INTRODUCTION TO PATHOLOGY AND THE STUDY OF DISEASES

- Faculty of Medicine -

- Foundation Block -

DR. AMMAR C. ALRIKABI*, DR. MAHA ARAFAH** AND DR. SUFIA HUSAIN***

*Professor, Associate Professor and Assistant Professor

Department of Pathology

King Khalid University Hospital and King Saud University

Introduction

Pathology is an important discipline which provides **the link** between basic biological sciences and the practice of medicine. In broad terms, the study of pathology encapsulates the way we think about diseases and about their causes, prevention and classification. Using a more limited definition, **pathology is the study of changes which occur in cells and tissues as a result of inborn genetic, extraneous environmental or behavioural damage.**

- Pathology is the study of disease processes.
- Epidemiology provides a broad context for understanding pathology.
- Both (pathology and epidemiology) provide a useful framework for classifying and understanding mechanisms of disease.

Health, illness and disease

Normal health or well being is a state which most of us experience most of the time. Illness, however, is the subjective state of not feeling well and sickness is a state of social dysfunction, i.e. a role that the individual assumes when ill. There is a wide range of normality and the human body can readily adapt to changes in the environment (e.g. by an increase in hemoglobin at an altitude where oxygen levels are low). Disease or ill health occurs when these limits or normality are overreached.

Disease is defined as a physiological or psychological dysfunction. It can be caused by an obvious structural abnormality such as a broken bone or a tumour or may be less well defined, as in the case of anorexia nervosa. All diseases have certain aspects which can form the basis of a classification and these include:

- Epidemiology.
- Aetiology.
- Pathogenesis.

Epidemiology

Epidemiology include sex and age, prevalence of a particular disease in addition to geographics distribution and incidence. **Prevalence** means the number of cases in a population at any one time while **incidence** is the number of new cases in a population over a given time. **Aetiology** is the direct cause of a disease while **pathogenesis** is the mechanism of disease production.

Epidemiology provides a wider context for the study, classification and diagnosis of diseases. Data recorded about incidence, prevalence, morbidity and mortality relate to populations, rather than individuals.

Knowledge of epidemiology is important for:

- Providing causal clues.
- Identifying risk factors and risk markers.
- Planning and executing disease prevention and health promotion.
- Providing adequate health care facilities.
- Setting up population screening programmes. (Screening is defined as identifying a disease in an apparently healthy population).
- Evaluating health care interventions.

Factors which affect the incidence (number of new cases occurring in a defined population over a defined time period) and prevalence (number of cases found in a defined population at a stated time) of disease include:

- Time: how the disease has varied over the course of time.
- Place: how the disease varies geographically.
- Person: what are the personal characteristics of those who suffer from the disease and how they differ from those who do not suffer from the disease, e.g. in age, sex, occupation, race, social class, behavior.

Changes in the incidence of disease with time may result from preventative measures, such as immunization programmes, or may reflect changes in social conditions. For example, increased smoking has led to an increase in heart disease and lung cancer.

Many diseases show significant **geographical** variations: in developed countries, heart disease, cancer and psychiatric illnesses are common whereas in underdeveloped countries, malnutrition and infection are often the commonest health problems. Different infectious agents are common in different geographical areas.

There are many well documented associations between diseases and occupation:

- Ship builders and insulation workers: asbestosis (asbestos-related scarring in the lungs); mesothelioma (malignant tumour of the lung pleura).
- Rubber and dye workers: bladder cancer through the effect of chemicals.
- Hardwood manufacturing: nasal cancer as a result of inhalation of wood dust.

Aetiology (causes of disease)

Diseases result from the interaction between individuals and their environment. Some diseases are the inevitable result of environmental factors (e.g. being run over by a bus) whereas others result from an environmental or behavioural factor acting in conjunction with a genetic predisposition, e.g. smokers with a strong family history of heart disease.

Some examples are:

- Genetic: Down's syndrome (extra chromosome 21).
- Infective: bacteria, viruses, fungi.
- Chemical: cirrhosis of the liver caused by alcohol damage; respiratory failure as a result of a paraquat poisoning affecting lungs.

- Radiation: Post-radiation cancer (e.g. skin cancer, squamous cell carcinoma) developing in the skin of a breast irradiated for mammary carcinoma).
- Mechanical: traumatic crush injury.

Idiopathic disease. In some instances, the underlying cause of a disease is obscure. Many euphemisms are used for this, including idiopathic, cryptogenic, essential and spontaneous. **Cause unknown** is a simpler and more honest way of saying the same thing.

Pathogenesis (mechanisms of disease)

The pathogenesis of a disease is the mechanism by which the cause(s) interact with the target cells or tissue to produce injury. Cells and tissues are relatively limited in the ways in which they can respond to insult or injury. There are a few fundamental processes which underlie most diseases:

- **Inflammation**: response to injury in living vascularized tissue.
- **Degeneration**: deterioration of cell function resulting from metabolic disease or ageing.
- **Carcinogenesis**: process of transformation of cells from the normal, controlled to the neoplastic autonomous state.
- **Immune reactions**: specific responses to foreign organisms or material.

Classification of disease

The most useful disease classification is based on the pathogenesis or underlying mechanism. Broadly speaking, diseases can be classified into two categories: "congenital" or "acquired". **Congenital diseases** are present at birth even though they may not be recognized or recognizable at that time. **Acquired diseases** only occur after birth. Both congenital and acquired diseases can be classified further (see table).

Classification of diseases based on their pathogenesis

Type	Basis	Examples
Congenital	Genetic	Reduction or absence of blood clotting factor VIII leads to haemophilia A (X chromosome linked).
	Non-genetic	Cleft lip and palate.
Acquired	Inflammatory	Dermatitis (eczema, inflammation of the skin), rheumatoid disease (inflammation of joints/arthritis).
	Vascular	Atherosclerosis (deposition of lipid with thickening of blood vessels) leading to a cerebrovascular accident (stroke), myocardial infarction (heart attack).
	Growth disorder	Cancer.
	Degenerative	Alzheimer's disease, Parkinson's disease.
	Drug induced	Bone marrow suppression, skin rashes, renal failure.
	Infective	Viral, bacterial or fungal diseases.
	Metabolic	Gout: deposition of uric acid crystals in joints and tissues. Diabetes mellitus: abnormal metabolism of carbohydrates and lack of insulin.

Ways of thinking about diseases

It is useful to have a logical framework for thinking about diseases. There are several ways of organizing information about diseases which include:

- **Definition**: clinical or pathological.
- **Epidemiological:** incidence, age/gender, geography, race.
- **Clinical presentation**: symptoms and signs. (The word symptom refers to the patient complaint while signs are clinical features discovered by the examining physician).
- **Underlying pathology**: understanding mechanisms of disease with changes in tissues visible by naked eye (macroscopic), changes seen only down the microscope (microscopic) and tissue function (pathophysiology).
- **Differential diagnosis**: other diseases which may be similar.
- **Treatment and management**: drugs, surgery, counseling.
- **Prognosis:** natural history of disease, disease outcome.

Diseases are often discussed in terms of their morbidity (degree of "illness" involved) and mortality. 5- and 10-year survival rates are often used as an expression of the disease outcomes. For example, in some types of lung cancer, the 5-year survival rate is 0%.

The diagnostic process

Patients present with symptoms and a clinical examination elicits signs which suggest a diagnosis. Examination of specimens (blood, urine, faeces, tissue samples) in the various pathology laboratories helps confirms this diagnosis and monitor treatment.

- Diagnosis involves clinical skills and laboratory tests.
- Specialist pathological techniques can aid in diagnosis.

Diagnosis

Diagnosis is the act of identifying a disease in an individual patient and is based on clinical history, physical examination and investigation. An understanding of and ability to integrate a knowledge of the classification, epidemiology and mechanisms of disease processes are essential. Making a diagnosis involves:

- Taking a clinical history of symptoms: what the patient has noticed is wrong (e.g. cough, breathlessness, pain).
- Clinical examination for signs: what the doctor finds wrong on examination (e.g. lumps, rashes, abnormal lung sounds).

The clinician then works through a series of questions:

- Which organ system is most likely to be affected?
- Which category of disease do the signs and symptoms most likely suggest, e.g. inflammation, malignancy or poisoning?
- Do other factors such as race, age, sex, behavioural patterns or occupation of the patient provide clues to the diagnosis?

The diagnostic process involves testing a series of hypotheses based upon the clinician's knowledge of the frequency of occurrence of the symptoms and signs in different disease states and upon the probability of these occurring in the population from which the patient is drawn. A list of possible diagnoses is constructed, known as the **differential diagnosis**, beginning with the most likely disease and progressing to include diagnoses which are less likely but are important to exclude. Reaching a diagnosis enables the clinician to start treatment and to give the patient some idea of the outcome of the disease (prognosis).

The role of the pathologist

The pathologist can help the clinician to make a diagnosis by looking at samples of tissue (biopsies) and by using a range of specialized laboratory techniques to refine the differential diagnosis. It is important to remember that pathology includes a large number of sub-specialities. Each of these investigates disease processes by examining or studying different body samples. For example, haematologists are concerned with disorders of the blood, whilst immunologists are concerned with disorders of the body's immune system. The clinical diagnosis can often only be made after several samples of blood, urine and tissue have been examined and the results assessed in the light of the parent's history and the clinical findings.

Techniques used in diagnostic histopathology:

Basic histological techniques involve the fixation and processing of biopsied or excised tissues so that they can be finely slided to a thickness of no more than 4-5 microns (μm) and stained on a glass slide to be

looked at under **the light microscope**. Cells can be scraped or aspirated from various parts of the body and placed directly on glass slides and stained; this is called **cytology.** In these preparations, abnormal cell morphology can be identified. This is done by performing Fine Needle Aspiration Cytology or FNA (suction of cells from a diseased organ) or by exfoliative cytology which is done by collecting detached or exfoliated cells from the surface of an organ (uterine cervix, bronchial tree or oral mucosa). The cells obtained by either methods are spread on glass slides which are subsequently stained and examined. . Sometimes, clinicians require a very urgent diagnosis during surgery and small amounts of tissue can be quickly frozen, sectioned and looked at within a few minutes (**'frozen section'**).

It is also possible to look at tissues at a much higher magnification using **the electron microscope**. This is an expensive and specialized technique, not used routinely, but it enables us to see cell structures to the level of individual mitochondria, nuclei and smaller. This is known as **ultrastructural examination**. Viral particles in cells can be seen by electron microscopy.

The autopsy

Pathologists also perform autopsies, i.e. the examination of the body after death. **The main purpose of the autopsy is to determine the cause of death,** but the pathologist can also confirm a clinical diagnosis made in life, as well as identifying diseases or conditions which were not apparent in life. Discussions between clinicians and pathologists about autopsy findings often lead to new insights into the causes and outcomes of disease. Autopsies provide useful material for teaching, and the "post-modrtem demonstration" is a popular format in which students can see and discuss at first hand the pathological process in disease.