Introduction to respiratory system and classification of major respiratory diseases

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objectives

At the end of this lecture, the student will be able to:

• Describe the main parts and function of the respiratory system.
• Mention how can a patient with respiratory disease present to the doctor.
• Enumerate the main tests used for diagnosing a respiratory disease.
• Classify respiratory diseases
INTRODUCTION

The respiratory system is a series of organs responsible for taking in oxygen and expelling carbon dioxide.
• The exchange of oxygen and carbon dioxide occurs in the alveoli.

• The trachea, filters the air that is inhaled. It branches into the bronchi, which are two tubes that carry air into the lungs.

• The diaphragm, a dome-shaped muscle at the bottom of the lungs, controls breathing
FUNCTIONAL ANATOMY AND PHYSIOLOGY

During breathing, free movement of the lung surface relative to the chest wall is facilitated by sliding contact between the parietal and visceral pleura, which cover the inner surface of the chest wall and the lung respectively, and are normally in close apposition.
• As air is inhaled through the upper airways, it is filtered in the nose, heated to body temperature and fully saturated with water vapor.

• Normal breath sounds originate mainly from the rapid turbulent airflow in the larynx and in these central airways.
• The acinus is the gas exchange unit of the lung and comprises branching respiratory bronchioles and clusters of alveoli.

• The filtered, moistened and heated air makes close contact here with the blood in the pulmonary capillaries (gas-to-blood distance < 0.4 μm), and oxygen uptake and CO2 excretion occur.
Lung defenses

Upper airway defences

- Large airborne particles are trapped by nasal hairs, and smaller particles settling on the mucosa are cleared towards the oropharynx by the cilia.
• During **cough**, expiratory muscle effort against a closed glottis results in high intrathoracic pressure, which is then released explosively.

• The **larynx** also acts as a sphincter protecting the airway during swallowing and vomiting.
Lower airway defences

• Inhaled particulate matter is trapped in airway mucus and cleared by the mucociliary escalator.

• Defective mucociliary transport is also a feature of several rare diseases, characterised by repeated sino-pulmonary infections and bronchiectasis.
• Airway secretions contain an array of antimicrobial peptides such as immunoglobulin A (IgA).

• Macrophages engulf microbes, organic dusts and other particulate matter. They are unable to digest inorganic agents such as asbestos or silica, which result in their death and the release of powerful enzymes that cause parenchymal lung damage.
INVESTIGATION OF RESPIRATORY DISEASE

Radiology

Chest X-ray
This is performed on the majority of patients suspected of having chest disease provides information on the lung fields, heart, mediastinum, vascular structures and the thoracic cage
Lung apex

Clavicular heads symmetrical either side of spine—no rotation

Trachea

Medial border of scapula

Aortic arch

Left hilum

Left ventricular border

Cardiac apex

Right hilum

Right atrial border

Right costophrenic angle

Right hemidiaphragm

Right cardiophrenic angle

Left hemidiaphragm (normally lower than R)

Gastric air bubble
Computed tomography (CT)

- CT provides detailed images of the pulmonary parenchyma, mediastinum, pleura and bony structures.

- Normal and abnormal structures will be seen clearly by CT.

- It is of special importance in lung cancer management.
Ultrasound

- Ultrasound (US) is sensitive at detecting pleural fluid.
Ventilation–perfusion imaging

- In this technique, the lungs are imaged using a gamma camera.

- Pulmonary embolism could be detected with this test.
Positron emission tomography (PET)

PET scanners show the avid ability of malignant tissue to absorb and metabolise glucose
Endoscopic examination

Laryngoscopy
• The larynx may be inspected indirectly with a mirror or directly with a laryngoscope.

Bronchoscopy
• The trachea and larger bronchi may be inspected using the bronchoscope.
Pulmonary function testing

Respiratory function tests are used to aid diagnosis, assess functional impairment, and monitor treatment or progression of disease. Obstructive and restrictive lung diseases could be assessed with these tests.
Arterial blood gases and oximetry

• Arterial blood gas machine measure O2 and CO2 pH and bicarbonate. Respiratory system function is gas exchange, this test give good idea about this function.

• Oximeter is an instrument that can measure O2 saturation.
PRESENTING PROBLEMS IN RESPIRATORY DISEASE

Cough

– Cough is the most frequent symptom of respiratory disease.
– Sputum production is common in patients with acute or chronic cough.

Breathlessness

– Breathlessness or dyspnoea can be defined as the feeling of an uncomfortable need to breathe.
Chest pain

- Chest pain is a frequent manifestation of both cardiac and respiratory disease.

Hemoptysis

- Coughing up blood.
Classification of respiratory diseases

- Obstructive pulmonary diseases
- Bronchiactsis
- Infections of the respiratory system
- Pleural diseases
  Tumours of the bronchus and lung
- Interstitial pulmonary diseases
- Pulmonary vascular disease
- Diseases of the upper airway
- Sleep-disorders
- Respiratory failure
- Diseases of the diaphragm and chest wall
- Lung transplantation
OBSTRUCTIVE PULMONARY DISEASES

• Bronchial narrowing (obstruction) hallmark obstructive pulmonary diseases.

• Two well known conditions:
  – Asthma
  – Chronic obstructive pulmonary disease
Asthma

- Asthma is a common disease in children and adult caused by airflow obstruction that is variable over short periods of time, or is reversible with treatment.
- Inflammation and temporary narrowing of a person’s airways makes it difficult for him to breathe
- Inhaled drugs usually used for treatment.
Different types of inhalers are available

Accuhaler (diskus)

Turbohaler

Metered dose inhaler
Chronic obstructive pulmonary disease (COPD)

• A pulmonary disease characterized by airflow limitation that is **not** fully reversible. This include tow related disease 1. chronic bronchitis and 2. emphysema

• Smoking is the main culprit.
BRONCHIECTASIS

- Bronchiectasis means abnormal dilatation of the bronchi. This result in production of large amount of sputum every day.
- Ciliary function impairment and long term infection like tuberculosis are major known causes.
INFECTIONS OF THE RESPIRATORY SYSTEM

• Infective microorganism could affect the respiratory system including: viruses, bacteria, fungi.

• Classified according to the location in the respiratory pathway to:
  – Upper respiratory tract infection
  – Lower respiratory tract infection
• **Upper respiratory tract infection**: infection of the nasal passages (rhinitis), epiglottis (epiglottitis), larynx (laryngitis), pharynx (pharyngitis), sinuses (sinusitis), trachea (trachiaitis). Influenza virus is a well known cause.

• **Lower respiratory tract infection**: infection involving bronchial tree (bronchitis), bronchiols (bronchiolitis), lung tissue (pneumonia).
• Tuberculosis (TB) is a common and well known disease world-wide.

• Usually involve the lungs (pulmonary TB), but also other organs and tissues (extrapulmonary TB) e.g. lymph nodes, bone and intestine.
PLEURAL DISEASES

• The accumulation of serous fluid within the pleural space is termed *pleural effusion*. Heart failure, TB, pneumonia complication are common causes of pleural effusion.
• Accumulation-in the pleural space- of:
  – Air called (pneumothorax)
  – Pus called (pyothorax)
  – Blood (hemothorax)
TUMOURS OF THE BRONCHUS AND LUNG

• Lung cancer is the most common cause of death from cancer world-wide.

• Tobacco use is the major preventable cause.

Primary lung tumors: arise from pulmonary tissues

Secondary lung tumors: arise from distal site but tumor cells get access by the blood to the lungs and built themselves there. This process called “meastasis”.

Lung tumor
INTERSTITIAL AND INFILTRATIVE PULMONARY DISEASES

A restrictive respiratory disease stops the lungs from expanding as they should, decreasing air capacity and making it harder to breathe.

– **Diffuse parenchymal lung disease**: a heterogeneous group of conditions affecting the pulmonary interstitium and/or alveolar lumen.
Lung diseases due to organic dusts
A wide range of organic agents may cause respiratory disorders on continuous exposure. Examples of such diseases include:

- Farmer’s lung
- Bird fancier’s lung
- Byssinosis (cotton)
Lung diseases due to inorganic dusts

In certain occupations, the inhalation of inorganic dusts, fumes or other noxious substances leads to specific pathological changes in the lungs e.g. exposure to chlorine, ammonia, silica and asbestos.
– Lung diseases due to systemic inflammatory disease
   Respiratory involvement in connective tissue disorders like rheumatoid arthritis.

– Lung diseases due to irradiation and drugs
   Exposure to and a lot of drugs could cause permanent lung damage.
PULMONARY VASCULAR DISEASE

– **Venous thromboembolism** of the lower limbs when happened could be travel to the right side of the heart and then to the pulmonary arteries causing blockage of one or more artery(s) and hence lung infarction.

– **Pulmonary hypertension:** increased pulmonary artery blood pressure more than normal generally produced as a result of narrowing blood vessels, causing a lack of oxygen and possible heart failure.
DISEASES OF THE UPPER AIRWAY

Upper airways may be involved with allergic, infectious, obstructive and malignant diseases.
SLEEP-DISORDERS

A variety of respiratory disorders affect sleep e.g. obstructive sleep apnoea
RESPIRATORY FAILURE

• The term respiratory failure is used when pulmonary gas exchange fails to maintain normal arterial oxygen and carbon dioxide levels.

• Two types known: type I and type II respiratory failure according to presence or absence of blood gas state.
DISEASES OF THE DIAPHRAGM AND CHEST WALL

Diseases of the diaphragm: e.g. Diaphragmatic hernias and paralysis may cause breathing difficulties.

Deformities of the chest wall: e.g. Thoracic kyphoscoliosis and pigeon chest could affect respiratory function.
LUNG TRANSPLANTATION

Lung transplantation is now an established treatment for carefully selected patients with advanced lung disease unresponsive to medical treatment.
What is the connection between the respiratory and cardiovascular system?

• The respiratory system and cardiovascular system are intricately intertwined in a complex manner, relying on one another to perform their physiological functions.
• Only together can they keep the body functioning through the transportation of gases and other elements.
• As a general rule, they are directly related, meaning when one system speed ups, the other system accompanies in an increased level of function and vice versa.
Further readings

Davidson clinical and practice of medicine 21\textsuperscript{st} Edition
Fishman’s pulmonary diseases and disorders 4\textsuperscript{th} edition
Thank you