against the radiation exposure to the patient, the risks of intravenous contrast, and in paediatrics a general anaesthetic is often required to facilitate imaging. In most cases of complicated pneumonia requiring a surgical intervention a CT scan is performed preoperatively. In the evaluation of children with complicated pneumonia, CT often reveals clinically significant findings not apparent on radiography [9].

Treatment

Determining severity of disease:

The initial assessment of disease severity is a key aspect to guide subsequent management. WHO guidelines exist for determining severe disease although these have limited clinical utility in well-resourced health care settings. Unlike in adult pneumonia, no validated disease severity scores exist in paediatrics. Consensus definitions of severe paediatric CAP published by the BTS and IDSA are shown below:

Non-severe pneumonia

In children who do not require hospitalisation, empiric amoxicillin (25mg/kg/q8h) is recommended as the first line antibiotic. Addition of a macrolide antibiotic is suggested if there is no clinical improvement after 48 hours. Macrolide antibiotics are first line in children with a penicillin allergy. The Australian Therapeutic Guidelines suggest a five-day course if there is good improvement by day three, and if treatment response is slower then to continue to a seven-day course. Penicillin resistance to S.pneumoniae is uncommon in Australia.

The PIVOT trial compared oral and intravenous penicillin for the treatment of non-severe paediatric CAP and reported no clinically significant difference in time to resolution of fever or oxygen requirement [10].

It is important to discuss with parents the expected course and organise for follow up review. It should be highlighted that persisting fevers, worsening in respiratory status or fluid intake should prompt a more urgent medical review.

Severe pneumonia

The management of severe pneumonia is beyond the scope of this article. The priorities in early management are largely as for suspected sepsis. Resuscitation and supportive care measures are aimed at normalising gas exchange and ensuring adequate oxygen delivery to tissues.

The Australian Therapeutic Guidelines recommend an intravenous third-generation cephalosporin and a macrolide e.g. Cefotaxime (50mg/kg/q8h) and Clindamycin (15mg/kg/q8h). The inclusion of a macrolide confers broader anti-staphylococcal coverage and impairs toxin production in toxic shock syndromes [11]. Where influenza is suspected the use of Oseltamivir may be appropriate.

Empyema requiring intervention may be managed by either insertion of percutaneous chest drain with instillation of fibrinolytics or by minimally invasive thoracoscopic surgery. A recent meta-analysis reported that rates of reintervention are lower in

children following surgical intervention but no difference in clinical outcomes [12]. These potential benefits need to be weighed against the more invasive and expensive procedure. In the setting of empyema complicated by bronchopleural fistula, only the surgical intervention is considered as fibrinolytics are contraindicated with BPF.

Complicated pneumonia

The term complicated pneumonia refers to several conditions originating from pneumonia, an acute infection of the lung parenchyma. We will discuss several important complications here. Other important extrapulmonary complications include haemolytic uraemic syndrome, hyponatraemia secondary to inappropriate antidiuretic hormone secretion, and sepsis.

Empyema thoracis

The most common complication of paediatric pneumonia is empyema thoracis, better known as empyema. This complicates approximately 2-7% of cases of community acquired pneumonia requiring hospital admission in children [13].

Empyema is the accumulation of purulent fluid within the pleural cavity. This is most commonly seen in preschool age children (1-5 years old) who typically present with persisting fevers (often for longer than five days), respiratory compromise, and pleuritic pain. It is important to note that pleuritic pain may be interpreted as chest pain or abdominal pain depending on which pleural surface is involved.

Empyema begins as a parapneumonic effusion. As microbes and leukocytes enter the pleural space there is an evolution from a simple protein rich fluid to a complex organising fluid with fibrin deposits forming loculations and septations within the fluid. This fluid can gather across the visceral lung surface and obstruct normal expansion, a so called trapped lung. The most common bacteria associated with paediatric empyema include Streptococcus pneumonia, Staphylococcus aureus and Streptococcus pyogenes [14].

Necrotising pneumonia

The next complication of paediatric pneumonia which this article will discuss is necrotising pneumonia. This is necrosis within the lung parenchyma, which leads to the destruction of the normal pulmonary architecture and the formation of cavitations. These cavitations usually but not always involve the pleura.

Panton-Valentine Leukocidin (PVL) is an exotoxin that forms pores in leukocyte cell membranes leading to the release of cytotoxic granules and extensive tissue injury. PVL positive S.aureus can be associated with severe necrotising pneumonia as well as skin and soft tissue infection [15]. Necrotising pneumonia should be considered in patients with a worse clinical syndrome of pneumonia, children presenting with a pyopneumothorax, or those not responding to appropriate antibiotic therapy [16].

Bronchopleural fistula

The final pulmonary complication this article will discuss is bronchopleural fistula (BPF). Children with necrotising pneumonia are at increased risk of developing bronchopleural fistulae and subsequent air leak with air accumulating in the pleural space. BPF is associated with greater morbidity, longer hospital stay and higher likelihood of surgical intervention [17].

Conclusion

This article has discussed the common pulmonary complications of pneumonia in children, as well as an approach to diagnosis and management of pneumonia in children. It is hoped that this gives a greater understanding to junior doctors working in Emergency or Paediatrics, to assist in managing this common paediatric presentation.

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