6 Respiratory System

6.1 Pleural Effusion

Proforma

History

Chief Complaints

- H/o cough, cold, fever, Expectoration
- H/o Breathlessness
- H/o Chest Pain
- H/o Wheeze
- H/o hemoptysis

ODP of chief complaints in detail.

Associated History / H/o Differential Diagnosis

- H/s/o Tuberculosis :
  - Evening rise in Temperature
  - Anorexia
  - Weight loss
  - Failure to gain weight
  - H/o Koch's / Koch's contact
  - H/o having taken treatment for 9 months.
  - H/s/o allergic manifestation of Tb :
    - H/o phylectenular conjunctivitis
    - H/o Erythema nodosum
    - H/o Joint pains (Ponsat's Disease)
    - MT test
    - History of Convulsions, unconsciousness, altered sensorium (Tb meningitis)
- H/o Trauma to chest
- H/o bone pains, weight loss, petechiae, purpura → Neoplasms (Rare)
- H/o dysentery, high fever with chills, right upper abdominal pain (hypochondriac region) → H/s/o Amebic liver abscess (subdiaphragmatic)
- H/o fever with rash → Measles/SLE
- H/o edema over feet, puffiness of face, Breathlessness on exertion, Extreme Pallor, Generalized anasarca, Hematuria → Suggestive of CCF, hypoproteinemia, anemia, nephrotic syndrome, beriberi (All causes of Transudates)
- H/o failure to thrive, poor dietary history, skin & hair changes → Kwashiorkor
- H/o Tapping of Effusion

H/o Complications

- H/o respiratory distress, Cyanosis
- H/o Sinuses over the chest → Tuberculous Pleural Effusion

Birth History : As usual

Immunization History — BCG Vaccine

Dietary History : As usual

Developmental History : As usual

Socioeconomic History : As usual

Examination

General Examination

- Vitals
- Anthropometry
- Lymphadenopathy
- Spine examination
- Stigmata of Tb :
  - Phylectenular conjunctivitis
  - Scars & Sinuses
  - Thickened spermatic cord
  - Erythema nodosum
  - BCG Mark

Systemic examination

- Examination of Neck
- *Examination of upper respiratory tract :*
  - Sinuses
  - Throat & Tonsils
  - Pharynx
- *Respiratory system examination :*

  Inspection, Palpation, Percussion, Auscultation (To be elicited in detail)
- *Examination of other systems in brief.*

Investigations : Refer to the discussion

Treatment : Refer to the discussion

Discussion on Pleural Effusion

Definition

Pleural Effusion is defined as a pathological collection of fluid in the pleural space.

Pathogenesis

The Pleural space is a potential space between the parietal pleura (which lines the chest wall) & the visceral pleura (which lines the outer surface of the lungs).

The pleural fluid in physiological conditions is a colourless liquid derived from plasma (but with a lower protein content) measuring about 0.2 ml/kg in volume. It is produced due to the difference in the hydrostatic pressure or oncotic pressure between the systemic capillaries (which line the parietal & visceral pleura) & the pleural space resulting in filteration of fluid into the pleural space. This fluid is drained via the parietal pleural stoma (pores) [into the venous circulation] & the lymphatics (into the mediastinal lymph nodes or the lymph nodes lining the chest wall).

Thus, any factor which either increases the filteration of fluid or impedes its absorption can cause Pleural effusion.

- **Increased filteration of fluid**

  There are 2 factors which can lead to increased filteration of fluid in the pleural space. They are :

  - *Increased hydrostatic pressure or decreased oncotic pressure* (generally caused by sytemic disorders) leading to filteration of mainly fluid (& a lesser quantity of proteins, cells, etc.) commonly known as ***Transudates***. Because the basic cause is systemic, transudates are commonly bilateral.
  - *Increased permeability of the capillaries* due to local diseases (either infection, inflammation, malignancy or trauma) leading to filteration of fluid along with cells, proteins etc. in higher quantities, commonly known as ***Exudates***. Because the basic cause is local, usually exudates are unilateral (though they may be bilateral).

- **Impaired absorption of fluid**

  Absorption of fluid from the pleural space can be impaired due to either blockage of lymphatics (or thoracic duct) or pleural stoma (pores). The resultant collecting fluid is usually an ***Exudate***.

Etiology of Pleural Effusion

In general, Systemic disorders lead to Transudative pleural effusion, whereas local lesions lead to Exudative pleural effusion. The causes of Transudates & Exudates are discussed in Table 6.1.

Classification of Pleural Effusion

- **Transudates** ┐
- **Exudates** ┘ discussed above
- **Empyema (Purulent Effusion)**

  Causes are :

  - Pyogenic infection — like Pneumonia and Lung abscess
  - Rupture of oesophagus
  - Trauma to chest
  - Rupture of subphrenic abscess through diaphragm into thorax
  - Rupture of mediastinal lymph nodes
  - Septicemia

- **Hemothorax (Hemorrhagic Effusion)**

  Causes are :

  - Tuberculosis
  - Pulmonary infarct
  - Bleeding disorder
  - Tumour
  - Trauma

- **Chylous Effusion**

  The effusion is milky-white in colour. It is further subclassified into :

  - *Chylothorax :* The effusion is derived entirely from Chyle & is hence rich in fat (triglycer-

Table 6.1 : Causes of Pleural Effusion (Causes of Transudates & Exudates)

Transudates	Exudates
Cardiac Cause ▪ CCF **Hematological Cause** ▪ Anemia **Renal Cause** ▪ Nephrotic syndrome **Gastro-intestinal Cause** ▪ Liver failure **Nutritional cause** ▪ Hypoproteinemia ▪ Beri-beri	**Infection** ▪ Tuberculosis ▪ Pneumonia ▪ Lung abscess ▪ Bronchiectasis **Trauma** ▪ Direct trauma to chest ▪ Iatrogenic ¤ Thoracic Surgery ¤ Peritoneal dialysis ¤ Perforation of SVC by central venous catheter **Malignancy** ▪ Primary ▪ Metastatic **Collagen vascular diseases** ▪ SLE ▪ Rheumatoid arthritis **Drugs** ▪ INH ▪ PAS ▪ Nitrofurantoin **Pulmonary infarction** **Subdiaphragmatic causes** ▪ Amebic liver abscess ▪ Acute Pancreatitis **Idiopathic :** Possibly viral (10–15%)

ides). It occurs due to damage to the thoracic duct due to any cause. Causes are :

- ¤ Trauma to the thoracic duct
- ¤ Tuberculosis
- ¤ Malignancy (Mediastinal lymphoma)
- ¤ Obstruction of lymphatic circulation due to any cause. (e.g. filariasis)

- *Chyliform or Pseudochylous effusion :* The effusion is milky-white in colour, but the whiteness is not due to chyle but due to Calcium, Proteins etc present in the fluid. The fluid is not rich in fat. Causes are :
  - ¤ Tuberculosis
  - ¤ Rheumatoid arthritis
  - ¤ Nephrotic syndrome
  - ¤ Malignancy

Clinical Features

Symptoms

The following are the chief symptoms of Pleural effusion. However, all symptoms may not be present in every patient with Pleural effusion.

Chief Complaints

- *Chest Pain :* The chest pain in pleural effusion is typically called as *Pleuritic* chest pain. It appears on the side of the effusion & is a sharp, stabbing pain which increases on deep inspiration, coughing, sneezing etc. The pain is sometimes also referred to the ipsilateral

shoulder (due to irritation of the pleura lining the diaphragm being supplied by the phrenic nerve).

- *Dry Cough :* A dry, irritating cough which increases in reclining posture is seen in a large number of patients with pleural effusion
- *Breathlessness :* Breathlessness is not a typical symptom of small effusion but may become evident with rapid accumulation of fluid in the pleural space.
- *Constitutional symptoms :* Fever, anorexia, fatigue, weight loss etc. are typically seen in tuberculous effusion, malignant effusion etc. but they may be absent in other types of effusion.

Miscellaneous symptoms

- In case of transudative effusion which occur in CCF, Nephrotic syndrome, hypoproteinemia etc., there may be other symptoms like swelling over the face & legs, Oliguria etc.
- Bone pains, Petechiae, Purpura etc may be present in Malignant effusion

Past History

- Past history of Tuberculosis
- Past history of trauma to the chest
- Past history of skin rashes as in Measles, SLE
- Dysentery, right hypochondriac pain (suggestive of amebic liver abscess → Right Pleural effusion)

Family history

- Family history of Tuberculosis
- History of Collagen-vascular diseases like SLE etc. in the family

Immunization history

Ask for BCG administration*

Signs

General Examination

- The patient may be febrile
- *Vitals :* Respiratory rate may be increased in case of large effusions
- Cervical lymphadenopathy may be seen in Tuberculous/malignant effusions.
- Look for presence or absence of BCG mark.

Systemic Examination

- *Inspection*
  - There may be bulging of the chest at the site of a large pleural effusion or in Empyema (however, it is usually not visible in small effusions).
  - The respiratory movements are decreased on the affected side.
  - The apex impulse may be non-visible or shifted (due to shift of the mediastinum).
  - Traille's sign is Positive — The trachea shifts to the opposite side of the pleural effusion (due to shift in mediastinum)
- *Palpation*
  - Respiratory movements are decreased on the affected side
  - The position of the apex beat is confirmed by palpation (shifted due to shift in mediastinum).
  - Tactile vocal fremitus shows decreased/absence of fremitus on the affected side (however, fremitus is increased at the level of the effusion).
- *Percussion*
  - The percussion note is stony dull at the affected side.
  - The following percussion findings are difficult to elicit in small children though they may be seen in adolescents & adults :
    - A resonant note just above the effusion—known as *Skodaic resonance*.
    - A triangle-shaped area of dullness *(Grocco's triangle)* on the opposite side of the effusion in the posterior chest against the spine — occurs due to collapse of the opposite lung following mediastinal shift caused by the Pleural effusion.
    - In left-sided effusions, there is conversion of the normally-occuring tympanic percussion note over the *Traube's*

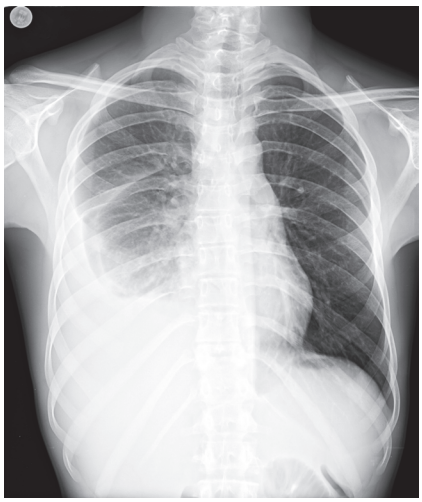
* Though BCG administration may not protect against Pulmonary Koch's, it has been found to impart some degree of protection against extra-pulmonary Koch's.

space (above the fundus of stomach) to a dull note.

- *Auscultation*
  - In small effusions, the breath sounds over the effusion are decreased, whereas, they are absent in moderate-large effusions.
  - At the level of the effusion, instead of vesicular breath sounds, bronchial breath sounds are heard.
  - Vocal Resonance is decreased (small effusions) or absent (Moderate-large effusions)
  - Aegophony is heard above the level of the effusion — Words spoken by the patient are heard by the auscultating examiner as the bleating of a goat due to relaxation of the lung above the pleural effusion.

Investigations

- **Routine Tests**
  - *CBC :* Neutrophilic leukocytosis may be seen in Para-Pneumonic effusions & Empyema.
  - *ESR :* Raised in tuberculous effusions, malignancies & collagen-vascular diseases.
  - *LFT :* To establish base-line liver enzymes values before starting AKT in case of tuberculous effusions.
  - *Urine Routine*
- **Sputum for AFB &/or Gastric lavage for AFB:** To detect tuberculosis*.
- **Mantoux Test (MT) :** To detect Tuberculosis†.
- **Imaging Tests**
  - **X-Ray Chest**
    - *PA view (Erect Posture) :* Shows presence of effusion only when the amount of pleural fluid exceeds 150–200 ml. The following changes are seen (Fig 6.1) :
      - Blunting of costophrenic angle
      - Homogenous opacity
      - Well-defined, regular, concave upper border whose lateral edge is higher than the medial one [*Ellis' Curve* — occurs due to tracking of the fluid upwards at the lateral edge (where the pleural surfaces lie close to each other) than at the medial side leading to the concave upper border of the effusion]
      - Collapsed lung may be visible above the effusion



(Courtesy : Dr. Hemant Shah & Dr. Bharat Boricha)
Fig 6.1 : Moderate right pleural effusion

      - The effusion is generally unilateral (common, Fig 6.1), however, in transudates it may be bilateral due to the systemic nature of the disease (Fig 6.2).

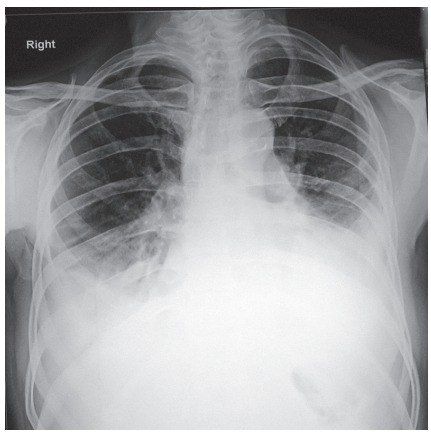


Fig 6.2 : Bilateral pleural effusion

* However, AFB are infrequently detected in tuberculous pleural effusions as the effusion is generally a hypersensitivity reacton to the tubercle bacilli.

† MT is frequently positive in case of tuberculous pleural effusion as it is a form of hypersensitivity reaction to the tubercle bacilli.

- The Pleural effusion may be free — the commonest variety (Fig 6.1) or it may be encysted (Fig 6.3)

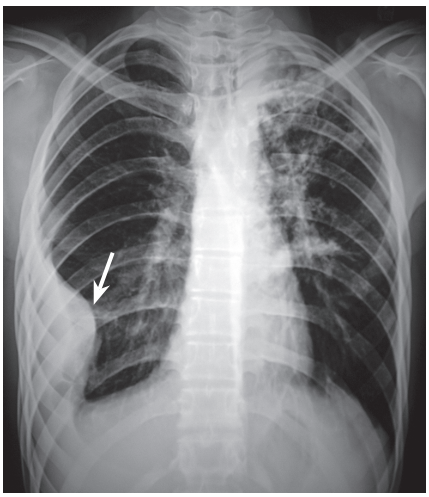


Fig 6.3 : Right-sided encysted pleural effusion

- *Lateral view :* The lateral view in X-Ray chest is more sensitive in diagnosing Pleural effusion than the PA view as it detects obliteration of the posterior costo-phrenic angle even when the fluid exceeds 50 ml. However, with the advent of other imaging modalities like USG, which is even more sensitive in diagnosing pleural fluid, this view is rarely used nowadays.

- **USG Chest :** USG is extremely sensitive in diagnosing pleural effusion as it detects even 5–10 ml of fluid in the pleural space. It helps in differentiating pleural effusion from pleural thickening & pleural tumours. It also helps in proper diagnosis of encysted pleural effusions (which may sometimes appear as masses on X-Ray). Also, in small effusions, aspiration of the pleural fluid under USG guidance is far safer & gives better yield than conventional pleural tapping.
- **CT Scan Chest :** It is the most sensitive imaging modality as far as pleural effusion is concerned. It helps in differentiating pleural effusion from pleural thickening, tumours etc. In addition to the pleural space, it also images the parenchyma & the mediastinal space — thus giving valuable information regarding the presence of small parenchymal lesions (undetected on X-ray) or mediastinal/hilar lymphadenopathy etc. However, it is rarely used as the primary investigation & is reserved for recurrent effusions/effusions not responding to treatment.

- **Thoracocentesis (Pleural fluid aspiration) :** It is done to differentiate the type of Pleural effusion — whether *Transudate* or *Exudate*.

  However, in patients with systemic disorders like CCF, Cirrhosis etc. where the pleural fluid is most likely to be a transudate, there is no necessity of thoracocentesis & treatment should be directed towards the primary cause.

  The pleural fluid collected is subjected to Physical, Chemical & Microbiological examination. The pleural fluid findings in transudates & exudates are elaborated in Table 6.2.

  In addition to the tests enumerated in Table 6.2, the pleural fluid may be subjected to the following tests if there is suspicion of it being a tuberculous effusion (the commonest cause of pleural effusion in our country).

  - *Pleural fluid ADA :* Adenosine deaminase (ADA) is found in lymphocytes, monocytes & macrophages. High levels of ADA in the pleural fluid (> 70 IU/L) are generally indicative of tuberculosis. Pleural fluid ADA levels < 35 IU/L usually signifies causes other than tuberculosis.
  - *Pl fluid Tb Antigen & Tb Antibody levels :* This test helps in detecting tuberculous effusion but is not very reliable.
  - *Pleural fluid PCR :* Polymerase chain reaction (PCR) may help in isolating tubercle bacilli from the pleural fluid. However, tuberculous effusions are a form of hypersensitivity reaction & are frequently transudates & thus the absence of a positive PCR does not exclude tuberculosis as a cause of the effusion.

- **Pleural Biopsy :** The traditional method of pleural biopsy is a *'blind procedure'* done at the site of maximum dullness on percussion (site con-

Table 6.2 : Differences between Transudates and Exudates

Characterisitic of Fluid	Transudates	Exudates
GROSS EXAMINATION		
Appearance	Clear	Hazy or Cloudy
Colour	Straw-coloured	Purulent (yellowish), greenish, reddish (hemorrhagic), whitish (chylous)
Specific gravity	< 1.010	> 1.015
Coagulation test (On Standing)	No Clot seen	Clotting present
BIOCHEMICAL EXAMINATION		
Glucose	> 40 gm%	< 40 gm%
Proteins	< 3 gm%	> 3 gm%
LDH	< 200 IU/L	> 200 IU/L
Cholesterol*	< 60 mg/dl	> 60 mg/dl
Amylase	Absent	Present (In Pancreatitis)
pH	> 7.2–7.3	< 7.2–7.3
Light's Criteria†		
▪ Pleural fluid Protein / Serum Protein	< 0.5	> 0.5
▪ Pleural fluid LDH / Serum LDH	< 0.6	> 0.6
▪ Pleural fluid LDH	< ⅔rd of serum LDH	> ⅔rd of serum LDH
Miscellaneous Ratios‡		
▪ Pleural fluid Glucose/Serum Glucose	> 0.5	< 0.5
▪ Pl fluid Cholesterol/Serum Cholesterol	< 0.3	> 0.3
MICROBIOLOGICAL EXAMINATION		
White-cell count	< 1000 per mm^3	> 1000 per mm^3
Differential count	Similar to peripheral blood	Lymphocytic predominance in Tuberculous effusion Polymorphic predominance in Pyogenic effusion Eosinophilic predominance in Malignancy, Pulmonary infarction etc.
Red-blood cells	Absent (Unless tap is traumatic)	Maybe present in malignant effusion even if the tap is non-traumatic
Abnormal/Malignant cells	Absent	May be present in Malignant effusion
Smear	Micro-organisms are absent	Bacteria may be seen in Pyogenic effusion AFB are seen in tuberculous effusion only when there is rupture of the subpleural caseous tuberculous focus into pleural space
Culture	No growth seen	Bacteria or AFB may be cultured in Pyogenic or tuberculous effusions respectively

* Cholesterol is used in transudative effusions containing high proteins such as in CCF treated with diuretics

† In CCF treated with diuretics, in addition to Cholesterol levels, **Roth's Criteria** of *Albumin gradient* (Serum albumin–Pleural fluid albumin) is used to differentiate between Transudates & Exudates. If the gradient is >1.2, it is a transudate, else an exudate.

‡ These ratios are less often used & are useful only in cases where the Little's & Roth's criteria are inconclusive.

firmed by X-ray as the site of maximim opacity).

The biopsy is performed by means of a pleural biopsy needle *(Abraham's needle)*. However, being a blind procedure, the sensitivity of pleural biopsy in diagnosing malignant pleural effusions (the commonest indication for performing pleural biopsy) is very low & hence this proceudre is now less preferred as compared to Thoracoscopy.

- **Thoracoscopy :** Being an invasive & an expensive test, thoracoscopy is indicated only when other tests fail to provide a diagnosis. The commonest indication for Thoracoscopy is malignancy, where it is used for diagnosis as well as treatment (use of talc to achieve sclerosis & prevent recurrent effusions).
- **Bronchoscopy :** Used only when Thoracoscopy also fails to provide a diagnosis & possibility of an endobronchial disease leading to the effusion is being considered.

Differential Diagnoses

- ***Pleural thickening :*** Acute symptoms such as fever, cough etc. are generally absent, though dull chest pain on the affected side on deep inspiration may be present. Mediastinum is not shifted. Percussion note is impaired, but not stony dull. USG (& occasionally CT) usually confirm the absence of fluid in the pleural space.
- ***Empyema :*** Resembles pleural effusion in most of the clinical features, but the toxicity is much higher. Clubbing may develop. X-Ray may reveal septations. Pleural tap shows presence of pus & neutrophilic leukocytosis. Pleural fluid Culture & blood culture may be positive. CT scan confirms presence of thick fluid in the pleural space.
- ***Pneumonia :*** Usually associated with high fever, cough & acute toxicity. Mediastinum is not shifted. Percussion note is impaired but not dull. Crepitations are heard & Vocal fremitus is increased.
- ***Pericardial effusion :*** Heart sounds are decreased in intensity. Mediastinum is not shifted. Percussion note is not dull in posterior chest, neither is the Traube's space obliterated. ECG shows attenuated QRS complexes. Cardiac shadow is enlarged on X-Ray chest.
- ***Chest mass :*** Clinical features generally reveal absence of fever. Clubbing may be present. Weight loss is severe. Other symptoms due to pressure on bronchi, blood vessels etc. may be present. USG chest/ CT chest generally reveals the diagnosis.

Complications

- Empyema
- Collapse of the adjacent lung
- Pleural thickening
- Bronchiectasis
- *Complications of Pleural tapping*
  - Pneumothorax
  - Hydropneumothorax
  - Infection → leading to Empyema
  - Hemorrhage → Hemothorax

Treatment

Treatment depends on the cause. Treatment for the commonest causes of pleural effusions is described below.

Definitive treatment

- **For Tuberculous effusions**
  - *Anti-Koch's therapy (AKT) :* 3-drug AKT (INH — 5 mg/kg/day + Rifampicin — 10mg/kg/day + PZA — 25–30 mg/kg/day) for 1st 2 months followed by 2-drug AKT (INH+Rifampicin — doses as above) for 4 months is generally curative.
  - *Corticosteroids :* The use of steroids in tuberculous pleural effusion is controversial. They do help in rapid absorption of fluid & are thus invaluable in case of large effusions or encysted effusions where there are high chances of pleural thickening on resoluton.

    However, routine use of steroids in uncomplicated small effusions is unwarranted & only increases the side-effects. Prednisolone, in a dose of 1–2 mg/kg/day for 4 weeks followed by tapering over the next 2 weeks is the drug of choice.
- **For Parapneumonic effusions**
  - *For small effusions :* No special treatment is required as majority of them resolve spontaneously with the same treatment as that for

pneumonia.

- *For large effusions :* Thoracocentesis for relief of breathlessness along with antibotics. Aspirated pleural fluid should be subjected to culture & antibiotic sensitivity tests. In case of thick pus, Intercostal drainage (ICD) may be done.

- **For Empyema**
  - *Antibiotics :* A broad-spectrum antibiotic should be started initially pending the culture report of pleural fluid, following which the specific antibiotics should be given for atleast 4–6 weeks.
  - *Intercostal drainage (ICD) :* ICD is advised if there is frank pus on pleural aspiration & glucose levels are < 35–40 mg/dl. Once inserted, the ICD should be kept till the returning fluid measures < 50 ml/day (about a week).
  - *Fibrinolytic therapy :* In case the drainage through the ICD decreases due to thickening & organizing of the pus into loculations, fibrinolytics like Streptokinase, Urokinase & Alteplase may be instilled into the pleural space.
  - *Decortication with VATS :* Video-assisted thoracoscopic surgery (VATS) is nowadays preferred over conventional thoracotomy in case the above measures fail to resolve the empyema. VATS enables division of the adhesions followed by decortication by stripping & resecting the parietal pleura.
  - *Decortication by thoracotomy :* This is now done only in cases where VATS is unavailable, unaffordable or has failed to achieve the desired results.

- **For Malignant effusions**

  Malignant effusions are notoriously recurrent & fail to respond to therapy in a large number of cases. In addition to Chemotherapy & all the methods described above such as Medication, thoracocentesis, ICD etc., *talc poudrage* (instillation of talc in the pleural cavity) with the help of thoracoscopy to achieve sclerosis is safe & very effective in advanced cases.

  Chemical Pleurodesis with substances like tetracycline is the last resort for palliation in advanced cases.

- **For CCF (commonest cause of transudates)**
  - *Diuretics :* Furosemide (IV — 1 mg/kg/dose or PO — 3 mg/kg/dose)
  - *ACE inhibitors :* Enalapril — 0.1 mg/kg/day
  - *Inotropes :* like Digoxin are less commonly used nowadays.

Adjunctive treatment

- **Rest :** Bed-rest is not required in all cases. It is recommended in patients with Empyema, those with large effusions & breathlessness & those with ICD.
- **Diet :** Adequate nutrition is essential in all cases. Some specific recommendations are :
  - *High-calorie diet* is generally advised in tuberculous effusions
  - *Salt-restricted diet* is advised in patients with CCF, renal failure etc.
  - *Fluid restriction* is advised in renal failure
  - *Medium-chain triglycerides (MCT)*, available as MCT oil, is highly efficacious in Chylothorax as MCT are absorbed & assimilated directly into the body without the formation of intermediary chylomicrons (which are the chief constituents of chylous pleural fluid).
- **Symptomatic treatment** of fever, cough, chest pain etc. helps in relieving the patient's symptoms & allaying anxiety.
- **Chest Physiotherapy** helps in increasing the expansion of the lungs & clearance of mucous secretions from the respiratory tract.

Few Practical Aspects Regarding Pleural Effusion

- **Causes of Decreased Movements of Chest :**
  - Consolidation
  - Hydropneumothorax

- Collapse (Massive collapse)
- Emphysema
- Obstruction to the main bronchus

- **Causes of Rales :**
  - Pneumonia/Bronchopneumonia
  - Pulmonary Edema
  - Bronchiectasis
  - Left-sided heart failure
  - Lung abscess/Cavity
- **Causes of Rhonchi :**
  - Bronchial asthma
  - Obstruction to bronchus
  - Bronchitis
  - Cardiac failure
- **Causes of Evening rise in temperature in Tuberculosis are :**
  - Normal diurnal variation with evening rise in temperature
  - Fever is noticed in the evening when the child is resting
- **In tuberculosis,** Exudate is much more common (Because of direct affection of pleura), however transudate is also present in the form of an allergic manifestation

Table 6.3 : Mediastinal Position in Respiratory lesions

In the Centre	
Pneumonia Bronchiectasis Emphysema Bronchial asthma	
Shifted	
To Opposite Side	**To Same Side**
Pleural Effusion Pneumothorax Hydropneumothorax Large tumour	Fibrosis Collapse

Table 6.4 : Difference between Empyema & Parapnemonic effusion

Empyema	Parapnemonic Effusion
pH < 7.2	pH > 7.2
Gm stain — organisms may be seen	Gm stain — organisms not seen
Culture positive	Culture negative
Pl. fluid sugar < 15	Pl. fluid sugar > 20

Table 6.5 : Tactile Vocal Fremitus/Vocal Resonance

Increases In	Decreases In
Consolidation Cavity	Pleural effusion Pneumothroax Emphysema Collapse / fibrosis Bronchial obstruction.

Table 6.6 : D/D of Dullness on Percussion in Respiratory Disease

Stony Dullness	Impaired Note
Pleural Effusion Massive collapse-consolidation Solid Tumours	Pneumonia Collapse Thickened Pleura Fibrosis Sequestration of lung Abscess Infarct

Table 6.7 : Causes of Bronchial Breathing

Tubular Breathing	Cavernous Breathing	Amphoric Breathing
Pneumonia Collapse Infarct	Cavity with irregular walls	Pneumonia Communicating with a bronchus.

✳ ✳ ✳

6.2 Pneumonia

Proforma

History

Chief Complaints

- H/o cough, cold, high fever, Expectoration
- H/o fast breathing &/or Breathlessness
- H/o Chest Pain
- H/o hemoptysis
- H/o irritabilty, anorexia, post-tussive vomiting or inability to suck (neonates)
- H/o Grunting or Stridor (neonates)

ODP of chief complaints in detail.

Associated History / H/o Differential Diagnosis

- H/o sudden onset of rhinorrhea, high fever with chills, expectoration & rapid progression of symptoms — S/o Bacterial Pneumonia
- H/o mild fever, severe persistent cough & indolent course — S/o Atypical Pneumonia
- H/o extra-pulmonary symptoms such as headache, bodyache, malaise, high fever & respiratory symptoms — S/o Viral Pneumonia (Influenza)
- H/o fever followed by rash with respiratory symptoms — S/o Post-viral (Post-Measles) Pneumonia
- H/o exposure to contaminated water with respiratory symptoms along with extra-pulmonary symtoms such as diarrhea, vomiting, oliguria etc. — S/o Legionella Pneumonia
- H/s/o Tuberculosis :
  - Evening rise in Temperature
  - Anorexia
  - Weight loss
  - Failure to gain weight
  - H/o Koch's / Koch's contact
  - H/s/o allergic manifestation of Tb :
    - H/o phylectenular conjunctivitis
    - H/o Erythema nodosum
    - H/o Joint pains (Ponsat's Disease)
    - MT test
    - History of Convulsions, unconsciousness, altered sensorium (Tb meningitis)
- H/o Respiratory symptoms in Immunocompromised patients (e.g. HIV) or patients on steroids/ Immunosuppressants — S/o Pneumocystis carinii/ Tuberculous/ Fungal Pneumonia
- H/o sudden onset of cough & difficulty in breathing post-feeding — S/o Aspiration Pneumonia
- H/o regular instillation of oil drops in nostril during massage — S/o Lipoid Pneumonia
- H/o worms in stools along with respiratory symtoms — S/o Loeffler's syndrome
- H/o exposure to Pigeon droppings followed by respiratory symptoms — S/o Hypersensitivity Pneumonitis
- H/o exposure to irritant, volatile chemicals or gases — S/o Chemical Pneumonitis
- H/o Chemotherapy or Radiation therapy foll. by resp symptoms — S/o Drug/Radiation-induced Pneumonia

H/o Complications

- H/o respiratory distress, cyanosis — S/o compications like Pleural Effusion, Pneumothorax, Empyema etc.
- H/o symptoms of Shock — S/o Septicemia
- H/o CNS symptoms like disorientation, focal neurological signs etc. — S/o Menigitis

Birth History : As usual

Immunization History

- BCG vaccine
- HIB vaccine
- Pneumococcal vaccine
- Influenza vaccine

Dietary History : In detail as malnutrition can predispose to Pneumonia

Developmental History : As usual

Socioeconomic History : As usual

Examination

General Examination

- Vitals
- Anthropometry
- Lymphadenopathy

- Stigmata of Tb :
  - Phylectenular conjunctivitis
  - Scars & Sinuses
  - Thickened spermatic cord
  - Erythema nodosum
  - BCG Mark

Systemic examination (refer to discussion)

- Examination of Neck
- *Examination of upper respiratory tract :*
  - Sinuses
  - Throat & Tonsils
  - Pharynx
- *Respiratory system examination :*

  Inspection, Palpation, Percussion, Auscultation (To be elicited in detail)
- *Examination of other systems in brief.*

Investigations : Refer to the discussion

Treatment : Refer to the discussion

Discussion on Pneumonia

Introduction

Pneumonia is defined as inflammation of the Parenchyma of the lung. Though, its incidence in children < 5 years of age has reduced significantly in developed countries, in developing countries such as India, Pediatric Pneumonia is a leading cause of mortality & hospital admissions.

Etiology

The etiology of Pneumonia can be broadly subdivided into Infective & Non-Infective causes.

- **Infective Causes (Table 6.8 & Table 6.9)**
  - *Bacteria*
    - *Typical Bacteria :* Pneumococcus, Streptococcus, Staphylococcus, Bordetella Pertussis
    - *Atypical Bacteria :* Mycoplasma Pneumonia, Chlamydia Trachomatis, Ureaplasma Urealyticum, Legionella
  - *Viruses :* RSV, Influenza, Parainfluenza, Rhinovirus, Adenovirus, Cytomegtalovirus(CMV)
  - *Fungus :* Aspergillosis, Histoplasmosis
  - *Protozoa :* Entamoeba Histolytica
  - *Rickettsiae*
- **Non-Infective Causes (Also called as Pneumonitis)**
  - *Allergic Pneumonia (e.g. Loeffler's syndrome) :* Due to hypersensitivity reaction of the body against Parasites like Ascaris, S. Stercoralis etc. during their passage through the lung causing Eosinophilic Pneumonia
  - *Drug-included Pneumonia :* It is an Interstitial Pneumonia usually caused due to drugs used in chemotherapy such as Bleomyin, Methotrexate etc.
  - *Radiation-induced Pneumonia :* It is also an Interstitial Pneumonia caused due to radiotherapy
  - *Inhalation of chemicals :* Certain aromatic chemicals when inhaled can trigger an acute inflammatory reaction in the lungs causing Pneumonitis
  - *Aspiration Pneumonitis :* Caused due to aspiration of gastric &/or oropharyngeal matter into the lungs. Common substances which are aspirated include :
    - Food : Usually while swallowing (Liquids more than solids)
    - Stomach Acid : In patients with GERD
    - Lipids : Lipoid Pneumonia which commonly occurs due to instillation of oil drops into nostrils during oil massage of newborns & infants
    - Foreign Bodies

Pathophysiology

Though the upper respiratory tract, especially the nasal passage is colonized by various microorganisms, the lower respiratory tract is sterile. This is achieved by the body by the means of physical barrier mechanism & Immunological defenses.

- **Physical barrier mechanism :** The downward-sloping nasal passage & convoluted upper &

Table 6.8 : Causative Organisms of Pneumonia grouped according to Patient's age

Age-Group	Bacteria		Viruses	Miscellaneous organisms
	Typical	Atypical		
Neonates (< 1 month of age)	› Group B Streptococcus › E. Coli › Listeria › Klebsiella › Enterococci › Nontypable H. Influenza	› Chlamydia trachomatis › Mycoplasma	› CMV › RSV › Herpes	› Pneumocystis carinii › Treponema pallidum › Toxoplasma gondii
Infants (1 month to 1 year of age)	› S. Pneumonia › S. aureus › H. Influenza (Group B) › Nontypable H. Influenza › Rarely Group B streptococci, E. Coli	› Chlamydia trachomatis › Ureaplasma Urealyticum › Mycoplasma	› RSV › Influenza › Parainfluenza › Rhinovirus › Adenovirus	› P. carinii
Preschool children (1 year to 5 years of age)	› S. Pneumoniae › S. Pyogenes › H. Influenzae › S. aureus › M. Tuberculosis	› Mycoplasma Pneumoniae	› RSV › Rhinovirus › Human metapneumovirus › Influenza › Parainfluenza › Adenovirus › Coronavirus	
School-going children (5 years to 12 years of age)	› S. Pneumoniae › S. Pyogenes › S. aureus › H. Influenza › M. Tuberculosis	› Mycoplasma Pneumoniae › Chlamydia Pneumoniae › Legionella	› Influenza › Adenovirus	› Aspergillus
Adolescents (>12 years of age)	› S. Pneumoniae › M. Tuberculosis	› Mycoplasma Pneumoniae › C. Pneumonia › Legionella	› Influenzae	› Aspergillus › Histoplasma Capsulatum

lower airways along with active sneeze reflex are non-conducive to easy entry of particulate matter. Also, the particulate matter in the inhaled air is largely trapped by the nasal hair & moist mucosa. The cilia on the respiratory mucosa further help in trapping & cleaning the deposited particles by pushing the particles upwards & away from the lower respiratory tract.

› **Immunological defenses :** There are two kinds of Immunological defense mechanism : Local Immunity & Systemic immunity

▪ *Local immunity :* Macrophages, IgA & other immunoglobulins, complement factors etc. present in the respiratory mucosa & distal airway secretions prevent the inhaled micro-organisms from attacking the lower respiratory tract. Also, in infants and older children, benign micro-organisms colonizing the upper airways do not allow the invading micro-organisms to adhere to the respiratory epithelium & thus aid in local defense mechanism.

Table 6.9 : Types of Pneumonia & their Etiological organisms

Community-acquired Pneumonia	› S. Pneumoniae › Mycoplasma › H. Influenza › Influenza virus › Respiratory syncytial virus
Atypical Pneumonia	› Mycoplasma › Chlamydia › Legionella › Ureaplasma Urealyticum › Mycobacterium Tuberculosis
Nosocomial Pneumonia	› E. Coli › Klebsiella › Pseudomonas › Staphylococcus aureus › Proteus › Enterococcus
Pneumonia in Immunodeficient/ Immunosuppressed children	› S. Pneumoniae › S. aureus › Pseudomonas › CMV › Varicella Zoster › Mycobacterium Tuberculosis › Pneumocystis Carinii › Aspergillus › Histoplasma Capsulatum
Pneumonia in children with pre-existing lung disease	› Pseudomonas › Staph aureus › Streptococcus Pneumoniae › Legionella › Burkholderia cepacia
Post-viral pneumonia (Following measles, Influenza etc)	› S. aureus (Is very severe & typically causes multiple abscesses) › Klebsiella
Bilateral Pneumonia	› Viruses › Legionella › Pnemocystis Carinii › M. Tuberculosis

- *Systemic Immunity :* The Systemic Immunity is provided by means of specific antibodies produced by B-lymphocytes against individual pathogenic micro-organisms.

  This is a very effective way to neutralize the invading micro-organisms. Unfortunately, it requires the presence of either passive antibodies transferred from the mother in the womb or a prior infection by the same micro-organism.

Pneumonia occurs when the invading micro-organisms breach the physical & immunological barriers of the body & attacks the lower respiratory tract. Factors predisposing to the breach of these defenses (thus leading to Pneumonia) are :

- Prematurity
- VLBW & LBW babies
- Infancy (especially in 1st 3–6 months of life)
- Immunodeficiency
- Malnutrition
- Congenital disorders
  - Congenital Cardiac disorders like VSD, PDA
  - Tracheo-esophageal fistula
  - Cleft lip & Palate
  - Cystic fibrosis
  - α-1 antitrypsin deficiency
- Acquired disorders
  - Asthma
  - GERD
  - Type 1 Diabetes Mellitus
  - Post-measles or Post-Chickenpox
  - Direct Injury to chest
  - Malignancy
  - Steroid therapy or Chemotherapy
  - Invasive Instrumentation : Intubation or Bronchoscopy of the respiratory tract
  - Tobacco-smoking

Pathogenesis

The invasion of the lower respiratory tract by micro-organisms triggers an inflammatory reaction which leads to Pneumonia. The actual end-result is caused by direct injury to the pulmonary tissue by the enzymes & toxins secreted by the micro-organism along with indirect injury (collateral damage)

caused by overproduction of cytokines & interleukins by the body's defense mechanism.

Both the microbial toxins & host cytokines disrupt the cell-membrane of pulmonary cells resulting in leakage of cellular content & increased mucus secretion *(Stage 1— Congestion)*. This is followed by localized collection of neutrophils by macrophages & other inflammatory cells at the site of infection *(Stage 2—Red Hepatization)*. This proteinaceus exudate physically obstructs the airways leading to atelectasis & also increases the airway resistance. This process is followed by deposition of fibrin within the exudate leading to an area of consolidation *(Stage 3— Gray Hepatization)*. This is classically seen on X-ray as Consolidation. In cases which recover, this is followed by a *fourth, final stage of Resolution* which occurs due to resorption of the inflammatory exudate & repair of Pulmonary tissue.

Clinical features

SYMPTOMS

- Rhinorrhea
- Cough
- High fever
- Fast breathing
- Breathlessness
- Chest Pain
- Anorexia
- Poor feeding/ Inability to suck (neonates)
- Grunting, Stridor (especially in neonates)
- Irritability (Neonates)
- Cyanosis (especially in neonates)
- Post-tussive vomiting (especially in neonates)

SIGNS

- **General Examination**
  - Vital Signs
    - Temperature : ↑ (Fever)
    - Heart rate : ↑ (Tachycardia)
    - Respiratory rate : ↑ (Tachypnea)
  - Cyanosis may be seen in severe cases, especially in neonates & infants
- **Systemic Examination**
  - *Respiratory System*
    - *Inspection*
      - Use of accessory muscles of respiration
        - Nasal flaring
        - Suprasternal, Intercostal & Subcostal retractions
        - Grunting &/or Stridor
      - Increased respiratory movements (Chest wall movements)
    - *Palpation :* Confirms the increased respiratory movements seen on Inspection
    - *Percussion :* Dull note on Percussion over the affected area of lung fields
    - *Auscultation*
      - *Breath Sounds :* Decreased breath sounds over affected lung fields
      - *Adventitious Sounds : Rales* (Crackles) are the most important diagnostic finding of Pneumonia. However, absence of Rales does not rule out Pneumonia. Nor does presence of Rales as an isolated feature confirm the presence of Pneumonia. *Rhonchi* may or may not be present. If Pneumonia is accompanied by Pleural effusion, a *Pleural friction rub* may be heard on auscultation.
  - *Per-Abdomen*
    - Abdominal distension may be present in cases complicated by Paralytic ileus.
    - Hepatomegaly may be seen
  - *Cardiovascular System :* In severe cases, there may be presence of signs of CCF.
  - *CNS :* In complicated cases with Meningitis, signs of meningeal irritation or Focal signs may be present.

Investigations

- ***Complete Blood Count (CBC)***
  - WBC count : *Leukocytosis with neutrophilia* is seen in Bacterial Pneumonia (whereas WBC count may be normal or elevated with lymphocytosis in Viral Pneumonia)

Table 6.10 : Common Causative agents of Pneumonia & their characteristic Features

Pneumococci (Typical Pneumonia)	➤ Abrupt onset of cold, high fever with chills & productive cough ➤ Rapid progression with Pleuritic chest pain, Tachypnea, Respiratory distress, Cyanosis etc. ➤ Crackles (Rales) may be heard on auscultation ➤ X-Ray typically shows Lobar consolidation
Staphylococcus aureus	➤ Usually develops as a secondary infection in patients with other viral infection like Influenza, Measles. ➤ Causes a very severe Pneumonia with high fever, cough, breathlessness, hemoptysis & may progress to respiratory failure. ➤ Commonly followed by complications like Lung abscesses, Pneumatocoeles (Thin-walled cavities), Pneumothorax, Empyemas etc.
H. Influenzae	➤ Clinically, it cannot be distinguished from other varieties of bacterial Pneumonia. ➤ It has become less frequent nowadays with widespread use of HiB vaccine in infants
E. Coli, Klebsiella etc.	➤ Occurs commonly in Neonates, Immunocompromised children & in Nosocomial infection ➤ Commonly presents as Bronchopneumonia especially involving the lower lobes ➤ It frequently leads to complications like Sepsis, Empyema or multiple abscesses etc
Chlaymydia Pneumoniae	➤ Classically presents itself as an atypical Pneumonia in school-going children & adolescents ➤ The constitutional symptoms such as fever are mild ➤ The disease runs an indolent course & coughing may persist even after successful completion of treatment
Mycoplasma Pneumoniae	➤ Also manifests as an atypical Pneumonia with mild clinical features in school-going children and adolescents ➤ Commonly causes Tracheobronchitis & Bronchopneumonia ➤ Though coughing may be severe & persistent, auscultation findings are frequently negligible ➤ X-Ray shows Bronchopneumonia with Patchy infiltrates
Legionella Pneumophila	➤ It is an uncommon type of Pneumonia transmitted due to aspiration of water contaminated with Legionella or inhalation of aerosols of contaminated water. ➤ In addition to fever, cough & chest symptoms, Legionella Pneumonia is classically associated with extrapulmonary signs & symptoms like diarrhea, electrolyte disturbances, hepatic & renal dysfunction, Carditis etc.
Viral Pneumonia (such as Influenza)	➤ Systemic symptoms such as headache, body ache, malaise, high fever are very common especially early in the disease ➤ Though fever may subside in about 3–5 days, dry cough persists longer. ➤ Usually spreads as an epidemic (or Pandemic) in community.

- ESR : ↑
- CRP : ↑

➤ ***X-Ray Chest**** **:** Radiological findings along with a differential WBC count is the cornerstone for diagnosis of Pneumonia. The characteristic X-Ray findings seen in Pneumonia are as follows :

- Lobar Consolidation (classically seen in Pneumococcal Pneumonia) [Fig 15.8].
- Interstitial Pneumonia (seen either in case of Viral Pneumonia or Pneumocystis carinii pneumonia).
- Infiltrate seen in lung fields (as in Tuberculosis) [Fig 15.24]
- Infiltrates with Cavities (Tb) [Fig 15.23].
- Miliary Mottling (Seen in Tuberculosis, Bronchopneumonia etc) [Fig 15.25].
- Bilateral lower lobe Pneumonia (Right > Left) (Aspiration pneumonia)
- Pneumonia complicated with Abscesses [Fig 15.17], Empyema / Pyothorax (commonly seen in Staph aureus or Klebsiella Pneumonia).

➤ *USG Chest :* Helps in diagnosis of Consolidation

* For X-ray images, please refer to Chap. 15 [page 494 to page 498].

& Pleural Effusion.

- *Blood Culture :* Though diagnostic in < 10% cases, blood culture should be done in all cases with Pneumonia to rule out presence of complications like Septicemia.
- *Sputum Smear & Culture :* Though difficult in small children, if successful, Gram stain & AFB stain of sputum along with Bacterial & Viral Cultures can help in obtaining a microbiological diagnosis.
- *Serological tests :* ELISA & Latex agglutination tests are now available for diagnosis of common organisms causing Pneumonia such as Mycoplasma & Chlamydia.
- *Polymerase Chain reaction (PCR)* is especially important to diagnose viral pathogens such as RSV, Adenovirus & for Mycobacterium Tuberculosis.
- *Cold agglutinin Test** *:* This is a crude test to diagnose Mycoplasma Pneumonia infection. However, since it is positive in < 50% cases of M. Pneumonia plus it may be false positive in Viral pneumonia, it has been largely given up in favour of serological testing for M. Pneumonia.
- *Specialized Tests* such as *Bronchoscopy*, *Bronchoalveolar lavage* & *Lung aspiration* are done in selected cases to obtain specimens for microbiological diagnosis.

Complications

- ***Local Complications***
  - Pleural Effusion
  - Emphysema
  - Lung abscess
  - Pneumothorax
  - Pyo-pneumothorax
  - Pericardial Effusion
- ***Systemic Complications***
  - Septicemia
  - Meningitis
  - Peritonitis
  - Septic Arthritis
  - Cardiac failure
  - Renal failure

Differential diagnosis

- Asthma
- Pleural Effusion
- Pneumothorax
- Bronchiectasis
- Bronchiolitis
- RDS

Treatment

- ***Antibiotic Therapy***

  Empirical antibiotics are started based on the age of the child & Clinical features suggestive of specific organisms. Later on, if a specific microbiological diagnosis is available, depending on the antibiotic sensitivity result, the therapy can be altered.

  For the vast majority of mildly-affected children > 6 months to 1 year of age, oral antibiotic therapy is the treatment of choice. For children < 6 months of age & those who are severely ill, hospitalization & inpatient therapy is a more rational choice. The choice of antibiotics in Pneumonia depends on the age of the patient, the presenting clinical spectrum (typical v/s atypical), community-acquired v/s nosocomial, immunocompetent patient v/s immunodeficient patient; local antibiotic-resistance patterns etc. A general guideline regarding the empirical antibiotic to be started against various causative organisms is given in Table 6.11. The actual choice is tailored according to specific circumstances.

- ***Adjunctive therapy***
  - *Rest :* Bed-rest is not required in all cases. It may be useful in febrile patients with large Pneumonia & those with complications. Sleeping in Head-high position may be more comfortable than supine position.
  - *Diet :* Adequate nutrition is essential in all cases. Initially, light diet or fluids may be preferred due to decreased appetite, cough & tachypnea. With improvement, this may be

* Cold agglutinin Test : It is performed by adding blood to a test-tube filled with anticoagulant & dipping the test-tube in ice-water. In positive cases, removal of the tube after a few minutes & on rotation, small clumps of RBC will be seen coating the tube.

gradually replaced with high protein-calorie diet.

- *IV fluids & electrolyte management* is essential in severely ill, hospitalized patients.
- *Oxygen therapy :* In severely ill patients with decreased oxygen saturation, oxygen administration via nasal prongs, nasal hood, mask etc. is helpful. In advanced cases, CPAP, BiPAP or mechanical ventilation via endotracheal intubation may be utilized.
- *Symptomatic treatment* of fever, cough, chest pain etc. helps in relieving the patient's symptoms & allaying anxiety.
- *Chest Physiotherapy :* Helps in increasing the expansion of the lungs & clearance of mucous secretions from the respiratory tract.

➤ ***Treatment of Complications***

- *For Pleural Effusion/Emphysema :* Thoracocentesis & Intercostal drainage (ICD)
- *For Pneumothorax :* Needle aspiration or Tube thoracostomy.
- *In case of Cardiac failure*
  - ¤ Diuretics
  - ¤ Ace inhibitors
  - ¤ Inotropes

Table 6.11 : Empirical guidelines for Antibiotic therapy in Community-acquired Pneumonia

Organism	Oral Antibiotics		Parenteral Antibiotics	
	1st line	Alternative	1st line	Alternative
Streptococcus Pyogenes	***Amoxicillin :*** 30–50 mg/kg/day q 8 hourly (80–90 mg/kg/day in Penicillin-resistant cases)	***Amoxicillin-Clavulanate :*** 30–40 mg/kg/day q 12 hourly OR ***Cefuroxime Axetil :*** 20–30 mg/kg/day q 12 hourly	***Benzyl Penicillin :*** 1–2 lac U/kg/day q 6 hourly OR ***Ampicillin :*** 100 mg/kg/day q 6 hourly	***Cefotaxime :*** 100 mg/kg/day q 8 hourly OR ***Ceftriaxone :*** 50–75 mg/kg/day q od
H. Influenza	***Amoxicillin :*** 30–50 mg/kg/day q 8 hourly	***Amoxicillin-Clavulanate :*** 30–40 mg/kg/day q 12 hourly OR ***Cefpodoxime :*** 10 mg/kg/day q 12 hourly	***Benzyl Penicillin :*** 1–2 lac U/kg/day q 6 hourly OR ***Ampicillin :*** 100 mg/kg/day q 6 hourly	***Cefuroxime :*** 50–100 mg/kg/day q 8 hourly OR ***Cefotaxime :*** 100 mg/kg/day q 8 hourly OR ***Ceftriaxone :*** 50–75 mg/kg/day q od
Staph. aureus	***Dicloxacillin :*** 50–100 mg/kg/day q 6 hourly OR ***Cephalexin :*** 50–100 mg/kg/day q 8 hourly OR ***Amoxicillin-Clavulanate :*** 40 mg/kg/day q 12 hourly	***Clindamycin :*** 30–40 mg/kg/day q 8 hourly OR ***Linezolid :*** 10 mg/kg/day q 12 hourly OR ***Co-trimoxazole :*** 10 mg/kg/day of TMP q 12 hourly	***Cloxacillin :*** 100 mg/kg/day q 6 hourly + Gentamicin 4 mg/kg/day q 12 hourly OR ***Cefazolin :*** 50–100 mg/kg/day q 6 hourly + Gentamicin 4 mg/kg/day q 12 hourly	***Vancomycin :*** 40–60 mg/kg/day q 8 hourly OR ***Linezolid :*** 10 mg/kg q 12 hourly
Mycoplasma Pneumoniae	***Erythromycin :*** 40 mg/kg/day q 6 hourly OR ***Azithromycin :*** 10–12 mg/kg OD	***Clarithromycin :*** 15 mg/kg/day q 12 hourly OR ***Doxycyxline :*** 100 mg BD (in children >8 years) OR ***Lexofloxacin :*** In adolescents & adults	—	—
Chlamydia Pneumonia	Same as Mycoplasma	Same as Mycoplasma	—	—
Legionella	Same as Mycoplasma	Same as Mycoplasma	—	—

Table 6.11 : Empirical guidelines for Antibiotic therapy in Community-acquired Pneumonia

Organism	Oral Antibiotics		Parenteral Antibiotics	
	1st line	Alternative	1st line	Alternative
Group B Streptococcus (Neonates)	Parenteral therapy preferred in Neonates		***Benzyl Penicillin :*** 1 lac U/kg/day q 6 hourly	***Ampicillin :*** 100 mg/kg/day q 6 hourly + ***Gentamicin*** : 4 mg/kg/day q 12 hourly
Listeria Monocytogenes (Neonates)	Parenteral therapy preferred in Neonates		***Ampicillin :*** 100 mg/kg/day q 6 hourly + ***Gentamicin*** : 4 mg/kg/day q 12 hourly	***Vancomycin :*** 40–60 mg/kg/day q 8 hrly + ***Gentamicin :*** 4 mg/kg/day q 12 hourly
Enterococcus (Neonates)	Parenteral therapy preferred in Neonates		***Ampicillin :*** 100 mg/kg/day q 6 hourly + ***Gentamicin :*** 4 mg/kg/day q 12 hourly	***Vancomycin :*** 40–60 mg/kg/day q 8 hrly + ***Gentamicin :*** 4 mg/kg/day q 12 hrly OR ***Linezolid :*** 10 mg/kg q 12 hrly
Anaerobic bacteria (Aspiration Pneumonia)	Parenteral therapy preferred		***Penicillin :*** 1 lac U/kg/day q 6 hrly + ***Metronidozole :*** 20–30 mg/kg/day q 8 hourly	***Piperacillin + Tazobactam :*** 300 mg/kg/day q 8 hourly OR ***Meropenam :*** 40–60 mg/kg/day q 12 hourly
E. Coli (Nosocomial Pathogen)	Parenteral therapy preferred		***Piperacillin + Tazobactam:*** 300 mg/kg/day q 8 hourly	***Meropenam :*** 40–60 mg/kg/day q 12 hourly
Fungal Pathogens (Aspergillus, Histoplasma)	Parenteral therapy preferred		***Liposomal Amphotericin B :*** 5 mg/kg/day OR ***Voriconazole :*** 8 mg/kg q 12 hourly	Echinocondin group of drugs such as Caspofungin
Influenza virus	***Oseltamivir :*** › < 1 year of age : 3 mg/kg bd › > 1 year of age : ▪ < 15 kg : 30 mg bd ▪ 15–23 kg : 45 mg bd ▪ 23–40 kg : 60 mg bd ▪ > 40 kg : 75 mg bd		***Zanamivir :*** Inhaled form 10 mg twice-a-day	
Herpes virus (Neonates)	Parenteral therapy preferred		Acyclovir 10 mg/kg IV q 8 hourly	—
RSV	—	—	Inhaled Ribavirin delivered through endotraceal tube, face-mask or nasal hood maybe used in severe cases	
Adenovirus (Immunocompromised patients)	—	—	Cidofovir may be useful in select cases	
Mycobacterium Tuberculosis	4-drug AKT with INH + Rifampin + Pyrazinamide + Ethambutal		—	—

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