

Pneumonia is an inflammation of the paranchyma of the lungs. It is a significant cause of mortality in childhood throughout the world, particularly in the developing countries, pneumonia is estimated to cause  $\approx 1.2$  million deaths. The incidence of pneumonia is more than 10-fold higher and the number of childhood-related deaths due to pneumonia  $\approx 2000$ -fold higher, in developing than in developed countries.

### **Etiology**

pneumonia are caused by microorganisms, noninfectious causes include aspiration of food or gastric acid, foreign bodies, hydrocarbons, and lipid substances, hypersensitivity reactions, and drug- or radiation-induced pneumonitis. The cause of pneumonia in an individual patient is often difficult to determine because direct culture of lung tissue is invasive and rarely performed.

. With the use of molecular diagnostic testing Bacterial or viral cause of pneumonia can be identified in 40-80% of children with community-acquired pneumonia.

*Streptococcus pneumoniae* is the most common bacterial pathogen in children 3 wk to 4 yr of age, whereas *Mycoplasma pneumoniae* and *Chlamydia pneumoniae* are the most frequent pathogens in children 5 yr and older. In addition to pneumococcus, other bacterial causes of pneumonia include group A streptococcus (*Streptococcus pyogenes*) and *Staphylococcus aureus*.

*S. pneumoniae*, *H. influenzae*, and *S. aureus* are the major causes of hospitalization and death from bacterial pneumonia among children in developing countries, although in children with HIV infection, *Mycobacterium tuberculosis*, atypical mycobacteria, *Salmonella*, *Escherichia coli*, and *Pneumocystis jiroveci* must be considered.

The incidence of pneumonia caused by *H. influenzae* or *S. pneumoniae* has been significantly reduced in areas where routine immunization has been implemented

. Viral pathogens are a prominent cause of lower respiratory tract infections in infants and children <5 yr of age. Viruses are responsible for 40

-80% of the episodes of pneumonia, more common in the fall and winter, rhinoviruses and respiratory syncytial virus (RSV) are the major pathogens, especially in children <2 yr of age. Other common viruses causing pneumonia include parainfluenza viruses, adenoviruses, and human metapneumovirus.

3. Atypical pneumonias caused by *Mycoplasma pneumoniae* & *Chlamydia pneumoniae* are more prevalent in school aged children & older children.

**Specific risk factors for development of pneumonia** 1. Lung diseases as asthma or cystic fibrosis. 2. Anatomic problems as tracheoesophageal fistula. 3. Gastroesophageal reflux disease (GERD) with aspiration. 4. Neurologic disorders which interfere with protection of the airways or compromise clearing of the airways. 5. Diseases which alter the immune system as immunodeficiency or hemoglobinopathies. 6. Season ( ↑in fall & winter). 7. Viral infections of the respiratory tract can predispose to the 2ry bacterial infections by disturbing the normal host defense mechanisms, altering secretions, & modifying bacterial flora.

**Recurrent pneumonia** Defined as 2 or more episodes in a single year or .3 or more episodes ever, with radiographic clearing between occurrences

### **Causes of recurrent pneumonia**

1. Aspiration susceptibility : Oropharyngeal incoordination, Vocal cord paralysis, GERD.

2. Immunodeficiency : Congenital & acquired.

3. Congenital cardiac defects : ASD, VSD, PDA.

4. Abnormal secretions or ↓clearance of secretions : Asthma, Cystic fibrosis, Ciliary dyskinesia.

5. Pulmonary anomalies : Sequestrations, Cystic adenomatoid malformation, TEF .

6. Airway compression or obstruction : Foreign body, Vascular ring, Enlarged lymph node, Malignancy.

7. Miscellaneous : e.g. Sickle cell anemia & Sarcoidosis.

### **Clinical presentations**

Viral and bacterial pneumonias are often preceded by several days of symptoms of an upper respiratory tract infection, typically rhinitis and cough. In viral pneumonia, fever is usually present; temperatures are generally lower than in bacterial pneumonia. Tachypnea is the most consistent clinical manifestation of pneumonia. Increased work of breathing accompanied by intercostal, subcostal, and suprasternal retractions, nasal flaring, and use of accessory muscles is common. Severe infection may be accompanied by cyanosis and respiratory fatigue, especially in infants. Auscultation of the chest may reveal crackles and wheezing, but it is often difficult to localize the source of these adventitious sounds in very young children with hyperresonant chests. It is often not possible to distinguish viral pneumonia clinically from disease caused by Mycoplasma and other bacterial pathogens

Bacterial pneumonia in adults and older children typically begins suddenly with a shaking chill followed by a high fever, cough, and chest pain. Other symptoms that may be seen include drowsiness with intermittent periods of restlessness; rapid respirations; anxiety; and, occasionally, delirium. Circumoral cyanosis may be observed. In many children, splinting on the affected side to minimize pleuritic pain and improve ventilation is noted; such children may lie on one side with the knees drawn up to the chest

### **Physical findings**

Depend on the stage of pneumonia. Early findings may include ↓ breath sounds, scattered crackles & rhonchi on the affected side. with increasing consolidation or with complications as pleural effusion, empyema, or pneumothorax → dullness on percussion & ↓ breath sounds. abdominal distention may be prominent due to gastric dilation from swallowed air &/or ileus. The liver may seem enlarged due to downward

displacement of the diaphragm 2ry to hyperinflation of the lungs or superimposed congestive heart failure (CHF).

There may be nuchal rigidity (in the absence of meningitis) especially with right upper lobe pneumonia

### Atypical pneumonia

Often caused by mycoplasma pneumonia or viral infections. The infections tend to start gradually, have minimal or non-productive cough, & have frequent constitutional symptoms as rash, headache, pharyngitis, & GIT symptoms. CXR tend to show patchy , peribronchial infiltrate with only occasional lobar consolidation.

### Diagnosis

1. CXR : to confirm the diagnosis & exclude complications as pleural effusion, pneumothorax, or empyema. In viral pneumonia →hyperinflation + bilateral interstitial infiltrates & peribronchial cuffing. In bacterial pneumonia →confluent lobar consolidation is typically seen .with pneumococcal pneumonia

The radiographic appearance alone is not diagnostic & CXR cannot reliably distinguish between bacteria & viral pneumonia. Radiographic findings resolve in variable times according to the causative agents (pneumococcus in 6-8 wk, RSV in 2-3 wk, adenovirus may take 1 yr to resolve). If significant radiological abnormalities persist > 6 wk, there should be a high index of suspicion for a possible underlying problem (e.g. unusual infections, anatomic abnormality, or immunodeficiency).

Follow-up CXR in pneumonia are generally not indicated except in children with pleural effusion, persistent or recurrent signs or symptoms with co morbid conditions (e.g. immunodeficiency).

2. WBC count may be useful in differentiating viral from bacterial pneumonia. In viral pneumonia →WBC count may be normal or ↑but usually not > 20,000/mm<sup>3</sup>with alymphocyte predominance. In bacterial

pneumonia → WBC count is often ↑ (15,000 – 40,000/mm<sup>3</sup>) with a granulocyte predominance.

3. The definitive diagnosis of a viral infection rests on the isolation of the virus or the detection of the viral antigen in the respiratory tract secretions. Tissue cultures require 5 - 10 days. Serologic techniques may be used to diagnose a recent viral infection but generally require testing of the acute & convalescent serum samples for ↑ antibodies to a specific viral agent (epidemiologic tool).

4. The definitive diagnosis of a bacterial infection requires isolation of the organism from the blood ( $\leq 10\%$  with bacterial pneumonia), from the pleural fluid (60-85%), or from lungs. Sputum culture is of no value ( due to carrier states in healthy children, e.g. staphylococcus aureus or H. influenza ).

5. In mycoplasma pneumonia → ↑ cold agglutinin titers  $> 1:64$  is found in 50% of cases but it is not specific ( may ↑ with other infection as influenza viral infection).

6. In group A streptococcus pneumonia → ↑ ASO titer

### **Treatment**

Treatment of suspected bacterial pneumonia is based on the presumptive cause and the age and clinical appearance of the child. For mildly ill children who do not require hospitalization, amoxicillin is recommended. In communities with a high percentage of penicillin-resistant pneumococci, high doses of amoxicillin (80-90 mg/kg/24 hr) should be prescribed. Therapeutic alternatives include cefuroxime axetil and amoxicillin/clavulanate. For school-aged children and in children in whom infection with *M. pneumoniae* or *C. pneumoniae* is suggested, a macrolide antibiotic such as azithromycin is an appropriate choice. In adolescents, a respiratory fluoroquinolone (levofloxacin, moxifloxacin, gemifloxacin) may be considered as an alternative

If viral pneumonia is suspected, it is reasonable to withhold antibiotic therapy, especially for those patients who are mildly ill, have clinical evidence suggesting viral infection, and are in no respiratory distress. Up

to 30% of patients with known viral infection may have coexisting bacterial pathogens. Therefore, if the decision is made to withhold antibiotic therapy on the basis of presumptive diagnosis of a viral infection, deterioration in clinical status should signal the possibility of superimposed bacterial infection, and antibiotic therapy should be initiated

#### Indications for hospital management

1. Age <6 mo
2. Sickle cell anemia with acute chest syndrome
3. Multiple lobe involvement
4. Immunocompromised state
5. Toxic appearance
6. Moderate to severe respiratory distress
7. Requirement for supplemental oxygen
8. Dehydration
9. Vomiting or inability to tolerate oral fluids or medications
10. No response to appropriate oral antibiotic therapy
11. Social factors (e.g., inability of caregivers to administer medications at home or follow up appropriately)

#### **Hospital management**

1. Close observation : Frequent monitoring of the degree of respiratory distress is essential. The respiratory rate, retractions, grunting, color, & level of consciousness should be recorded every 1-2 hr

2. O<sub>2</sub> therapy : The presence of respiratory distress is an indication of O<sub>2</sub> therapy. The method of administration depends on the age & patient tolerance ( infants → head box, older children → O<sub>2</sub> mask or nasal

prongs ). O<sub>2</sub> concentration depends on the degree of respiratory distress & the level of PaO<sub>2</sub>. Practically, 40-60% O<sub>2</sub> concentration is usually sufficient & the subsequent changes will depend on the course of the illness. O<sub>2</sub> should be used continuously & should be withdrawn gradually

### 3. Antibiotics .

The empiric treatment of suspected bacterial pneumonia in a hospitalized child requires an approach based on the clinical manifestations at the time of presentation. Parenteral cefotaxime or ceftriaxone is the mainstay of therapy when bacterial pneumonia is suggested. If clinical features suggest staphylococcal pneumonia (pneumatoceles, empyema), initial antimicrobial therapy should also include vancomycin or clindamycin

4. IV fluid : In infants with moderate-severe respiratory distress, oral feeding is hazardous & may → serious complications. Maintenance IV fluid is usually needed during the 1st 2-3 days to provide an adequate fluid intake. If the patient is still having a significant distress, NG tube feeding should be gradually replace the IV fluid. Oral feeding can be resumed in patients with minimal or no distress.

5. In developing countries, oral zinc (10 mg/day for <12 mo, 20 mg/day for ≥12 mo) reduces mortality among children with clinically defined severe pneumonia

### 6. Complication:

**Pleural effusion & empyema** : Pleural effusion most often occur with pneumococcal pneumonia. Patients respond poorly to treatment of pneumonia & develop worsening respiratory distress & chest pain or discomfort. CXR shows the presence of fluid in the pleural space, a finding that can be confirmed on U/S

**Respiratory failure** : Fortunately, most cases of pneumonia with respiratory failure respond to management & recover completely in 7-10 days. In severe cases of bronchopneumonia in infants, assisted mechanical ventilation may be life-saving. The clinical criteria to initiate mechanical ventilation are cyanosis ( in spite of 60% O<sub>2</sub> ) or progressive

deterioration of the level of consciousness. On the laboratory level, O<sub>2</sub> saturation < 90% or PaO<sub>2</sub> < 50 mmHg (with 60% O<sub>2</sub>) or PaCO<sub>2</sub> > 60 mmHg are indications for mechanical ventilation. When facilities for intensive care are not available, manual ventilation with bag & mask is an alternative.

**Congestive heart failure (CHF)** : Myocarditis & CHF may occur especially in infants with severe bacterial bronchopneumonia. Treatment include digoxin & diuretics. The fluid intake should be ↓ about 20-30%.

**Paralytic ileus** : severe pneumonia is the commonest cause of reflux ileus in infants which → vomiting & abdominal distention. Plain abdominal X-rays in erect position → multiple fluid levels. The patient should be kept on maintenance IV fluid with complete rest of the GIT. The condition usually subsides within few days & gradual oral feeding can be resumed

## Prevention

that vaccination has reduced the incidence of pneumonia hospitalizations. the 13-valent pneumococcal conjugate vaccine (PCV13) ,influenza vaccine recommendations to include all children >6 mo of age might be expected to affect pneumonia hospitalization rates