
PNEUMONIA, ACUTE IN INFANTS AND CHILDREN

Clinical Features

WHO Algorithm for Diagnosing Pneumonia

Causative Organisms

Investigations

Treatment

Admission

Complicated Pneumonia

References

These guidelines do not apply to the immuno-compromised child, the child with chronic lung disease, or any child under the tertiary respiratory team.

Clinical Features

Pneumonia, bronchiolitis and asthma are all common illnesses that result in children presenting with acute lower respiratory symptoms and signs. Antibiotics should be given to children with pneumonia but not to children with bronchiolitis or asthma. It is therefore important to differentiate these and other respiratory illnesses.

Pneumonia is more common and more severe in younger children. In Auckland the hospitalisation rate of those < 2 years is 11 times higher than those aged ≥ 4 .

Most children with pneumonia present with cough or difficulty breathing, but only the minority of children with these symptoms have pneumonia. In pre-school aged children with cough or difficulty breathing, the World Health Organization (WHO) has defined 3 key clinical signs to use when deciding whether a child has pneumonia. These are tachypnoea, chest indrawing and absence of wheezing.

Based on these 3 signs the WHO has developed algorithms for deciding whether or not a child has severe pneumonia, pneumonia or no pneumonia (see below).

The WHO defines tachypnoea as a respiratory rate (RR):

- > 60 breaths per minute if < 2 months old;
- > 50 if aged 2-12 months and
- > 40 if aged 12 months to 5 years.

Count the respiratory rate over 60 seconds. RR counted over 30 seconds are 2 to 4 breaths per minute higher than RR counted over 60 seconds. Chest indrawing is defined as retraction of the lower chest wall on inspiration.

Tachypnoea increases the probability that a child has pneumonia, and its absence reduces the probability. Chest indrawing increases the probability of pneumonia, but its absence does not significantly reduce the probability. Nasal flaring or grunting increases the probability 3-fold, and crepitations 2 to 3 fold. The absence of these signs reduces the probability by approximately 25%. The presence of wheeze decreases the likelihood of pneumonia in children aged > 2 months but increases the likelihood in children aged < 2 months. The absence of wheeze neither increases nor decreases the probability of pneumonia. The presence or absence of fever neither increases nor decreases the probability of pneumonia.

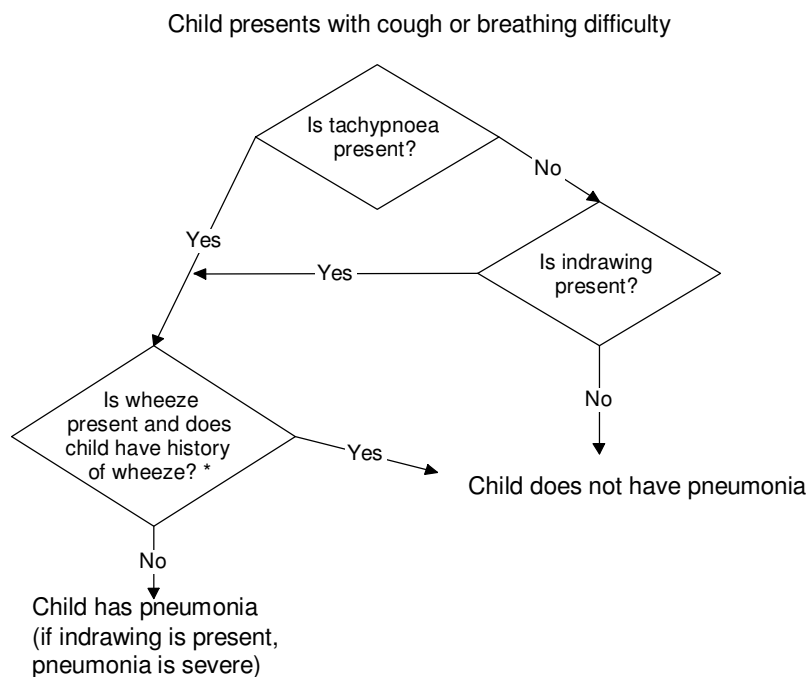
PNEUMONIA, ACUTE IN INFANTS AND CHILDREN

Clinicians use a combination of clinical signs when deciding whether or not a child has pneumonia. Unfortunately the probability of pneumonia based upon the presence or absence of these combinations has not yet been adequately evaluated.

A reasonable conclusion from the literature is that tachypnoea is the key clinical sign. If chest indrawing, nasal flaring, grunting or crepitations are also present then the probability of pneumonia is increased further. A child with wheeze and a past history of wheeze is unlikely to have pneumonia. If there is no respiratory distress, tachypnoea, crackles or decreased breath sounds there is no pneumonia.

Atypical presentations without obvious respiratory symptoms are not rare (abdominal pain and vomiting mimicking an acute abdomen; meningismus mimicking meningitis).

WHO Algorithm for Diagnosing Pneumonia



* A child with indrawing with a first episode of wheezing should be treated as if this illness is severe pneumonia even though that diagnosis may be proved incorrect in the subsequent 24 to 48 hours. The WHO recommends antibiotics only be given to those with pneumonia or severe pneumonia.

Causative Organisms

The proportion of pneumonia that is secondary to viral or bacterial infection differs between countries. There is minimal published data on this in New Zealand. In developing countries more pneumonia is bacterial than in developed countries, but viral studies are less extensive. In all countries the clinical severity of pneumonia is the best predictor of aetiology. The probability of

PNEUMONIA, ACUTE IN INFANTS AND CHILDREN

bacterial infection increases with increasing severity of the episode and decreasing age of the child.

In developed countries the aetiology of community acquired pneumonia has been defined by the child's age as well as the severity of the episode of illness. A summary of the results from studies performed is contained in Table 1.

Table 1 Aetiology of Pneumonia by Age Group in Developed Countries*

Age group	Predominant organisms from most to least frequent in each age group
0 to 1 months	Group B streptococcus Gram negative organisms
1 to 3 months	<i>Chlamydia trachomatis</i> Respiratory syncytial virus (RSV) <i>Bordetella pertussis</i>
1 to 24 months	RSV, other respiratory viruses [†] Mixed viral or viral/bacterial infections Bacterial infections: mostly <i>Streptococcus pneumoniae</i> and less frequently haemophilus species (both typable and non-typable) and <i>Mycoplasma pneumoniae</i>
2 to 5 years	Respiratory viruses <i>Streptococcus pneumoniae</i> Haemophilus species <i>Mycoplasma pneumoniae</i> <i>Chlamydia pneumoniae</i>
6 to 18 years	<i>M. pneumoniae</i> and <i>S. pneumoniae</i> are the predominant pathogens. Respiratory viruses account for < 15% of episodes of pneumonia in children > 5 years of age.

* The proportion of bacterial pneumonia in each age group increases with increasing severity.

† Other respiratory viruses = parainfluenza, influenza and adenoviruses

Investigations

Having made a clinical decision that a child has pneumonia, there is little information other than age and illness severity to guide the decision about antibiotics. The readily available investigations are seldom helpful in this regard.

Sputum and throat swabs do not help determine who should receive antibiotics. Sputum production is a non-specific response to airway inflammation, produced by viral and bacterial infections and by non-infectious processes such as asthma. Trying to obtain a sputum sample from a pre-school aged child is usually unrewarding. Leukocytes are found as frequently in sputum from which a virus is subsequently isolated as from sputum from which a bacterial culture is positive.

Where nasopharyngeal and percutaneous lung aspiration samples have been obtained simultaneously, bacterial culture of the nasopharyngeal sample has been poorly predictive of the culture results from lung aspirates. A blood culture is an insensitive test for bacterial pneumonia in children. In a recent study of Auckland children hospitalised with pneumonia blood cultures were positive in 3% (10/389) with 4 of these 10 positive cultures revealing a skin contaminant.

PNEUMONIA, ACUTE IN INFANTS AND CHILDREN

Neither the presence nor height of fever, nor the total or differential white cell count nor the serum CRP help to differentiate viral from bacterial causes. Inter-observer agreement between radiologists is poor when categorising children's CXR as normal, equivocal or indicative of pneumonia or when differentiating children who have a proven viral or bacterial cause.

In summary: investigate if you remain uncertain about the diagnosis after history and examination or if you think the risk of a complication warrants further investigation e.g.

- Infants < 3/12 old who are non-specifically unwell with fever and tachypnoea require a full infection screen.
- Infants and children who are acutely unwell or remain unwell despite treatment need a CXR to rule out empyema, and blood cultures.

Treatment

Prescribe antibiotics for pneumonia. Given the dearth of randomised controlled trials, choose the antibiotics based on the severity of the illness and the age of the child.

- Oral antibiotics will provide adequate coverage for most mild to moderate episodes of pneumonia.

Age 3 months to 5 years: Amoxicillin 40 mg/kg/day (max. 500 mg/dose) given in 3 divided doses for 7 to 10 days

Age > 5 years: Erythromycin 40 mg/kg/day (max. 500 mg/dose) in 4 divided doses for 7 days

- Do not prescribe antibiotics to try to prevent pneumonia. Antibiotics do not prevent pneumonia in children with upper respiratory tract infections.
- Parenteral antibiotics should only be used for those requiring hospitalisation
- Penicillin resistance. When making empirical antibiotic choices for pneumonia it is not usually necessary to cover penicillin resistant pneumococci. Unlike pneumococcal meningitis, penicillin resistance has not been shown to alter the clinical outcome of pneumonia.

1. Staphylococcal Pneumonia

Although Staphylococcal pneumonia is classically associated with lung abscess and empyema, consider it in any child who is very unwell, has abscesses elsewhere or has developed pneumonia as a consequence of chickenpox, influenza or measles. Staphylococcal pneumonia is a medical emergency – if you suspect it, you must discuss the child with your consultant.

Appropriate initial IV antibiotics for suspected Staph aureus pneumonia are Flucloxacillin and Gentamicin. Most community acquired MRSA in Auckland is sensitive to Gentamicin. Theoretical evidence suggests that combined therapy with flucloxacillin and an aminoglycoside is superior to flucloxacillin alone in treatment of invasive Staph aureus infections.

PNEUMONIA, ACUTE IN INFANTS AND CHILDREN

2. Pneumonia Not Likely To Be Staphylococcal

Suggested empirical IV therapy for inpatients with uncomplicated pneumonia (no suspicion of staphylococcal disease, no lung abscess or pleural effusions) is:

Age	Antibiotic	mg/kg/dose	Interval (hrs)
Less than 3 months	Cefotaxime +	50 mg	8 ⁱ
	Amoxicillin	50 mg	6 ⁱⁱ
3 months to 2 years	Cefuroxime	25-30 mg (max 1500 mg / dose)	8
2 to 5 years (immunisation status incomplete or uncertain)	Cefuroxime	25-30 mg (max 1500 mg / dose)	8
2 to 5 years (fully immunised)	Amoxicillin	25-30 mg (max 2000 mg / dose)	8
Over 5 years of age	Amoxicillin ⁱⁱⁱ	25-30 mg (max 2000 mg / dose)	8

- i. In term babies < 7 days old, reduce to 12 hourly
- ii. In term babies < 7 days old, reduce to 8 hourly
- iii. In a child > 5 years, if there are features of mycoplasma consider oral Erythromycin instead.

Duration of therapy is determined by clinical response. Intravenous therapy should be used until the child is afebrile and, in the case of severe pneumonia, for several days after this. Total duration of therapy is usually 7 -10 days.

Monitor pulse rate, respiratory rate, temperature, and oxygen saturation.

Admission

Many children can be treated as outpatients: those > 3 months who do not look toxic, who have mild respiratory symptoms, who are drinking well and taking oral medication. Review these children (by phone or in person) within 24 hours.

Indications for admission include any of the following:

1. Ill or toxic appearance.
2. Age < 6 months.
3. Respiratory distress interfering significantly with feeding.
4. Hypoxaemia: oxygen saturation less than 93 - 94% on air.
5. Significant dehydration.

PNEUMONIA, ACUTE IN INFANTS AND CHILDREN

6. Pleural effusion or lung abscess.
7. No response or further progression despite appropriate oral antibiotics.
8. Pre-existing medical illness.
9. Social stress, no car, no phone, language or communication barriers.

Complicated Pneumonia

Pleural Fluid

Discuss all children with pleural effusions with a consultant. It may indicate Staph.aureus or other invasive bacterial disease that may not remain localised to the chest. If the effusion is trivial and the child responds very well to treatment, continue as for simple pneumonia. In this situation, pleural tap may not be necessary. In all other cases, perform a diagnostic pleural tap for cell count, gram stain and culture. (Protein, glucose, pH, LDH, viral immunofluorescence and culture may be useful in selected patients). A chest ultrasound will help decide the best site for pleural tap.

Do not forget tuberculosis. Place a Mantoux in every child with a significant pleural effusion, and consider sending pleural fluid for microscopy, culture and PCR for TB.

Empirical Antibiotic Therapy While Awaiting Pleural Fluid Results:

Age	Antibiotic	mg/kg/dose	Interval (hrs)
Over 5 years	Gentamicin + Flucloxacillin	2.5 (max. 100 mg /dose)	8
		50 (max. 2 000 mg/dose)	6
3 months - 5 years	Gentamicin + Flucloxacillin	2.5	8
		50	6
Less than 3 months and has had a normal LP.	Gentamicin + Flucloxacillin	2.5	8 ⁱ
		50	6 ⁱⁱ
Less than 3 months and has not had an LP.	Cefotaxime + Flucloxacillin	50	6 ⁱ
		50	6 ⁱⁱ
Less than 3 months and suspect MRSA	Gentamicin + Vancomycin	2.5	8 ⁱ
		10-15	6 ⁱⁱⁱ

- i. In term babies < 7 days old, reduce to 12 hourly
- ii. In term babies < 7 days old, reduce to 8 hourly
- iii. In term babies < 7 days old, loading dose 15mg/kg then 10mg/kg/dose 12-hourly. If 2-4 weeks of age give loading dose of 15mg/kg then 10mg/kg/dose 8-hourly.

Definitive Antibiotic Therapy For Pneumonia With Pleural Effusion

Is guided by finding a causative organism in blood culture or pleural aspirate (either directly by culture or indirectly by antigen detection). Duration of IV therapy is guided by clinical progress. Continue until there has been no fever for five days.

PNEUMONIA, ACUTE IN INFANTS AND CHILDREN

Indications for a pleural drain

1. A rapidly progressive course
2. A pleural collection that is enlarging despite antibiotics
3. Severe respiratory distress
4. Mediastinal shift
5. A large amount of frankly purulent fluid on diagnostic tap

A Paediatric Surgeon should insert pleural drains under general anaesthetic. This also facilitates ongoing surgical input into management of the pleural collection.

Lung Abscess

Staphylococcus aureus is the commonest cause. Empirical IV antibiotic therapy is Flucloxacillin 50 mg/kg/dose 6 hourly, and Gentamicin 2.5 mg/kg/dose 8 hourly (monitor Gentamicin levels) as above. Dose frequency should be reduced in infants under the age of 7 days. Use Vancomycin instead of Gentamicin in recent graduates of neonatal intensive care, or in those in whom you suspect MRSA. This must be discussed with your consultant, and ID approval will be required.

If the child is deteriorating on Flucloxacillin and Gentamicin, change the Gentamicin to Vancomycin at 10 mg/kg/dose (max. 500 mg/dose) 6 hourly (by infusion over one hour). Discuss with your consultant. ID approval will be required.

If you suspect the abscess has resulted from aspiration, anaerobic organisms may be involved. Consider treating with Clindamycin (PO, IM or IV) 30 mg/kg/day in divided doses 6 - 8 hourly (max. 450 mg/dose every 6 hours). There is no liquid preparation of this drug available. Discuss with your consultant. ID approval will be required, and a formal ID consultation is recommended.

Intravenous antibiotics are continued until the patient has been afebrile for seven days. Oral antibiotics are given to complete a minimum four week course.

References

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