Chapter 1

Pathology and practice of surgery

Basic pathological terminology

This is a brief introduction to a few basic terms of pathology. More definitions relating to pathology will arise throughout the book. Definitions are an important basic premise from which to build more complex concepts within a particular subject.

Terminology

Aetiology
The 'cause' of a disease.

Pathogenesis
The 'mechanism(s)' by which a disease occurs.

Cellular adaptive responses

- Atrophy: partial or complete wasting, from the Greek 'trophy' meaning growth, and the prefix 'a' meaning absence of.
- Hypertrophy: increase in size of cells.
- Hyperplasia: increase in number of cells.
- Metaplasia: reversible change of one mature tissue cell type, for another mature tissue cell type.
- Necrosis: cell death (not dependent on an energy-using process), usually from ischaemic causes.
- Apoptosis: a cell death reaction (dependent on an energy-using process), which is pre-programmed as part of the normal cell life cycle. It can also be induced by toxins (e.g. free radicals), micro-organisms or some inflammatory mediators (e.g. interferon).

Note

- Apoptosis stems from the etymological root to 'fall away'.
- Cell injury can be classified into 'reversible' and 'irreversible' cell injury.

Ischaemia
Supply of blood inadequate for a tissue/organ's metabolic need.

Infarction
Death of tissue following acute ischaemia where irreparable damage has occurred.

True gangrene
Necrosis with putrefaction.

Dry gangrene (mummification)
Dessication of necrosed tissues usually secondary to chronic ischaemia. Tissues appear black because of deposits of iron sulphide from degraded haemoglobin. There is a dry, shrivelled area with an inflammatory zone at the junction of living and dead tissue (line of demarcation).

Wet gangrene

Saprophytic infection and putrefaction of tissues. Progressive infection exacerbates ischaemia, spreading gangrene and necessitating more proximal amputation.

Gas gangrene

Spreading tissue necrosis when Clostridia spores gain access to the wound (most commonly *Clostridium perfringens*) in which there is extensive soft tissue or muscle injury. Clostridium produces gas and powerful toxins which cause further tissue damage and spreads infection.

Meleney's gangrene

May occur at the site of abdominal surgery. It is caused by a combination of aerobic and anaerobic bacteria forming a cellulitis followed by gangrene.

Fournier's gangrene

Spontaneous onset of rapidly progressing gangrene of the scrotum in otherwise healthy men. It is caused by synergism of faecal bacteria and anaerobes (similar aetiology to Meleney's).

Necrotising fasciitis

Rapidly spreading necrosis through fascial planes often with normal looking overlying skin in the early stages. Later, the skin is deprived of blood supply and becomes painful, red and, finally, necrotic. The patient is then severely ill with fever and toxaemia. It is caused by mixed flora including Streptococcus, Staphylococcus, gram-negatives and anaerobes.

Transudate

An imbalance of hydrostatic and oncotic pressures resulting in a fluid of low protein content (<30g/L) crossing an intact endothelial surface.

Causes:

- Increased hydrostatic pressure (congestive cardiac failure [CCF], sodium/fluid retention, venous thrombosis).
- Decreased oncotic pressure (hepatic failure, malnutrition, nephrotic syndrome).
- Decreased lymphatic drainage (irradiation, lymphadenectomy).

Exudate

Inflammatory process resulting in a fluid of high protein content (>30g/L) crossing a damaged endothelium.

Causes:

- Serous (malignant ascites).
- Haemorrhagic (peritonitis).
- Purulent (*Escherichia coli* peritonitis).
- Fibrinous (pericarditis).
- Pseudomembranous colitis (*Clostridium difficile*).

Fistula

An abnormal communication between two epithelialised surfaces lined by chronic granulation tissue. Fistulae can be congenital or acquired (inflammatory causes, neoplastic causes, traumatic causes, infective causes). They can also be classified according to output: low <200ml in 24 hours, moderate 200-500ml in 24 hours, high >500ml in 24 hours.

Granuloma

Histologically, an apparently expansile mass of macrophages. Immunologically, a collection of activated macrophages surrounded by lymphocytes.

Causes:

- Indigestible organisms (e.g. TB).
- Foreign bodies.
- Crohn's disease.
- Idiopathic.

Abscess

A localised collection of pus, surrounded and walled off by damaged and inflamed tissue.

Pus

Fluid at the site of an established infection, containing dead white blood cells, both living and dead bacteria, and fragments of dead tissue.

Acute inflammation

This is defined as the immediate and early response to injury:

- Vascular changes, vasodilation and increased permeability, results in an exudate of protein-rich fluid, 'tissue oedema'.

- Leukocytes (mainly neutrophils) adhere and migrate to, then through, the vessel wall, to the site of the injury (they follow a chemotactic gradient).
- Phagocytosis of the offending agent then follows.
- During phagocytosis, there is release of toxic metabolites and proteases that can damage surrounding tissue.

Note

- Galen's mnemonic for acute inflammatory characteristics is Rubor, Calor, Dolor, Tumour, and Functio laesa.
- Vasoactive mediators in the above reaction are: histamine, 5-Hydroxytryptamine (5-HT), lysosomal enzymes, prostaglandins (PGs), leukotrienes (LTs), paroxysmal atrial fibrillation, nitrous oxide (NO), cytokines.
- Another system that kicks in at the stimulus of tissue injury is the coagulation cascade as well as the complement cascade.

The possible outcomes of acute inflammation are:

- Complete resolution.
- Scarring of affected tissue (in tissue incapable of regeneration).
- Abscess formation.
- Chronic inflammation.

Chronic inflammation

This is defined as inflammation of a prolonged duration (days to years), during which inflammation and tissue healing are proceeding simultaneously. It is characterised by the following:

- Infiltration of mononuclear cells. These are different from the cells seen in acute inflammation (neutrophils), as they are made up of lymphocytes, macrophages and plasma cells.
- Tissue destruction secondary to the effects of the inflammatory cells.
- New vessel formation, fibroblast proliferation and fibrosis.

Note

- An important definition to realise is that neutrophils are polymorphonucleocytes, and that macrophages are a type of monocyte. Both, however, are capable of phagocytosis.

Functions of the lymphatic system are:

- To drain the fluid from acute inflammation.
- To present antigen to the T- and B-cell systems located in more central lymph nodes for the purpose of the immune response. This is usually a good thing, but it can have a downside. When the lymphatic ducts become a pathway for spread of the infection, this is termed lymphangitis, or when the infection reaches the lymph nodes, this is termed lymphadenitis.

The systemic effects of inflammation are:

- Pyrexia.
- Leukocytosis.
- Raised erythrocyte sedimentation rate (ESR)/C-reactive protein (CRP).

Microbiology

Important definitions

- Gram stain: a technique named after Dr HC Gram, differentiating bacteria into two large groups, based on the properties of their cell wall, i.e. gram-positive, staining blue, or gram-negative, staining pink. The test is NOT a substitute for culture, and clinical application depends on whether the site is normally sterile, or not.
- Gram-positive organisms: a characteristic of gram-positive organisms is the ability to make exotoxins, which are proteins and enzymes that damage host cells. Examples are Staphylococci, Streptococci and Clostridia.
- Gram-negative organisms: a characteristic of gram-negative organisms is the production of endotoxins in their cell membranes, which have a clinical effect on death of the cell, stimulating macrophages to release inflammatory cytokines

with a toxic effect. Examples are *Escherichia coli*, Pseudomonas, Salmonellae.
- Cocci are spherical.
- Bacilli are rod-shaped.
- Aerobes need O_2 to grow.
- Anaerobes need an O_2-free environment to grow.
- Facultative anaerobes are aerobes that are capable of growing in O_2-free conditions.

Microflora

Staphylococci

A basic coagulase test rapidly differentiates between *Staphylococcus aureus* (SAU) (+) and the species of the coagulase-negative Staphylococci (CNS or CoNS) (-) which includes *S. epidermidis*, *S. haemolyticus* and many others.

Streptococci

The first differentiation is made based on haemolysis of red cells contained in the horse blood agar plate. Alpha-haemolysis (greenish colonies) denotes the *S. viridans* group, including the oral Streptococci (long coccal chains on microscopy), the faecal Streptococci (now named Enterococci) (short chains or diploccocal) and *S. pneumoniae* (short chains or diplococcal). Beta-haemolysis refers to complete lysis of the horse red cells resulting in complete clearing of the agar. These beta-haemolytic Streptococci are grouped as Group A, Group B, Group C, Group G, etc., and many species exist. A third group of Streptococci does not result in any haemolysis on the plate.

Rationale for antibiotic prophylaxis

It is essential to know about typical commensals of body surfaces and cavities. A commensal is an organism that forms part of the normal microbial flora of a body surface or cavity. Commensals are important because they can become infective organisms under certain circumstances. For example, *Staphylococcus aureus* is a skin (and nasal cavity) commensal organism, and when the skin is breached (i.e. cut) these organisms have the potential to cause wound infection.

Antibiotic prophylaxis is an essential concept to grasp; the administration of antibiotics to prevent infection by bacteria. Thus, it is important to know the appropriate antibiotic for prophylaxis. The choice of antibiotic is based on the recognised commensals that cause infection in the region of the intended surgery.

Prophylactic antibiotics are best given on induction of anaesthesia via the intravenous route, which achieves the maximal dose at time of surgery. There is no evidence in favour of giving more than one dose. The main aim of prophylaxis is to prevent postoperative wound infection.

Conventionally, surgical principles would suggest that antimicrobial prophylaxis is not required for 'clean' surgery. However, the case mix and comorbidities, and technical demands of the procedure, support the use of prophylaxis in selected clean procedures, e.g. joint replacement surgery.

Transmission of infection can be either via an exogenous or endogenous route. It should be emphasised at this point that endogenous organisms form the overwhelming majority of transmitted infections. Hand washing is a highly important preventative measure by hospital staff.

Surgical site infections

Surgical site infections (SSIs) can be either superficial or deep.

Superficial surgical site infections

This is infection of the incision site (see the classification of wound types [clean/dirty] on p12 for the incidence of superficial SSIs, although this is a guide only, as other factors affect the potential for wound infection, e.g. diabetes, chest infection [coughing on the wound], immune deficiency, etc). The consequences of superficial SSIs are less serious than for deep SSIs. The common causative organisms of superficial SSIs are *Staphylococcus aureus* or Streptococci. Antibiotics suitable for these organisms are flucloxacillin and benzyl penicillin.

Deep surgical site infections

This refers to infection of surgical implants (e.g. orthopaedic or vascular) or deep abdominal sepsis.

Orthopaedic implants are susceptible to coagulase-negative Staphylococci or alpha-haemolytic Streptococci.