

TUTORIAL 7

THE EXAMINATION OF RESPIRATORY SYSTEM

OVERALL OBJECTIVES

At the end of this module the student should be able to differentiate, diagnose and manage common respiratory problems like:

1. **Upper airway obstruction** [laryngotracheobronchitis (LTB), foreign body (FB) in airway] and
2. **Lower airway obstruction** [pneumonia and its complications (pleural effusion, pneumothorax, cysts, collapse), chronic chest disease (pulmonary TB, bronchiectasis)]

To look for extra general features:

1. **Cough:**
 - Productive: results from an inflammatory or infective exudate on the bronchial mucosa: Cystic fibrosis, Pulmonary Tuberculosis (PTB)
 - Non-productive nocturnal: post nasal drip, asthma
 - On exercise: asthma
 - Dry intermittent or persistent: may imply irritation of the upper respiratory tract or of the bronchial wall by a foreign body, or an enlarged lymph node.
 - Productive more than 2 weeks: Consider PTB
 - Croupy: barking associated with stridor and hoarseness – Croup, acute laryngotracheobronchitis (LTB)
 - Whooping: inspiratory gasp, prolonged distressing cough, ending in a whoop, may follow vomiting – pertussis
 - During or after feed: inhalation, aspiration
 - Bovine brassy: Tracheitis
 - Absent during sleep – psychogenic
2. Halitosis and a productive cough – Chronic suppurative lung disease
3. Sputum:
 - Clear mucoid or tacky tenacious – indicative of asthma
 - Green yellow, grey (dirty) – infection most common is PTB
 - Haemoptysis: rare in children – may indicate cystic fibrosis or PTB
4. Parotid enlargement in lymphocytic interstitial pneumonia (LIP)
5. Delirium, pleural pain, rusty sputum and herpes labialis – suspect pneumococcal pneumonia
6. Look for plethora

1. INSPECTION

Comment on general inspection

To avoid anxiety in children, mother should hold the child on her lap during the initial examination. Inspection should be done first before doing anything else which may disturb the child. Clothing need to be removed and chest exposed as the examination proceeds.

Scene: look around if there is a specimen container and note its contents like sputum, blood, mucous or pus

Expose the chest and look for:

- Scars: post op, post chest drain insertation
- Pigmentation: Addisons disease
- Rashes: on the chest wall

Features of allergic facies

Note tired looking face, open mouth breathing, double folds of lower eye lids (Denne-Morgan lines), allergic shiners, allergic salute (nasal crease) and nasal discharge.

Shape of the chest

Normal chest is elliptical i.e. its anteroposterior diameter is lesser than its transverse diameter that is 3:5 respectively. Abnormal forms can be as follows:

1. **Asymmetry: Retraction** of chest wall on one side may be due to;
 - lung collapse, fibrosis, spinal deformity
2. **Asymmetry: Bulging** of chest wall on one side may be due to:
 - Pleural effusion, pneumothorax, massive cardiomegaly, kyphosis or intrathoracic tumour.
3. **Deformity:** Check for scoliosis or kyphosis and ask older children to touch their toes to determine whether the deformity is fixed or postural
4. **Barrel shaped chest:** Increased AP diameter and angle of Louis becomes more prominent: consider air trapping
5. **Harrison's sulcus:** This is transverse constriction which begins at the level of the xiphisternum, passes outward and slightly downwards. The sulcus is formed along the line of diaphragm (normal diaphragm pulls on soft ribs). Causes:
 - Chronic airway obstruction
 - Left to right cardiac shunt
 - Rickets
6. **Hoover sign:** it is isolated subcostal recession associated with hyperinflation of the lungs in a patient with peripheral airway disease. It causes diaphragm to flatten and to contract laterally against the lower chest wall resulting in indrawing below the rib cage.
7. **Pectus carinatum** (pigeon chest)
8. **Pectus excavatum** (funnel chest)
9. **Rachitic rosary:** Rickets
10. **Absent clavicles:** Cleido-cranial dysostosis
11. **Absent pectoralis:** Poland's syndrome

Movements of chest:

1. Stand at the end of the bed and compare two sides of the chest – pathology is usually on the side with lesser movement
2. Note the signs on one side of chest and compare with the other side of chest on the respective point
3. Count respiratory rate for a full minute – say if its normal or abnormal
4. Note nasal flaring, difficulty in breathing or shortness of breath
5. Note respiratory movements – normal or abnormal
6. State if patient is in respiratory distress. Is it mild, moderate or severe
7. **Look for intercostal & subcostal recession.** It is also due to airway obstruction or decreased lung compliance and by using accessory muscles, especially sternocleidomastoids.

Common causes of fast breathing

1. Airway obstruction
2. Bronchopneumonia
3. Metabolic acidosis
4. Atelectasis
5. Pneumothorax
6. Fever and anxiety
7. Drugs like salicylates

8. **Note if tracheal tug is present:** Tracheal tug is downward pull of the trachea, manifested by a downward movement of the thyroid cartilage. In children it is due to lower airway obstruction probably due to lung compliance problems. This recession is due to greater negative intrathoracic pressure which draws in the soft tissue.
9. **Audible sounds:**
 - Stridor, stertor, snoring, hoarseness, wheeze
 - Grunting (breathing out against a closed glottis) increases pressure in the lungs and small airways to prevent collapse and improve oxygen transfer.

Acute laryngotracheobronchitis (stridor)

Common between 6 months to 2 years of age

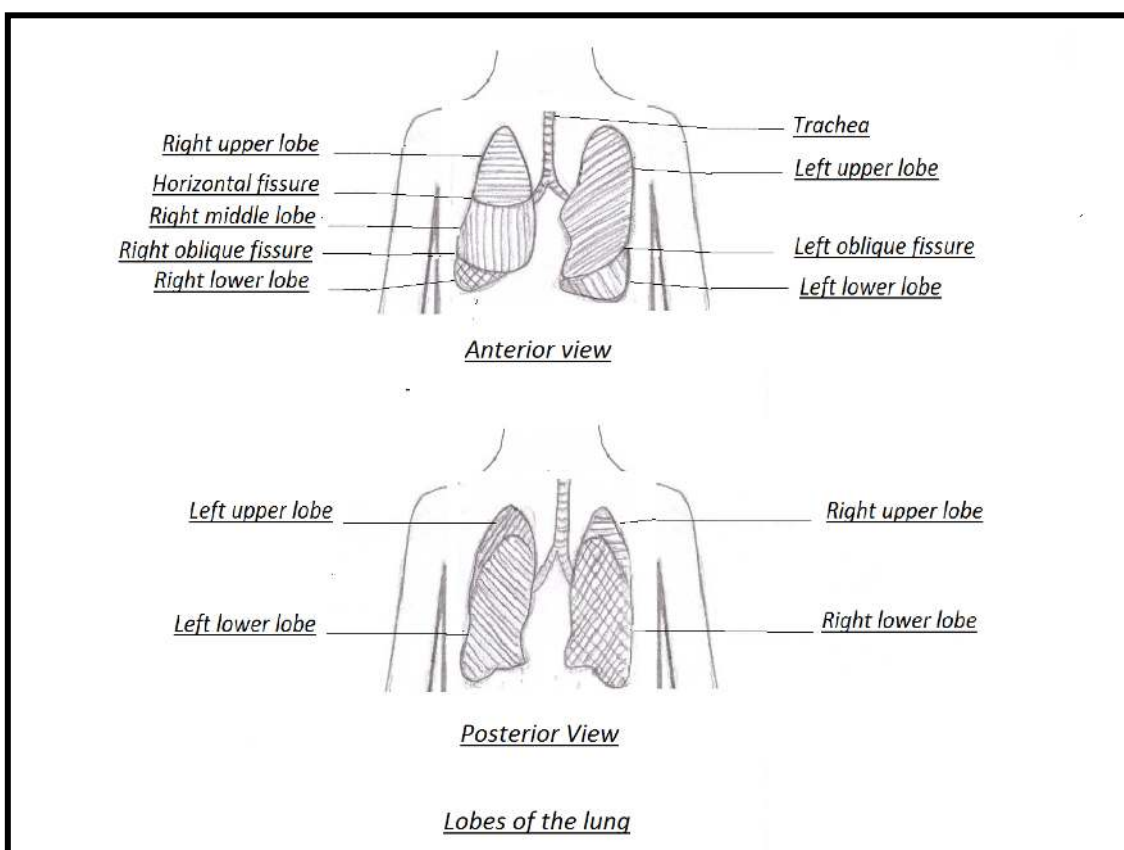
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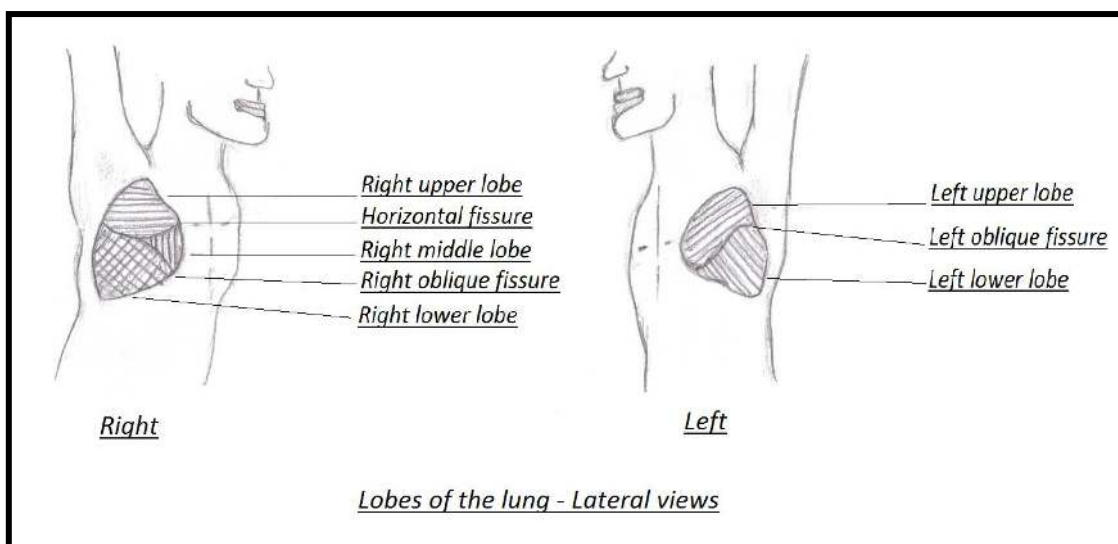
- Grade 1: inspiratory strider
- Grade 2: Inspiratory and expiratory strider
- Grade 3: Inspiratory and expiratory strider and pulsus paradoxus
- Grade 4: Impending apnoea, cyanosis, apathy and marked retractions

Type of breathing patterns

1. **Cheyne- Stokes breathing:** It is terminal pattern of respiration which dependent on CO₂ drive. It is characterised by progressively deeper and faster breathing followed by a gradual decrease in breathing until apnoea. The pattern repeats, with each cycle and usually takes 30 seconds to 2 minutes.
 - First there is rapid and deep breathing which causes fall in PCO₂ in pulmonary blood. When this blood reaches the brain, it inhibits the respiratory centre and causes apnoea.

- As a result of apnoea, alveolar pulmonary PCO_2 gradually builds up. When this blood carrying high CO_2 reaches in the brain, it causes stimulation of respiratory centre and in this way respiration begins again. Thus, initiating the new cycle.
 - Causes include left cardiac failure, increased intracranial pressure (trauma, cerebral haemorrhage), and acute kidney injury or sever pneumonia.
2. **Kussmal respiration:** It is deep and rapid breathing pattern that indicates that the body or organs have become too acidotic. The respiratory centre is stimulated and body works constantly to maintain a normal temperature and neutral blood pH. Causes are the conditions which lead to metabolic acidosis like diabetic ketoacidosis, chronic kidney injury etc.
 3. **Sleep apnoea:** cessation of air flow for more than 10 seconds, more than 10 times at night during sleep
 4. **Shallow and painful breathing:** pleuritic
 5. **Paradoxical respiration:** it is paradoxical inward movement of abdomen during inspiration. Causes: diaphragmatic paralysis, COPD etc.





2. PALPATION

Feel for any tenderness, to exclude any local inflammatory condition like Teitze's disease (costochondritis) or fractured rib. Crepitations are felt in case of surgical emphysema. Note the position of mediastinum:

Palpation of trachea (to assess the upper mediastinum)

Stand in front of the patient and place your 3 fingers (ring, middle, and ring finger) in a way that index and ring fingers rest on the right and left sternoclavicular joints respectively while the middle finger is free to feel the gap between the sternomastoid muscle (of either side) and trachea. Reduced gap indicates the shifting of trachea toward that side. A tracheal position 1-2 mm to the right is considered as normal due to aortic arch curving over from right to left displacing the trachea

Conditions which pull the trachea

1. Atelectasis or collapsed upper lobe of lung
2. Fibrosis of lungs
3. Pneumonectomy

Conditions which push the trachea

1. Pneumothorax
2. Pleural effusion
3. Upper mediastinal tumour
4. Retrosternal goiter
5. Bochdalek hernia

When trachea is not displaced to the side of fibrosis or collapse of lung or to the opposite side in case of pleural effusion, this is called as **splinting of trachea**.

Palpation of apex beat (to assess the lower mediastinum)

Apex beat is localised at the most lateral and inferior point at which palpating fingers are raised with each heart beat. Place the palm of your hand over the pericardium and feel the apex beat. If not palpable, then try to feel it by turning the patient to his/her left side.

Following may be the cause when it is not palpable:

1. Thick muscular chest wall
2. Pneumothorax of left side
3. Pleural effusion of left side
4. Pericardial effusion
5. Emphysema
6. Dextrocardia

If apex beat is palpable then localise it by placing the index finger over it vertically. The apex beat is normally situated in the 5th intercostal space in midclavicular line in small children & 1 cm medial to left midclavicular line in older children & adolescents. Now assess if it is at the right position or displaced. This may be displaced “pushed” outward only or outward and downward. Apex beat may also be “pulled” mean displaced inward.

Causes which push the apex beat – outward/downward

1. Left ventricular enlargement
2. Right ventricular enlargement (outwards only)
3. Pleural effusion of right side
4. Pneumothorax of right side
5. Pectus excavatum

Causes of displacement of apex beat inward (pulled)

1. Collapse of right lung
2. Fibrosis of right lung
3. Dextrocardia – apex beat on the right hand side

Vocal fremitus

This is feeling of voice vibration with the flat hand on chest wall. Its not easy to demonstrate in small children.

Method: Place the palm of your hand flat on the identical points on either side of the chest wall and ask the patient to say “One, one, one” or “ninty nine” and feel the vibration. The vocal fremitus may be nornal or

- **Increased vocal fremitus:** in cavitation, collapse with patent bronchus and consolidation (better conduction to the surface)
- **Diminished vocal fremitus:** in asthma, bronchiolitis, pneumothorax, pleural effusion, fibrosis and collapse with obstructed bronchus

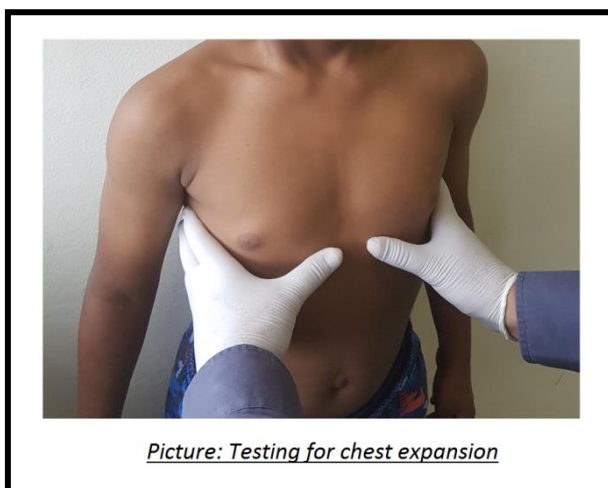
Chest expansion

The angle of Louis is impalpable in children so the first space below the clavicle is the 1st intercostal space. Assessment of symmetrical chest expansion by placing the hands around the thorax of a child is usually not done as breathing in children is shallow.

Following methods can be used in older children and adolescents

Method 1: Fix the fingertips of either hand at the patient's side and make the thumbs just meet in the midline, in front of the chest. Now ask patient to take deep breaths. See the distance of departure of each thumb from midline and compare them.

Method 2: Encircle the chest with a tape-measure and bring the end in front of the chest below the nipples. Ask the patient to take a deep breath and measure the chest expansion. The normal chest expansion in a 5-year old child is 1cm or more, 2.5 cm in older children and more than 5 cm in adolescents and adults.



Note if the chest movement is symmetrical or asymmetrical:

Asymmetry of chest movement can be due to:

1. Pleural effusion
 - exudate (pus)
 - transudate (clear fluid)
 - or blood
2. Collapse or consolidation
3. Pneumothorax
4. Fibrosis

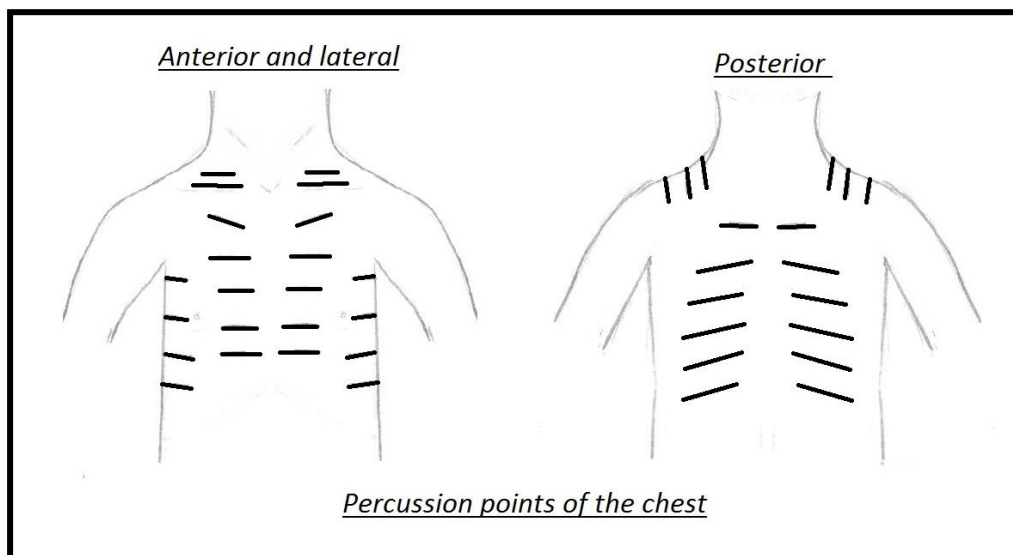
3. PERCUSSION

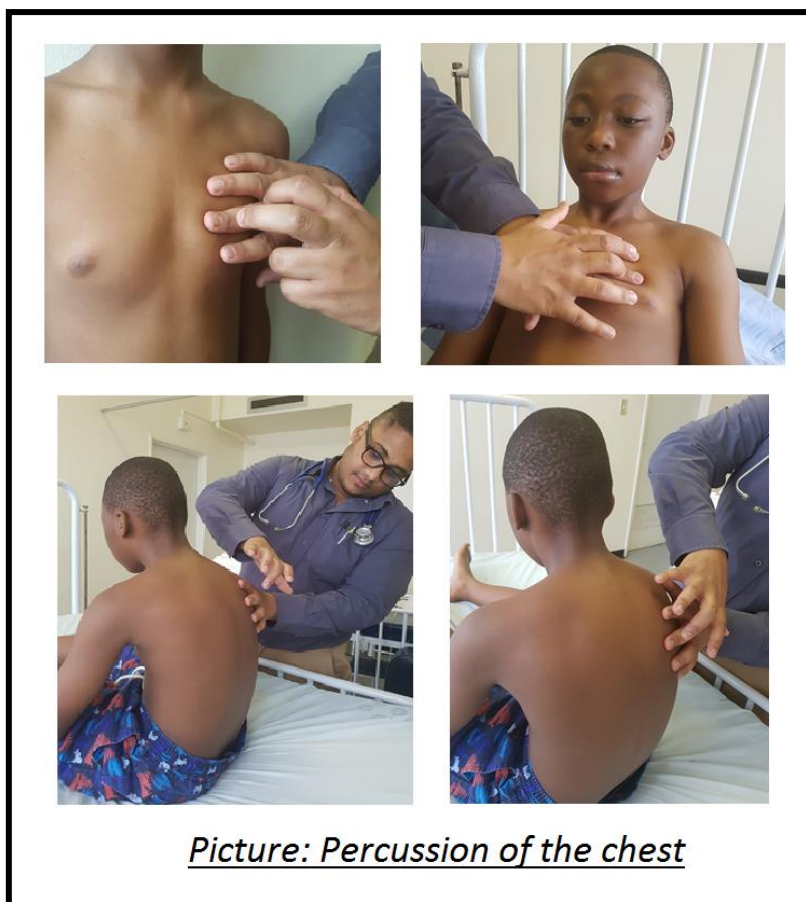
The most important reason to percuss the chest of a child is to assess for hyperinflation or dullness. The technique for a right-handed person is as follows:

Rules of percussion:

- 1) The middle finger of left hand is called as **Pleximeter** & middle finger of right hand is called as **Plexor**

- 2) Percussion is done from resonant to dull area and comparison is done with respective point on the other sides.
- 3) Pleximeter should be placed parallel to the border of organ to be percussed in close contact with the body surface and Plexor should strike the middle phalanx of Pleximeter perpendicularly
- 4) Movements should take place at the wrist and finger joints
- 5) Strike the Plexor twice and then lift it off the Pleximeter i.e. it should not remain in contact with Pleximeter after striking it because it stops the overtones and hence changes the character of the sound produced.
- 6) The blow should be no heavier than is necessary to elicit the resonance of the part being examined, and the wrist joint must move loosely.
- 7) The character of the sound varies quantitatively and qualitatively producing different types of percussion notes.





Picture: Percussion of the chest

Methods of percussion:

Chest is percussed anteriorly, laterally and posteriorly.

Apical percussion

Rotate the head of the patient to the opposite side and place the pleximeter above the medial third of clavicle and percuss it.

Clavicular percusson

Place a finger above and below the clavicle and stabilise it. Now percuss the clavicle directly without pleximeter.

Anterior percussion

After apical and clavicular percussions move in front of the chest

Precaution should be taken to keep the pleximeter away from the cardiac dullness

Upper border of the liver must be percussed and marked before starting to percuss for the anterior of the chest. Look for obvious differences between left and right chest

Posterior percussion

Patient sits up on the bed and crosses his hands in front of the chest places on the shoulders and bends forward. Now start percussion and look for obvious difference between left and right chest.

Lateral percussion

Patient sits up on the bed and place his/her hands on the head. Now percuss the lateral sides of chest from above downward and look for obvious difference between left and right chest.

Types of percussion notes

- **Normal resonance**
A percussion note heard over a normal air-filled lung will be resonant
- **Hyperresonant:** Hyperresonance on percussion indicates too much air within the lung tissue note, that may be due to:
 - Pneumothorax
 - Air trapping in bronchospasm
 - Bronchiolitis
 - Emphysema
- **Decreased resonance** – may be due to:
 - Consolidation
 - Pleural thickening
 - Fibrosis
 - Collapse of lung
- **Dull note**
 - Percussion note over a solid organ like liver, spleen and heart
- **Stony dull** - percussion note over the fluid filled cavity for example:
 - Pleural effusion
 - Ascities
- **Tympanitic note**
Percussive note over a cavity containing air. A best example to percuss over an empty stomach.

Signs of hyperinflation

1. Loss of cardiac dullness
2. Upper border of liver pushed down (usually in 4th to 5th intercostal space)
3. Barrel shaped chest – increased AP diameter

Causes of hyperinflation

1. Chronic asthma
2. Emphysema
3. Cystic fibrosis
4. Bronchiolitis
5. Chronic lung disease

4. AUSCULTATION

Patient should sit or lie down supine on the bed with upper garments removed. Now ask the patient to relax, open the mouth and take deep breaths.

Small children can be examined in their mothers' lap and auscultation can just be done while they are breathing normally.

Warm the chest piece of stethoscope by rubbing it on the palm of your hand and out it on the chest wall in a way that it is in full contact with the chest and should not move on the skin while patient is breathing.

First auscultate anteriorly and then posteriorly. When auscultating, first note character of breath sounds, second character of vocal resonance, and third the presence or absence of other sounds.

Auscultate:

- Anteriorly from clavical down to 6th rib
- Laterally from axilla to the 8th rib
- Posteriorly down to the 11th rib



Picture: Posterior auscultation (example of auscultation)

Breath sounds are two types: vesicular and bronchial

Vesicular breath sound

This is produced by the passage of air in and out of normal lung tissue. It is heard all over the healthy chest and most typically in the axillary and intrascapular regions. Throughout inspiration the sound is fairly intense and of low pitch with a characteristic rustle.

Bronchial breathing

This is pathological sound. It is blowing and hollow in character. Expiration may be prolonged and is harsher and more intense than inspiration. There is pause between inspiration and expiration. When auscultating the chest, the abnormal side is usually the side with decreased breath sounds.

Broncheal breathing may also be produced by the passage of air through the trachea and large bronchi. It is very intense when heard over the trachea but far less intense and of same quality when heard over a diseased lung. The inspiratory sound of bronchial breathing is harsh and becomes inaudible shortly before the end of inspiration. Not to say the child has bronchial breathing if listening near the trachea. Always look for Cor Pulmonale in Chronic Lung Disease

Causes of bronchial breathing

- Consolidation of lung
- Cavitation
- Collapse (with patent bronchus)
- Top of pleural effusion

Vocal resonance

It is difficult to assess in small children but easy in older children and adolescents.

Method: Auscultate when patient say “one, one, one” or “ninety-nine”. The ear perceives, not the distinct syllables, but a resonant sound, the intensity of which depends on the loudness and depth of the patient’s voice and the conductivity of his lungs; the nearer the stethoscope is to a large bronchus, the more intense the sound. Each point examined on one side of the chest should be at once compared with the corresponding point on the other side. Vocal resonance of normal intensity generally conveys the impression of being produced just at the chest-piece of the stethoscope. If it seems to be nearer the ear than this, the resonance is increased. Increased resonance occurs when the lung substance conducts the sound waves set up by the voice more clearly than usual from the bronchi.

Decreased vocal resonance may be due to:

- Reduced conduction
 - Pleural effusion
 - Marked pleural thickening
 - Pneumothorax
- Reduced air flow
 - Generalised COPD
 - Localised lung collapse

Increased vocal resonance may be due to:

- Consolidation
- Cavitation
- Collapse with patent bronchus

Crackles

These are discontinuous crackling or bubbling sounds produced due to the presence of mucous or fluid in bronchi or alveoli. These may be fine (due to the presence of fluid in the alveoli as occurs in heart failure or early stages of pneumonia when there is exudate in alveoli) or coarse (due to secretions in the bronchi in bronchitis or bronchiectasis).

- Early inspiratory: small airway disease – bronchiolitis
- Mid inspiratory: pulmonary oedema
- Late inspiratory: pulmonary fibrosis

Crackles in the inspiration and expiration (biphasic) are present in bronchiectasis

Wheeze

These are prolonged uninterrupted noises, arising in the bronchi due to the partial obstruction of lumen, by swelling of mucosae, by viscous secretion or by constriction of bronchial smooth muscle often associated with turbulent air flow within the lumen. These are high pitched and can be heard without the use of stethoscope.

- Asthma (high pitched and expiratory)
- Bronchiolitis
- COPD

A pleural rub/friction rub:

It is described as grating or creaking sound made when roughened inflamed surfaces of the pleura move over one another during respiration. It has a superficial course, grating, creaking quality surfaces from just beneath the bell/diaphragm of the stethoscope. It is a sign of pleurisy (pleuritic).

Transmitted sounds

These are sounds transmitted from oropharynx to the chest and are common in infants and toddlers with lots of mucous and secretions in their upper respiratory tract. They are rough, sometimes leathery sounds often mistaken for a pleural rub and first hearing.

At end summarise your findings and make a reasonable provisional diagnosis in the light of history and your clinical examination.

Summarise your findings and make a provisional diagnosis:

- Identify the anatomical section of the system affected
- Work out possible aetiology and pathology of the disease process
- Is the organ function is compromised and to what degree?
- Look for complications of the disease process

For chronic symptoms note some of the clues on general examination

- Anthropometry
- Finger clubbing
- Chest deformity
- Generalised lymphadenopathy

Upper respiratory tract infection	Middle respiratory tract infection	Lower respiratory tract infection
<ul style="list-style-type: none"> • Rhinitis • Otitis media • Sinusitis • Tonsillitis • Mastoiditis • Pharyngitis 	<ul style="list-style-type: none"> • Spasmodic laryngitis • Laryngotracheobronchitis • Epiglottitis 	<ul style="list-style-type: none"> • Tracheitis • Tracheobronchitis • Bronchitis • Bronchiolitis • Pneumonia • Empyema

Differential diagnosis of airway obstruction according to signs & symptoms

Acute upper airway obstruction	Persistent upper airway obstruction	Lower airway obstruction
<ul style="list-style-type: none"> • Laryngotracheobronchitis • Acute bacterial epiglottitis • Foreign body aspiration • Retropharyngeal abscess • Bacterial tracheitis • Subglottic oedema after intubation • Angioneurotic oedema 	<ul style="list-style-type: none"> • Laryngomalacia • Vocal cord paralysis • Subglottic stenosis • Laryngeal papillomatosis • Obstructive sleep apnoea 	<ul style="list-style-type: none"> • Acute viral bronchiolitis • Asthma • Cystic fibrosis • Foreign body inhalation

Foreign body inhalation should be considered in DD if:

- Strider not responding to therapy
- Asthma not responding to bronchodilators
- Pneumonia not responding to treatment
- Repeated episodes of pneumonia occurring in the same lobe
- Unexplained chronic cough
- Unexplained lobar collapse
- Localised bronchiectasis

Differential diagnosis of pneumonia according to signs and symptoms

Condition	Symptoms	Signs
Bronchiolitis	Cough Wheeze Rapid breathing Poor feeding	Oral frothing Respiratory difficulty Hyperinflated chest Diffuse crackles Bilateral rhonchi
Bronchopneumonia	Cough Wheeze Irritability Fever Poor feeding	Flaring of alar nasi Grunting Respiratory difficulty Unilateral or bilateral crackles Occasional rhonchi
Wheezy bronchitis	Cough Wheeze Low grade fever Irritability	Tachypnoea Recessions Audible wheeze Bilateral rhonchi
Tuberculosis	Contact with a PTB patient Persistent cough may be associated with wheeze or strider Failure to thrive Weight loss and night sweats	Mild fever and tiredness Erythema nodosum Pleural effusion Phlyctenular conjunctivitis Reactive (Porcet) arthritis Hepatosplenomegaly Generalised Lymphadenopathy
Pneumocystis Jirovecii	Fever Non-productive cough	Tachypnoea Intercostal & subcostal recession Prominent hypoxia Respiratory distress with hypoxia out of proportion to the chest findings Fine crackles
Asthma	Family history of asthma or allergies Coughing specially at night Shortness of breath Whistling sound when breathing out Chest congestion and tightness	Breathing difficulty Intercostal and subcostal recessions Hyperinflated chest Wheezing especially during expiration

If an atopic child has chronic cough, who is otherwise thriving, asthma should be considered in differential diagnosis. But if such a child is losing weight or failing to thrive then tuberculosis, cystic fibrosis and HIV related lung disease should be considered.