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CHAPTER 1

Perioperative Care

Tristan E McMillan

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Assessment of fitness for surgery

Learning point

Before considering surgical intervention it is necessary to prepare the patient as fully as possible.

The extent of pre-op preparation depends on:

- Classification of surgery:
  - Elective
  - Scheduled
  - Urgent
  - Emergency
- Nature of the surgery (minor, major, major-plus)
- Location of the surgery (A&E, endoscopy, minor theatre, main theatre)
- Facilities available

The rationale for pre-op preparation is to:

- Determine a patient’s ‘fitness for surgery’
- Anticipate difficulties
- Make advanced preparation and organise facilities, equipment and expertise
- Enhance patient safety and minimise chance of errors
- Alleviate any relevant fear/anxiety perceived by the patient
- Reduce morbidity and mortality

Common factors resulting in cancellation of surgery include:

- Inadequate investigation and management of existing medical conditions
- New acute medical conditions

Classification of surgery according to the National Confidential Enquiry into Patient Outcome and Death (NCEPOD):

- Elective: mutually convenient timing
- Scheduled: (or semi-elective) early surgery under time limits (eg 3 weeks for malignancy)
- Urgent: as soon as possible after adequate resuscitation and within 24 hours

Patients may be:

- Emergency: admitted from A&E; admitted from clinic
- Elective: scheduled admission from home, usually following pre-assessment

In 2011 NCEPOD published Knowing the Risk: A review of the perioperative care of surgical patients in response to concerns that, although overall surgical mortality rates are low, surgical mortality in the high-risk patient in the UK is significantly higher than in similar patient populations in the USA. They assessed over 19 000 surgical cases prospectively and identified four key areas for improvement (see overleaf).
1. **Identification of the high-risk group** preoperatively, e.g. scoring systems to highlight those at high risk

2. **Improved pre-op assessment, triage and preparation**, proper preassessment systems with full investigations and work-up for elective patients and more rigorous assessment and preoperative management of the emergency surgical patient, especially in terms of fluid management

3. **Improved intraoperative care**: especially fluid management, invasive and cardiac output monitoring

4. **Improved use of postoperative resources**: use of high-dependency beds and critical care facilities

1.1 **Preoperative assessment**

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<td>The preassessment clinic is a useful tool for performing some or all of these tasks before admission.</td>
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Preassessment is timed so that the gap between assessment and surgery is:
- Long enough so that a suitable response can be made to any problem highlighted
- Short enough so that new problems are unlikely to arise in the interim

The timing of the assessment also means that:
- Surgical team can identify current pre-op problems
- High-risk patients can undergo early anaesthetic review
- Perioperative problems can be anticipated and suitable arrangements made (e.g. book intensive therapy unit [ITU]/high-dependency unit [HDU] bed for the high-risk patient)
- Medications can be stopped or adapted (e.g. anticoagulants, drugs that increase risk of deep vein thrombosis [DVT])
- There is time for assessment by allied specialties (e.g. dietitian, stoma nurse, occupational therapist, social worker)
- The patient can be admitted to hospital closer to the time of surgery, thereby reducing hospital stay

The patient should be reviewed again on admission for factors likely to influence prognosis and any changes in their pre-existing conditions (e.g. new chest infection, further weight loss).

Preassessment is run most efficiently by following a set protocol for the preoperative management of each patient group. The protocol-led system has several advantages:
- The proforma is an aide-mémoire in clinic
- Gaps in pre-op work up are easily visible
- Reduces variability between clerking by juniors

However, be wary of preordered situations because they can be dangerous and every instruction must
be reviewed on an individual patient basis, eg the patient may be allergic to the antibiotics that are prescribed as part of the preassessment work-up and alternatives should be given.

**Preoperative history**

A good history is essential to acquire important information before surgery and to establish a good rapport with the patient. Try to ask open rather than leading questions, but direct the resulting conversation. Taking a history also gives you an opportunity to assess patient understanding and the level at which you should pitch your subsequent explanations.

A detailed chapter on taking a surgical history can be found in the new edition of the PasTest book *MRCS Part B OSCES: Essential Revision Notes in Information Gathering under Communication Skills*. In summary, the history should cover the points in the following box.

---

**Taking a surgical history**

1. **Introductory sentence**
   Name, age, gender, occupation.

2. **Presenting complaint**
   In one simple phrase, the main complaint that brought the patient into hospital, and the duration of that complaint, eg ‘Change in bowel habit for 6 months’.

3. **History of presenting complaint**
   (a) *The story* of the complaint as the patient describes it from when he or she was last well to the present
   (b) *Details of the presenting complaint*, eg if it is a pain ask about the site, intensity, radiation, onset, duration, character, alleviating and exacerbating factors, or symptoms associated with previous episodes
   (c) *Review of the relevant system(s)* which may include the gastrointestinal, gynaecological and urological review, but does not include the systems not affected by the presenting complaint. This involves direct questioning about every aspect of that system and recording the negatives and the positives
   (d) *Relevant medical history*, ie any previous episodes, surgery or investigations directly relevant to this episode. Do not include irrelevant previous operations here. Ask if he or she has had this complaint before, when, how and seen by whom
   (e) *Risk factors*. Ask about risk factors relating to the complaint, eg family history, smoking, high cholesterol. Ask about risk factors for having a general anaesthetic, eg previous anaesthetics, family history of problems under anaesthetic, false teeth, caps or crowns, limiting comorbidity, exercise tolerance or anticoagulation medications

4. **Past medical and surgical history**
   In this section should be all the previous medical history, operations, illnesses, admissions to hospital, etc that were not mentioned as relevant to the history of the presenting complaint.

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*continued overleaf*
5. Drug history and allergies
List of all drugs, dosages and times that they were taken. List allergies and nature of reactions to alleged allergens. Ask directly about the oral contraceptive pill and antiplatelet medication such as aspirin and clopidogrel which may have to be stopped preoperatively.

6. Social history
Smoking and drinking – how much and for how long. Recreational drug abuse. Who is at home with the patient? Who cares for them? Social Services input? Stairs or bungalow? How much can they manage themselves?

7. Family history

8. Full review of non-relevant systems
This includes all the systems not already covered in the history of the presenting complaint, eg respiratory, cardiovascular, neurological, endocrine and orthopaedic.

Physical examination
Detailed descriptions of methods of physical examination can only really be learnt by observation and practice. Don’t rely on the examination of others – surgical signs may change and others may miss important pathologies. See MRCS Part B OSCEs: Essential Revision Notes for details of surgical examinations for each surgical system.

Physical examination
**General examination:** is the patient well or in extremis? Are they in pain? Look for anaemia, cyanosis and jaundice, etc. Do they have characteristic facies or body habitus (eg thyrotoxicosis, cushingoid, marfanoid)? Are they obese or cachectic? Look at the hands for nail clubbing, palmar erythema, etc

**Cardiovascular examination:** pulse, BP, jugular venous pressure (JVP), heart sounds and murmurs. Vascular bruits (carotids, aortic, renal, femoral) and peripheral pulses

**Respiratory examination:** respiratory rate (RR), trachea, percussion, auscultation, use of accessory muscles

**Abdominal examination:** scars from previous surgery, tenderness, organomegaly, mass, peritonism, rectal examination

**CNS examination:** particularly important in vascular patients pre-carotid surgery and in patients with suspected spinal compression

**Musculoskeletal examination:** before orthopaedic surgery
CHAPTER 2
Surgical Technique and Technology

David Mansouri

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1.1 Skin anatomy and physiology

Learning point

A core knowledge of skin anatomy and physiology is essential to understand fully the processes involved in wound healing. The skin is an enormously complex organ, acting both as a highly efficient mechanical barrier and as a complex immunological membrane. It is constantly regenerating, with a generous nervous, vascular and lymphatic supply, and has specialist structural and functional properties in different parts of the body.

All skin has the same basic structure, although it varies in thickness, colour, and the presence of hairs and glands in different regions of the body. The external surface of the skin consists of a keratinised squamous epithelium called the epidermis. The epidermis is supported and nourished by a thick underlying layer of dense, fibroelastic connective tissue called the dermis, which is highly vascular and contains many sensory receptors. The dermis is attached to underlying tissues by a layer of loose connective tissue called the hypodermis or subcutaneous layer, which contains adipose tissue. Hair follicles, sweat glands, sebaceous glands and nails are epithelial structures called epidermal appendages which extend down into the dermis and hypodermis. See Figure 2.1.

The four main functions of the skin

- **Protection:** against UV light, and mechanical, chemical and thermal insults; it also prevents excessive dehydration and acts as a physical barrier to microorganisms
- **Sensation:** various receptors for touch, pressure, pain and temperature
- **Thermoregulation:** insulation, sweating and varying blood flow in the dermis
- **Metabolism:** subcutaneous fat is a major store of energy, mainly triglycerides; vitamin D synthesis occurs in the epidermis

Skin has natural tension lines, and incisions placed along these lines tend to heal with a narrower and stronger scar, leading to a more...
favourable cosmetic result (Figure 2.2). These natural tension lines lie at right angles to the direction of contraction of underlying muscle fibres, and parallel to the dermal collagen bundles. On the head and neck they are readily identifiable as the ‘wrinkle’ lines, and can easily be exaggerated by smiling, frowning and the display of other emotions. On the limbs and trunk they tend to run circumferentially, and can easily be found by manipulating the skin to find the natural skin creases. Near flexures these lines are parallel to the skin crease.
1.2 Classification of surgical wounds

Learning point

Wounds can be classified in terms of:
- **Depth**: superficial vs deep
- **Mechanism**: incised, lacerated, abrasion, degloved, burn
- **Contamination or cleanliness**: clean, clean contaminated, contaminated, dirty

**Depth of wound**

**Superficial wounds**

Superficial wounds involve only the epidermis and dermis and heal without formation of granulation tissue and true scar formation. Epithelial cells (including those from any residual skin appendages such as sweat or sebaceous glands and hair follicles) proliferate and migrate across the remaining dermal collagen.

Examples of superficial wounds:
- Superficial burn
- Graze
- Split-skin graft donor site

**Deep wounds**

Deep wounds involve layers deep to the dermis and heal with the migration of fibroblasts from perivascular tissue and formation of granulation tissue and subsequent true scar formation. If a deep wound is not closed with good tissue approximation, it heals by a combination of contraction and epithelialisation, which may lead to problematic contractures, especially if over a joint.

**Mechanism of wounding**

The mechanism of wounding often results in characteristic damage to the skin and deeper tissues. Wounds are categorised as follows:
- **Incised wounds**: surgical or traumatic (knife, glass) where the epithelium is breached by a sharp object
- **Laceration**: an epithelial defect due to blunt trauma or tearing, which results from skin being stretched and leading to failure of the dermis and avulsion of the deeper tissues. It is usually associated with adjacent soft-tissue damage, and vascularity of the wound may be compromised (eg pretibial laceration in elderly women, scalp laceration after a blow to the head)
- **Abrasion**: friction against a surface causes sloughing of superficial skin layers
- **Degloving injury**: a form of laceration when shearing forces parallel tissue planes to move against each other, leading to disruption and separation. Although the skin may be intact, it is often at risk due to disruption of its underlying blood supply. This occurs when, for example, a worker’s arm gets caught in an industrial machine
- **Burns**

**Contamination of wounds**

Wounds may be contaminated by the environment at times of injury. Surgical procedures and accidental injuries may be classified according to the **risk** of wound contamination:
- **Clean** (eg hernia repair)
- **Clean contaminated** (eg cholecystectomy)
- **Contaminated wound** (eg colonic resection)
- **Dirty wound** (eg laparotomy for peritonitis)
1.3 Principles of wound management

Learning point

The principles of wound management are concerned with providing an optimum environment to facilitate wound healing. There are three ways in which wound healing can take place:
- First (primary) intention
- Second (secondary) intention
- Third (tertiary) intention

First (primary) intention
This typically occurs in uncontaminated wounds with minimal tissue loss and when the wound edges can easily be approximated with sutures, staples or adhesive strips, without excessive tension. The wound usually heals by rapid epithelialisation and formation of minimal granulation tissue and subsequent scar tissue.

Ideal conditions for wound healing
- No foreign material
- No infection
- Accurate apposition of tissues in layers (eliminating dead space)
- No excess tension
- Good blood supply
- Good haemostasis, preventing haematoma

Second (secondary) intention
Usually secondary intention occurs in wounds with substantial tissue loss, when the edges cannot be apposed without excessive tension. The wound is left open and allowed to heal from the deep aspects of the wound by a combination of granulation, epithelialisation and contraction. This inevitably takes longer, and is accompanied by a much more intense inflammatory response. Scar quality and cosmetic results are poor. Negative pressure dressings (eg Vac) can facilitate secondary intention healing when large wound defects are present.

Wounds that may be left to heal by secondary intention:
- Extensive loss of epithelium
- Extensive contamination
- Extensive tissue damage
- Extensive oedema leading to inability to close
- Wound reopened (eg infection, failure of knot)

Third (tertiary) intention
The wound is closed several days after its formation. This may well follow a period of healing by secondary intention, eg when infection is under control or tissue oedema is reduced. This can also be called ‘delayed primary closure’.
# CHAPTER 3

**Postoperative Management and Critical Care**

Hayley M Moore and Brahman Dharmarajah

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1.1 The physiology of homeostasis

Learning point

Homeostasis is the maintenance of a stable internal environment. This occurs on two levels:

- **Normal cellular physiology** relies on controlled conditions, including temperature, pH, ion concentrations and $O_2/CO_2$ levels
- **System physiology** within the body requires control of blood pressure and blood composition via the cardiovascular, respiratory, GI, renal and endocrine systems of the body

These variables oscillate around a set point, with each system drawn back to the normal condition via the homeostatic mechanisms of the body.

Homeostatic feedback works on the principles of:

- Detection via sensors
- Afferent signalling
- Comparison to the ‘set point’
- Efferent signalling
- Effector action

The structure of the cell

Learning point

Cells are the building blocks of the body. They consist of elements common to all cells and additional structures that allow a cell to perform specialised functions.

Elements common to all cells include:

- Cell membrane
- Cytoplasm
- Nucleus
- Organelles:
  - Mitochondria
  - Endoplasmic reticulum
  - Golgi apparatus
  - Lysosomes

**Cell membrane**

The cell membrane is a phospholipid bilayer formed by the inner hydrophobic interactions of the lipid tails with the hydrophilic phosphate groups interacting on the outside. Cholesterol molecules are also polarised, with a hydrophilic and hydrophobic portion. This forms a major barrier that is impermeable to water and
water-soluble substances, allowing the cell to control its internal environment. The membrane is a fluid structure (similar to oil floating on water) allowing its components to move easily from one area of the cell to another.

There are a number of proteins that are inserted into or span the cell membrane and act as ion channels, transporter molecules or receptors. These transmembrane proteins may be common to all cells (eg ion channels) or reflect the specialised function of the cell (eg hormone receptors).

Cytoplasm
The cytoplasm is composed of:

- **Water**: 70–85% of the cell mass. Ions and chemicals exist in dissolved form or suspended on membranes
- **Electrolytes**: predominantly potassium, magnesium, sulphate and bicarbonate, and small quantities of sodium and chloride
- **Proteins**: the two types are structural proteins and globular proteins (predominantly enzymes)
- **Lipids**: phospholipids and cholesterol are used for cell membranes. Some cells store large quantities of triglycerides (as an energy source)
- **Carbohydrates**: may be combined with proteins in structural roles but are predominantly a source of energy

Under the cell membrane a network of actin filaments provides support to the cytoplasm. There is also a cytoskeleton consisting of tubulin microtubules which enables the cell to maintain its shape and to move by extension of cellular processes called pseudopodia.

Dispersed in the cytoplasm are the intracellular organelles such as the nucleus, mitochondria, Golgi apparatus and endoplasmic reticulum. There are also fat globules, glycogen granules and ribosomes.

The cytoplasm is a complex and busy region of transport between the cell membrane and the intracellular organelles. Binding of molecules to cell-surface receptors activates secondary messenger systems such as cyclic adenosine monophosphate (cAMP) and inositol triphosphate (IP₃) across this network of the cytoplasm.

The nucleus
A double phospholipid membrane surrounds the nucleus and this is penetrated by nuclear pores which allow access to small molecules. The nucleus contains the DNA and is the primary site of gene regulation.

The bases of DNA comprise two purines, adenine (A) and guanine (G), and two pyrimidines, thymidine (T) and cytosine (C); A forms a bond with T, and G forms a bond with C. DNA is a double helix with a backbone of deoxyribose sugars either side of the paired nitrogenous bases, which act as the code.

DNA is stored in the nucleus in a condensed form, wrapped around proteins called histones. When condensed the genes are inactive. The DNA unwinds from the histone protein when the gene becomes activated. The two strands separate to allow transcription factors access to the DNA code. The transcription factor binds to the gene promoter region and allows an enzyme called RNA polymerase to produce complementary copies of the gene in a form known as messenger RNA (mRNA). Messenger RNA is then transported out of the nucleus to the ribosomes for translation into protein.
**Mitochondria**
These structures generate >95% of the energy required by the cell. Different cells have different numbers. They are bean-shaped, with a double membrane – the internal membrane is folded into shelves where the enzymes for the production of energy are attached. Mitochondria can self-replicate and contain a small amount of DNA.

**Endoplasmic reticulum**
This is a network of tubular structures, with the lumen of the tube connected to the nuclear membrane. These branching networks provide a huge surface area of membrane and are the site of the major metabolic functions of the cell. They are responsible for most of the synthetic processes, producing lipids and proteins together with the attached ribosomes.

The ribosome is responsible for translating the mRNA into protein. The mRNA travels along the ribosome and may pass through several ribosomes simultaneously, similar to beads on a string. Each amino acid binds to a small molecule of transfer RNA (tRNA), which has a triplet of bases that correspond to the amino acid that it is carrying. These bases are complementary to the bases on the mRNA strand. Energy produced by ATP is required to activate each amino acid. The ribosome then catalyses peptide bonds between activated amino acids.

**Golgi apparatus**
The Golgi apparatus is structurally similar to the endoplasmic reticulum (ER) and lies as stacked layers of tubes close to the cell membrane. Its function is secretion. Substances to be secreted leave the ER by becoming enclosed in a pinched-off piece of membrane (a vesicle) and travel through the cytoplasm to fuse with the membrane of the Golgi body. They are then processed inside the Golgi to form secretory vesicles (or lysosomes), which bud off the Golgi body and fuse with the cell membrane, disgorging their contents.

**Basic cellular functions**

**Learning point**

Basic cellular functions are common to all cells. They include:
- Transport across membranes
- Generation of energy from carbohydrates and lipids
- Protein turnover

**Transport across membranes**
Molecules may be moved across cell membranes by:
- **Simple diffusion:** this occurs down either a concentration or an ion gradient. It depends on the permeability of the membrane to the molecule. No energy is required for this process
- **Simple facilitated diffusion:** this also occurs down a concentration gradient, but the molecule becomes attached to a protein molecule that facilitates its passage (eg a water-soluble molecule that would be repelled by a cell membrane, attached to a carrier molecule which can pass easily through a cell membrane). There is no energy requirement for this process
- **Primary active transport:** in which energy from ATP is used to move the molecule against a concentration or ion gradient. This is also called a ‘pump’
- **Secondary active transport:** in which energy is used to move a molecule against
a concentration or ion gradient. This energy comes from the associated movement of a second molecule down a concentration gradient. If both these molecules are moving in the same direction, this is called ‘co-transport’. If they are moving in opposite directions this is called ‘counter-transport’

- **Endocytosis and exocytosis**: these processes involve a piece of membrane budding off from the cell membrane to envelop a substance, which is then internalised by the cell (endocytosis). Conversely, secretory vesicles from the Golgi apparatus may fuse with the cell membrane, releasing their contents outside the cell (exocytosis)

**The sodium/potassium pump**
This pump (also called Na⁺/K⁺ ATPase) is used by cells to move potassium ions into the cell and sodium ions out of the cell. It is present in all cells of the body and maintains a negative electrical potential inside the cell. It is also the basis of the action potential.

Na⁺/K⁺ ATPase consists of two globular protein subunits. There are two receptor sites for binding Na⁺ on the inside of the cell. When three Na⁺ ions bind to the receptors on the inside of the cell, ATP is cleaved to ADP, releasing energy from the phosphate bond. This energy is used to induce a conformational change in the protein, which extrudes the Na⁺ ions from the cell and brings the K⁺ ions inside the cell. As the cell membrane is relatively impermeable to Na⁺ ions this sets up a concentration, and therefore an ion gradient (called the **electrochemical gradient**). Water molecules tend to follow the Na⁺ ions, protecting the cell from increases in volume that would lead to cell lysis. In addition, K⁺ ions tend to leak back out of the cell more easily than Na⁺ ions enter.

**Generating energy**
Cells generate energy by combining oxygen with carbohydrate, fat or protein under the influence of various enzymes. This is called **oxidation** and results in the production of a molecule of ATP which is used to provide the energy for all cellular processes. The energy is stored in the ATP molecule by two high-energy phosphate bonds and is released when these bonds are broken.