Management and complications of pneumonia

Matthew F Thomas
Alice Wort
David A Spencer

Abstract

Pneumonia is the leading cause of mortality in children under five worldwide. Death is rare in developed countries, but it remains a major cause of hospital admissions and of both acute and chronic morbidity. Understanding current management and recognition of complications is important to all paediatricians. The causative organism varies with age and differentiating between viral, bacterial and other causes can be challenging. Supportive care and antibiotic treatment are the mainstays of modern management. The evidence base to support treatment policy is remarkably weak.

The incidence of both uncomplicated and complicated pneumonia has been increasing, particularly that of empyema and necrotic lung disease. There is evidence that the introduction of the new conjugate pneumococcal vaccines has reduced the incidence of pneumonia in many parts of the world, although the incidence of complications including empyema and necrotising pneumonia *may* possibly have increased as a consequence of this policy. The management of complications has changed over recent years and remains the subject of some controversy. The syndrome of inappropriate anti-diuretic hormone secretion (SIADH) has long been cited as a complication of pneumonia; but the existence of this entity is now being questioned. There is increasing evidence that pneumonia increases the risk of chronic obstructive pulmonary disease, bronchiectasis and asthma in later life.

Keywords abscess; empyema; inappropriate ADH syndrome; lung; necrosis; paediatrics; pleural; pneumonia

Pneumonia is now estimated to be the leading cause of mortality in children under five worldwide. The incidence varies with age with the greatest burden falling in the 1–5 year age group. Aetiology varies considerably with viral pneumonia being relatively more common in younger children. Causes by age group are listed in Table 1.

Management of pneumonia

Differentiating between bacterial and viral pneumonia

This is a significant challenge, particularly in younger children. There are few reliable distinguishing clinical features. The presence of wheeze *may* increase the likelihood of viral infection in infants.

No single test or combination of tests is able to differentiate between bacterial and viral pneumonia with sufficient reliability to be applicable in routine clinical use. Radiological findings are insensitive in predicting aetiology.

General management of children with uncomplicated pneumonia

Adequate analgesia is important. Pleuritic pain impairs coughing and deep inspiration. Other sources of discomfort include referred abdominal pain and headache. Simple analgesia is usually sufficient to keep children comfortable. Two studies have found an association between ibuprofen and the risk of subsequent empyema, but these findings probably reflect the fact that children who develop empyema are usually sicker than patients with uncomplicated disease.

Supplementary oxygen should be given if the oxygen saturation falls below 92%. Nasal cannulae or a head box may be required in small infants. Children with pneumonia are at increased risk of dehydration due to increased insensible water loss and inadequate fluid intake. Maintenance of enteral intake using either a naso-gastric (NG) tube or frequent small volume feeds is more physiological than intravenous (IV) fluids. NG tube placement obstructs the airway and impairs airflow, although it is not known if this is of any genuine clinical importance.

Physiotherapy is not beneficial in acute pneumonia. It is uncomfortable for the patient, does not promote resolution of consolidation and may increase duration of fever.

Admission to hospital

A significant proportion of cases are mild and can be managed at home. Respiratory distress, uncontrolled pain and poor feeding are sensible reasons for admission. Admission is often required if the child does not improve after a standard course of oral antibiotics because the risk of complicated, atypical or more severe disease is higher. Social issues and the ability of the family to provide appropriate supervision and care must also be considered.

Antibiotic treatment

- Whether to treat with antibiotics or not?

Viruses are a common cause of pneumonia but anti-viral agents are not indicated in uncomplicated disease affecting otherwise normal children. Antibiotics are not indicated for viral pneumonia, and their inappropriate use increases the risk of antibiotic resistance, which is a major management problem in many parts of the world. Unfortunately, routine investigations are usually unable to differentiate clearly between viral and bacterial infection. It is suggested that empiric antibiotic treatment is avoided in patients with milder disease of unproven aetiology, but this is not usually feasible in more severely affected patients.

- Choice of agent:

A 2010 Cochrane review addressed antibiotic treatment of community acquired pneumonia in children. Amoxicillin and Co-trimoxazole are effective for ambulatory patients with non-severe pneumonia (Odds Ratio (OR) 1.12; 95% Confidence Intervals (CI) 0.61 – 2.03) and had similar failure rates (OR 0.92; 95% CI 0.58 – 1.47). For children with severe or very severe

Matthew F Thomas *MBChB MRCPCH PhD is an Academic Clinical Lecturer in Respiratory Paediatrics, Great North Children's Hospital, Newcastle-Upon-Tyne, UK. Conflicts of interest: no conflicts of interest.*

Alice Wort *MBBs MRCP is a Paediatric Pneumonia Research Fellow at the Great North Children's Hospital, Newcastle-Upon-Tyne, UK. Conflicts of interest: no conflicts of interest.*

David A Spencer *MBBS (Hons) MD MRCP FRCPCH is Consultant in Respiratory Paediatrics, Great North Children's Hospital, Newcastle-Upon-Tyne, UK. Conflicts of interest: no conflicts of interest.*

Causes of pneumonia by age

Neonatal period	1–12 months	1–4 years	5–16 years
Streptococcus agalactiae (Group B streptococcus)	Respiratory Syncytial Virus (RSV)	RSV	*Streptococcus pneumoniae*
Escherichia coli	Parainfluenza Viruses	Parainfluenza Viruses	*Mycoplasma pneumoniae*
		Influenza	
Cytomegalovirus (CMV)	*Chlamydia trachomatis*	Adenovirus	*Chlamydia pneumoniae*
Listeria monocytogenes	*Staphylococcus aureus*	*Streptococcus pneumoniae*	*Mycobacterium tuberculosis*
	Streptococcus pneumoniae	*Haemophilus influenzae*	
	Bordetella pertussis	*Mycoplasma pneumoniae*	
		Mycobacterium tuberculosis	

Table 1

disease IV Penicillin or Ampicillin plus Gentamicin is superior to Chloramphenicol. Other suggested agents include Ceftriaxone, Levofloxacin, Amoxicillin-clavulanate and Cefuroxime. Macrolide treatment should be considered when *Mycoplasma* or *Chlamydia* infection is suspected. It is unclear if Azithromycin alone is more effective than Amoxicillin or Amoxicillin-clavulanate for the treatment of acute pneumonia in all age groups, but there is increasing concern regarding the emergence of macrolide resistance. The British Thoracic Society (BTS) guidelines recommend Azithromycin as a first line treatment in children over 6 years of age as *Mycoplasma* is more prevalent in older children.

- Duration of treatment:

Three large scale randomised controlled trials (RCTs) demonstrate that 3 days treatment with Amoxicillin is as effective as 5 days in non-severe community acquired pneumonia with equivalent cure, treatment failure and relapse rates. There is little data comparing treatment regimes in other situations such as severe disease or nosocomial pneumonia.

- Route:

Oral Amoxicillin rather than IV Penicillin may be suitable for hospital based treatment of severe pneumonia in non-hypoxic children.

Practice points

- Supportive care includes adequate analgesia, supplementary oxygen and attention to fluid balance
- Amoxicillin and co-trimoxazole are effective first line treatments for non-severe community acquired pneumonia
- Three days treatment is usually as effective as five days

Complications of pneumonia

Parapneumonic effusion & empyema

Parapneumonic effusion is an exudate within the pleural space associated with underlying pneumonia. Complicated effusion refers to secondary invasion of the pleural fluid by the infectious agent and empyema is defined by the presence of frank pus in the pleural fluid. Parapneumonic effusion and empyema can be divided into three stages:

- Exudative stage – fluid accumulation within the pleural cavity without loculation.
- Fibropurulent stage – presence of pus and fibrin deposition leading to loculations.
- Organisational stage – organised empyema with multiple loculations trapping the lung and hard rind formation.

In clinical practice these changes represent points in a continuous spectrum of disease.

The incidence of empyema in children has risen significantly over the last 15 years. It is unclear what has driven this increase.

Microbiology

The commonest causative organisms globally are *Streptococcus pneumoniae*, *Streptococcus pyogenes* and *Staphylococcus aureus*. Other important causes include *Mycobacterium tuberculosis*, *Streptococcus anginosus* group which is associated with recurrent aspiration and *Fusobacterium* spp. which may result in Lemierre's syndrome. *S. pneumoniae* serotype 1 has previously been identified as the commonest cause in UK children using molecular diagnostic techniques. In the UK, the introduction of the seven-valent pneumococcal conjugate vaccine (PCV7) into the childhood immunization regimen in 2006 led to a decrease in the incidence of invasive pneumococcal disease (IPD). After vaccine introduction, more non-vaccine-type serotypes increased in frequency than decreased, consistent with vaccine-induced replacement. The thirteen-valent pneumococcal conjugate vaccine (PCV13) was introduced in 2010 and covers six extra serotypes to PCV7 including: serotype 1 and serotypes 7F and 19A, major causes of replacement disease. Initial data suggests that there has again been a decrease in the overall incidence of invasive pneumococcal disease following introduction of PCV13 in the UK, but further work is ongoing to determine if vaccine-induced replacement disease may be occurring.

Clinical features

Parapneumonic effusion and empyema should be considered in children with persisting fever despite treatment with appropriate antibiotics for 48 hours. Symptoms are similar to those of pneumonia but cough, dyspnoea, pleuritic and abdominal pain are more prominent. Signs include reduced chest movement,