Respiratory system

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The respiratory system comprises the upper airway(above cricoid cartilage): the nose, mouth, oropharynx , larynx while Lower airway including the trachea and lungs.

Respiratory disease is responsible for a major problems which cause of high mortality and morbidity .its cover wide spectrum of pathogenesis including infectious, inflammatory, neoplastic e.g. pulmonary T.B. ,pneumonia, Asthma ,COPD, and CA lung . cigarette smokers is the majors risk factor for the most lung diseases .

In most cases of URTI are caused by different types of viruses , they usually occur in fall and winter . They are usually self-limiting, while in some instances may lead to serious respiratory illness and may lead to acute respiratory failure and death .

Lower respiratory tract infection accounts for approximately 10% of the world-wide burden of morbidity and mortality. Seventy-five per cent of all antibiotic usage is for these diseases, despite the fact that they are mainly due to viruses.

Manifestation of Reparatory Diseases:

Cough:

Cough is the most frequent symptom of respiratory disease presenting either dry or productive cough (with sputum).
Acute cough: is one lasting less than 3 weeks while chronic cough lasts more than 8 weeks , The most common cause of acute cough : is acute upper respiratory tract viral infection. Acute cough is usually self-limiting and benign, but may occur in more serious conditions.

Acute cough

(<3 weeks)
Viral respiratory tract infection
Bacterial infection(acute bronchitis)
Inhaled foreign body
Inhalation of irritant dusts/fumes
Pneumonia
Inhaled foreign body
Acutehypersensitivity pneumonitis

Chronic cough

(>8 weeks)
Gastro-oesophageal reflux disease
Asthma
Postviral bronchial hyperreactivity

Rhinitis/sinusitis
Cigarette smoking
Drugs, especially angiotensin-converting enzyme inhibitors
Irritant dusts/fumes
Lung tumour
Tuberculosis
Interstitial lung Disease
Bronchiectasis

'Red flag' symptoms associated with cough

Haemoptysis
- Breathlessness
- Fever
- Chest pain
- Weight loss

Sputum : Sputum should be inspected for colour:green ,yellow in color, Mucoid sputum rusty , bloody (hemoptysis),frothy(pul. edema) , foul smell(bronchiectasis , pneumonia , lung abscess, thick and sticky in asthma , cystic fibrosis

Hemoptysis: is coughing up blood from the respiratory tract and always requires investigation, Blood-streaked sputum or clots in sputum for more than a week suggest lung cancer. Hemoptysis with purulent sputum suggests infection.

Common causes of hemoptysis	
Pulmonary	• Bronchitis • Pulmonary embolism • Bronchiectasis • Lung cancer
Cardiac	• Mitral stenosis/acute pulmonary edema
Infectious	• Tuberculosis • Lung abscess
Hematologic	• Coagulopathy
Vascular	• Arteriovenous malformations
Systemic diseases	• Wegener granulomatosis • Goodpasture syndrome • Systemic lupus erythematosus, vasculitis

Massive hemoptysis: either ≥500 mL of expectorated blood over a 24 hour period or bleeding at a rate ≥100 mL/hour

Dyspnea (breathlessness): feeling of an uncomfortable need to breathe, This is one of the most common and dramatic medical emergencies. Although respiratory causes are common, it can result from cardiac disease, metabolic disease or poisoning causing acidosis, or from psychogenic causes. Obesity and Neurogenic.

Severely breathless patients are dyspnoeic at rest walking around the house, washing, dressing and even eating ,
Breathlessness when lying flat (orthopnoea) is usually feature of HF
Breathlessness that wakes the patient from sleep is typical of asthma and left ventricular failure (paroxysmall nocturnal dyspnoea).
Breathlessness when lying on one side (trepopnoea) is due to unilateral lung disease
Breathlessness on sitting up (platypnoea) with relief on lying down is rare and due to right-to-left shunting.

i	17.25 Modified Medical Research Council (MRC) dyspnoea scale
Grade	Degree of breathlessness related to activities
0	No breathlessness, except with strenuous exercise
1	Breathlessness when hurrying on the level or walking up a slight hill
2	Walks slower than contemporaries on level ground because of breathlessness or has to stop for breath when walking at own pace
3	Stops for breath after walking about 100 m or after a few minutes on level ground
4	Too breathless to leave the house, or breathless when dressing or undressing

Chest pain: can result from cardiac, respiratory, oesophageal or musculoskeletal disorders. The approach to this common symptom was covered in others lectures

Dysphonia (hoarseness) :

is most commonly caused by laryngitis. Damage to the left recurrent laryngeal nerve by lung cancer ‘bovine’ cough

Stridor: high-pitched harsh sound due partial obstruction of the upper airway. tracheal obstruction

Wheeze: high-pitched whistling sound due narrowed small airways is common in asthma and COPD.

Finger clubbing: Clubbing is painless soft-tissue swelling of the terminal phalanges. The enlargement increases convexity of the nail

Congenital or familial (5–10%)

Acquired

Thoracic **(~80%)**

Chronic suppurative conditions:

Pulmonary tuberculosis
Bronchiectasis
Lung abscess
Empyema

-Cystic fibrosis

-Tumours: Lung cancer,Mesothelioma and fibroma

-Pulmonary fibrosis

Respiratory rate:

Tachypnea: is a respiratory rate >25 breaths/min. It is caused by increased ventilatory drive in fever, acute asthma and exacerbation of COPD, or reduced ventilatory capacity in pneumonia, pulmonary oedema and interstitial lung disease

Bradypnea:

A slow respiratory rate of <10 breaths/min (occurs in opioid toxicity, hypercapnia, hypothyroidism, raised intracranial pressure and hypothalamic lesions

Breathing patterns:

Periodic breathing (Cheyne–Stokes) : respiration) is cyclical with increasing rate and depth of breathing, followed
by diminishing respiratory effort and rate, ending in aperiod of apnoea or hypopnoea.

Hyperventilation: is a common response to acute anxiety or emotional distress
Hyperventilation with deep, sighing respirations(Kussmaul respiration) occurs in metabolic acidosis
caused by diabetic ketoacidosis, acute renal failure, lactic acidosis, and salicylate and methanol poisoning.
Although patients may not be aware of breathlessness,their respiratory rate increases and they appear to have‘air hunger’.

Apnea: is the absence of breathing; hypopnoea is areduction in airflow or respiratory movements by >50% for 10 seconds or more. Obstructive sleep apnoea/hypopnoea syndrome (OSAHS)

Cyanosis: is a blue discoloration of the skin and mucous membranes that occurs when the absolute concentration of deoxygenated haemoglobin is increased >50 g/l. can be difficult to detect, particularly in black and Asian patients.

Fever : Fever is an increase in body temperature above upper normal limit if the oral temperature is >37.7° C. signs . usually caused by a cellular response to infection, immunological disturbance or malignancy .although It is nonspecific sign fever is consider one of cardinal feature of pneumonia , TB , and other respiratory diseases.
Fever and night sweats as in TB.

Investigations of Pulmonary Diseases:

Pulse Oximeters:

with finger or ear probes measure the hemoglobin that is oxygenated, non-invasive continuous assessment of oxygen saturation in patients and its response to oxygen therapy.
SpO2 should be maintained at 94–98%. Movement artifact,poor tissue perfusion, hypothermia and nail varnish can
lead to spuriously low SpO2 values.
Dark skin pigmentation and raised levels of bilirubin or carboxyhaemoglobin can result in false increases in SpO2. Oximetry is less accurate with saturations <75%

CBC ,RFT, LFT ,Serum Electrolytes and D dimer:

Standard blood tests such as the blood counts and blood chemistry point to specific disorders or may provide information about the severity of a lung disorder (e.g., polycythemia chronic hypoxemia, leukocytosis in lung infection). D-dimer measurements to screen for thromboembolism.

Microbiological investigations:

Sputum, pleural fluid, throat swabs, blood, and bronchial washings and aspirates can be examined for bacteria, fungi and viruses.

Cytology and histopathology:

Cytological examination of sputum and exfoliated cells in pleural fluid or bronchial washings, or of fine needle aspirates from lymph nodes or pulmonary lesions, can support a diagnosis of malignancy but a larger tissue biopsy is often necessary

Immunological and serological tests:

May be supported in Asthma diagnosis immunoglobulin E (IgE), measurement of antibody against specific antigen.
Respiratory viruses detected in nose/throat swabs by immunofluorescence
legionella infection may diagnosed by detection of the urinary antigen
They may identify a reaction to fungi such as Aspergillus
antigens involved in hypersensitivity pneumonitis, such as farmer's lung
A interferon-gamma release assays (IGRA)are useful in diagnosis of TB

Arterial blood gases (ABG):

The measurement of acid–base (pH andHCO3–) status, PaO2 and PaCO2
in an arterial blood sample is essential for assessing the degree and type of respiratory failure and for measuring acid–base status and Acid–Base Disturbance.

Respiratory acidosis:

decrease in pH occurs in severe acute asthma, severe pneumonia, exacerbations of COPD and neuromuscular disorders. Elevation of $PaCO_2$

Elevation of $PaCO_2$ for more than more than 2–3 days may occur in COPD lead to renal retention of HCO_3^- and normalization of pH,

➔**Compensated Respiratory Acidosis**

Respiratory alkalosis:

Hyperventilation occurs with respiratory conditions(asthma, pulmonary thromboembolism, pleurisy),high altitude and acute anxiety. Alveolar hyperventilation

leads to decrease in $PaCO_2$ and a consequent increase in pH. If hyperventilation persists, as occurs with stays at high altitude, increased renal excretion of HCO_3^- – results in normalisation of pH, i.e.**Compensated Respiratory Alkalosis.**

Metabolic acidosis:

In acute renal failure, diabetic ketoacidosis and lactic acidosis results from loss of HCO_3^-

The decrease in pH stimulates arterial chemoreceptors, resulting in alveolar hyperventilation with a consequent decrease in $PaCO_2$

Compensated metabolic acidosis is hyperventilation to decrease the arterial pCO_2. This hyperventilation was first described by Kussmaul in patients with diabetic ketoacidosis .

Metabolic alkalosis:

the pH of tissue is elevated beyond the normal range (7.35–7.45).such as in Loss of gastric secretions - Vomiting, NG suction and in diarrhea

This is the result of decreased hydrogen ion concentration

The increase in pH induces alveolar hypoventilation via arterial chemoreceptors, with consequent increase in $PaCO_2$.to decease the PH and lead to what's called **Compensated metabolic alkalosis.**

Causes of Acid–Base Disturbance:

Disturbance	pH	CO_2	HCO_3^-	Cause
Respiratory acidosis	↓	↑	↑	Acute ventilatory failure with: Severe acute asthma Severe pneumonia Exacerbation of COPD Thoracic skeletal abnormality, e.g. kyphoscoliosis Neuromuscular disorders, e.g. muscular dystrophy
Respiratory alkalosis	↑	↓	↓	Hyperventilation due to anxiety/panic Central nervous system causes, e.g. stroke, subarachnoid haemorrhage Salicylate poisoning, early phase
Metabolic acidosis	↓	↓	↓	Increased production of organic acids: Diabetic ketoacidosis Poisoning: alcohol, methanol, ethylene glycol, iron, salicylate Acute renal failure Lactic acidosis, e.g. shock, post cardiac arrest Loss of bicarbonate: Renal tubular acidosis, severe diarrhoea, Addison's disease
Metabolic alkalosis	↑	↑	↑	Loss of acid: Severe vomiting, nasogastric suction Loss of potassium: Excess diuretic therapy, hyperaldosteronism, Cushing's syndrome, liquorice ingestion, excess alkali ingestion: milk–alkali syndrome

Respiratory Function Tests:

Spirometer is helpful in assessing breathing patterns that identify conditions such as asthma, pulmonary fibrosis, cystic fibrosis, and COPD

The forced expired volume in 1 second **(FEV1)** is the volume exhaled in the first second, and **the forced vital capacity (FVC)** is the total volume exhaled.

FEV1/FVC ratio is usually >75%. influenced by age, gender, height and race.

In the elderly the ratio is usually 70–75%. Reduction in the FEV1/FVC ratio indicates airway obstruction.

FEV1 is disproportionately reduced in airflow obstruction, resulting in FEV1/FVC ratio of less than 70%. In this situation, spirometry should be repeated following inhaled short-acting β2-adrenoceptor agonists (e.g. salbutamol); an increase of > 12% and > 200 mL in FEV1 or FVC indicates significant reversibility.

In interstitial lung disorders, e.g. idiopathic pulmonary fibrosis, pulmonary sarcoidosis or hypersensitivity pneumonitis, there is a decrease in FVC with preservation of FEV1

So the **FEV1/FVC ratio** is high or normal which indicate a restrictive defect

lung volumes by rebreathe an inert non-absorbed gas (usually helium) and recording the dilution of test gas by lung gas. This measures the volume of intrathoracic gas which mixes quickly with tidal breaths. lung volume may be measured by body plethysmography, which determines the pressure/volume relationship of the thorax. This method measures total intrathoracic gas volume, including poorly ventilated areas such as bullae.

Transfer factor: DLCO or TLCO (diffusing capacity or transfer factor of the lung for carbon monoxide

To measure the capacity of the lungs to exchange gas, patients inhale a test mixture of 0.3% carbon monoxide.

Chest X-ray:

Imaging studies of the chest are extremely useful in evaluating lung structure

The chest radiograph provides information about the lung parenchyma and pleura, the cardiac silhouette, mediastinal structures, and body habitus. Examining old chest radiographic images is essential for assessing progression of disease

A poster anterior (PA) film provides information on the lung fields, heart, mediastinum, vascular structures and thoracic cage.

In reading of chest x ray Look at:

- the shape and bony structure of the chest wall
- whether the trachea is central
- whether the diaphragm is elevated or flat
- the shape, size and position of the heart
- the shape and size of the hilar shadows
- the size and shape of any lung abnormalities and vascular shadowing.

Lung opacity .may represent accumulation of fluid, lobar collapse or consolidation. the presence of an air bronchogram as in pneumonia . Collapse (implying obstruction of the lobar bronchus) is accompanied by loss of volume and displacement of the mediastinum towards the affected side.other pathological finding might be seen in chest –ray such as :

Cavitation , Solitary or multiple lung nodules, Reticular shadow, Pneumothorax and Pleural effusion.

lateral view chest x-ray adds valuable information about areas that are not well seen on the PA projection. In particular, the retro cardiac region, the posterior bases of the lung, and the bony structure of the thorax (e.g., the vertebral column) are better visualized on the lateral radiograph.

Chest CT Scan:

Computed tomography (CT) provides more accurate information than chest x-ray about the pulmonary and mediastinal structures, and it is essential in the assessment of interstitial lung disease, lung masses, and other disorders.

provides detailed images of the pulmonary parenchyma, mediastinum, pleura and bony structures. In cases of suspected lung cancer, CT is central to both diagnosis and staging, and facilitates percutaneous needle biopsy.

CT pulmonary angiography (CTPA) has become the investigation of choice in the diagnosis of pulmonary thromboembolism.

Chest Ultrasound: Transthoracic ultrasound has evolved to assess the pleural space it can distinguish pleural fluid from pleural thickening, identify a pneumothorax and, may be used to guide pleural aspiration, biopsy and intercostal chest drain insertion safely.

It is also used to guide needle biopsy of superficial lymph node or chest wall masses .

Ventilation and perfusion Scan VA/Q:

For efficient gas exchange there must be a match between ventilation of the alveoli (VA) and their perfusion (Q).It is a nuclear medicine scan that uses radioactive material (radiopharmaceutical) to examine airflow (ventilation) and blood flow (perfusion) in the lungs. The aim of the scan is to look for evidence of pulmonary embolism (PE).

Positron Emission Tomography(PET Scan):

PET is useful in the staging of mediastinal lymph nodes and distal metastatic disease in patients with lung cancer and in the investigation of pulmonary nodules. It is used to assess metabolic activity of lung masses and can suggest a diagnosis of malignancy It is helpful in assessing whether a pulmonary nodule is benign or malignant.

Magnetic Resonance Imaging:

MRI does not have ionizing radiation its useful in pregnant female patient
It's used in the differentiation of benign from malignant pleural disease. MRI is very useful in the study of aortic dissection and may have a role in the evaluation of pulmonary emboli.

Bronchoscopy:

used for diagnostic or therapeutic indications.
Insertion a thin tube containing a light and camera into the lungs through the nose or mouth

Flexible bronchoscopy is usually performed under local anaesthesia with sedation, on an outpatient basis. Abnormal tissue in the bronchial lumen or wall can be biopsied, and bronchial brushings, washings or aspirates can be taken for cytological or bacteriological examination. Small biopsy specimens of lung tissue, taken by forceps passed through the bronchial wall (transbronchial biopsies),
as sarcoidosis and diffuse malignancy.

Rigid bronchoscopy requires general anesthesia using for removal of a foreign body

Endobronchial ultrasound:

allows directed needle aspiration, stage lung cancer. It may also be useful in T.B , sarcoidosis diagnosis

Thoracoscopy:

It is used increasingly to stage lung cancer. It may also be useful in non-malignant conditions, such as tuberculosis of the mediastinal lymph nodes or sarcoid.
the insertion of an endoscope through the chest wall, facilitates biopsy under direct vision and is performed by surgeons and an increasing number of physicians. This modality is the gold standard for the evaluation of complex pleural effusion, and for staging of tumor .

Respiratory failure:

Fails to maintain normal arterial oxygen and carbon dioxide levels. Its classification into types I and II relates to the absence or presence of hypercapnia (raised $PaCO_2$).
Note :PaO_2: 80 to 100 (mm Hg), or 10.5 to 13.5 (kPa)
$PaCO_2$: 35 to 45 mm Hg (5 to 5.5 kPa) Arterial blood pH: 7.35to 7.45.

Type I respiratory failure: HYPOXIA WITH NORMAL $PaCO_2$,Diseases causing impair ventilation locally with sparing of other regions, Hypoxia (PaO_2 < 8.0 kPa (60 mmHg))+ Normal or low $PaCO_2$ (≤ 6 kPa (45 mmHg))

Causes: Acute asthma, Pulmonary oedema, Pneumonia, Lobar collapse, Pneumothorax, Pulmonary embolus and ARDS

Type II respiratory failure: is Arterial hypoxia with hypercapnia seen in conditions that cause perfusion mismatch leaving insufficient normal lung to correct $PaCO_2$, or any disease that reduces total ventilation

perfusion mismatch, latter includes not just diseases of the lung but also disorders affecting any part of the neuromuscular mechanism of ventilation. Hypoxia (PaO_2 < 8.0 kPa (60 mmHg))+ Raised $PaCO_2$ (> 6 kPa (45 mmHg))

Acute severe asthma
Acute exacerbation of COPD
Upper airway obstruction
Acute neuropathies/paralysis
Narcotic drugs
Primary alveolar hypoventilation
Flail chest injury
Sleep apnoea
Kyphoscoliosis
Myopathies/muscular dystrophy
Ankylosing spondylitis

In severe chronic COPD and type II respiratory failure develop abnormal tolerance to raised $PaCO_2$ and may become dependent on hypoxic drive to breathe.

Removal of this stimulus by excessive oxygen therapy may result in alveolar hypoventilation with further increase in $PaCO_2$, which can lead to deterioration and death

In these patients lower concentrations of oxygen (24-28% by Venturi mask) should be used to avoid precipitating worsening respiratory depression, regular monitoring of arterial blood gases is important to assess progress.

Management of respiratory failure:

Diagnosis and management of the underlying cause is crucial. In type I respiratory failure, high concentrations of oxygen(40–60% by mask) will usually relieve hypoxia

ventilation may be needed to relieve hypoxia.

Reverse the cause: e.g. acute upper airway obstruction (foreign body inhalation laryngeal obstruction (angioedema, carcinoma or vocal cord paralysis) tension pneumothorax. In all such cases, high-concentration (e.g. 60%) oxygen should be administered pending a rapid examination of the respiratory system and measurement of arterial blood gases.

Airway management
ICU admission
Correct the hypoxia
Correct the hypercapnia
Noninvasive ventilation
Mechanical ventilation

Correction of hypoxemia

O_2 administration high concentration o_2 supply (40-60%)
Goal: Adequate O_2 delivery to tissues
PaO_2 = > 60 mmHg
Arterial O_2 saturation >90%

Correction of hypercapnia

Control the underlying cause
Controlled O2 supply(lower concentrations of oxygen (24-28%)
1 -3 lit/min, titrate according O2 saturation
O2 supply to keep the O2 saturation >90% but <93 to avoid inducing hypercapnia

Noninvasive Ventilatory support by :

Intermittent Positive Pressure Ventilation (IPPV)

Mild to moderate Respiratory failure
Patient should have
Intact airway,
Alert, normal airway protective reflexes
Nasal or full face mask
Improve oxygenation,
Reduce work of breathing
Increase cardiac output
Its used in management of Acute exacerbated COPD, asthma,
If the patient seriously ill and not take benefit from above measures go to

Mechanical ventilation through Endotracheal intubation

Indications:
Severe Hypoxemia
Altered mental status

Weaning from mechanical ventilation

Stable underlying respiratory status
Adequate oxygenation
Intact respiratory drive
Stable cardiovascular status
Patient is a wake, has good nutrition, able to cough and breathe deeply