

Chapter 4

Principles of preoperative assessment, optimisation and management

Aims

This chapter attempts to give an overall picture of the rationale of preoperative assessment and management. In particular it outlines:

- what we are trying to achieve and the rationale for preoperative preparation
- the adverse effects of preoperative morbidity (e.g. diabetes, hypertension or obesity) on postoperative outcome and how can they be minimised
- the favourable (and unfavourable) outcomes of doing preoperative tests, their significance and the concept of sensitivity and specificity
- the resource implications of over (and under) investigation
- the commonly prescribed drugs which have a relevance to perioperative management
- the evidence that optimisation of patients' haemodynamic parameters improves outcome

Objectives

After reading this chapter you should:

- have a clear appreciation of the rationale for preoperative assessment and its impact on patient morbidity and mortality
- have a clear strategy for optimising the patient physically and mentally and thereby reducing risk
- appreciate that returning patients to a healthy state as soon as possible postoperatively is the overall aim of preoperative assessment and management
- have a clear strategy for managing existing patient drug administration in the perioperative period
- appreciate that, above all, excellence in perioperative management requires a team approach between all parties involved i.e. the patient, the patient's family (where appropriate), the GP, the surgical team, the anaesthesia team, other relevant medical and diagnostic specialties and the nursing and paramedical staff on the ward

Introduction

Advances in anaesthetic and surgical technique coupled with an ageing population have led to an increasing number of 'High Risk' operative events; these events impose ever-increasing demands on patients' health and wellbeing.

The imperative of the pre-operative visit is to assess the risks of surgery and anaesthesia, and to balance them against the benefits of the proposed operation. The surgeon and anaesthetist concerned must therefore jointly carry it out. Two elements combine to constitute a high-risk surgical event, firstly the health of the patient, and secondly the nature of the surgery.

The health of the patient in turn embraces two factors, firstly the presence or absence of significant co-morbidities such as heart disease or respiratory disease, secondly and probably more subtly, the patients inherent physiological reserves.

The bulk of this chapter deals with identification and correction of reversible elements of any existing co-morbidities through well-established principles. However recent studies are developing insights, which allow objective assessment not just of 'coexisting disease' but also more significantly of 'physiological reserve', and in turn ways of 'optimising' that reserve.

Managing the high-risk patient involves two essential stages;

- **Identification of the 'High Risk' patient.**
- **Optimisation of the 'High Risk' patient.**

Identification of the 'High Risk' patient:

The Scale of the Problem:

Although the overall role and recommendations of the National Confidential Enquiry Into Perioperative Deaths (NCEPOD) have already been discussed in Chapter 2, it is worth re-emphasising some of the key points in the context of preoperative assessment. Annually there are about 2.8 million operations in England, Wales, and Northern Ireland. The risk of death within 30 days of operation is estimated between 0.7 - 1.7%. Thus approximately 20,000 deaths within 30 days of an operation are reported to NCEPOD each year. A random sample from these deaths showed that:

- One third of deaths occurred on or before day 2 of the operation.
- The types of operation included: general surgery 46%, orthopaedics 22%, vascular surgery 11%, urology 7% and cardiac surgery 4%.
- The classification of operations was: emergency 15%, urgent 52%, scheduled 24% and elective 7%.
- 87% of patients were aged over 60 years, and 71% of patients were aged over 70 years.
- 84% of patients scored 3 or higher on the ASA score (see below).
- 85% of patients had one or more co-existing diseases at the time of operation, 45% had cardiac disease, 30% had respiratory disease and 16% renal impairment.
- 23% had had their operation delayed to improve their condition.
- Surgeons when questioned indicated that in 58% of patients a significant risk of death had been identified before operation, and that they knew that 8% of patients operated on were almost certain to die.
- 32% of patients were admitted to an intensive care unit (ICU) post operatively, and 8% to a high dependency unit (HDU).
- 5% of patients were denied ICU admission through lack of capacity.
- Respiratory diseases were implicated in the death of 37% of patients, cardiac diseases in 36% and renal impairment in 22% of patients.

Other studies and data bases give an overall perioperative mortality of between 1-3%, however in the age group of 65years and above;

Mortality associated with elective surgery ~ 5 - 10%
Mortality associated with emergency surgery ~ 23 - 55%

Thus patients that die after surgery are more likely to be elderly, to have coexisting medical disorders and require urgent or emergency surgery. The NCEPOD data suggests that in the majority of cases these risks are identified before surgery both by surgeons and anaesthetists. Most deaths occur after abdominal, colorectal or major orthopaedic surgery.

Identification of the 'High Risk' patient - by clinical assessment:

Various scoring systems are available as clinical tools to assess severity of perioperative risk, the two most commonly used, the American Society of Anaesthesiologists (ASA) classification and the Goldman Index score for the presence of significant co-morbidities and are discussed below. However, Shoemaker in the course of his landmark studies in the early eighties identified a list of specific circumstances that are probably useful to include here:

- History of severe cardiorespiratory illness.
- Extensive ablative surgery for carcinoma.
- Severe multiple trauma (involving 3 or more organs, 2 or more cavities)
- Massive acute blood loss ~ 8 units.
- Age > 70 years.
- Clinical shock, MAP ~ 60 mmHg.

- Septicaemia.
- Significant respiratory failure PaO₂ < 8 kPa (60 mmHg) on room air
- On mechanical ventilation for > 48 hours.
- Acute abdominal catastrophe with haemodynamic instability.
- Acute renal failure.
- End stage vascular disease.

Identification of the 'High Risk' patient - by physiological assessment:

Some patients have a level of cardiovascular reserve that is so low that they are unable to meet the physiological challenge of major surgery. Studies have shown that the ability to increase oxygen delivery in response to stimulation with filling and inotropes tested pre-operatively, correlates directly with outcome post operatively. Patients who readily elevate their oxygen delivery in response to stimulation do not die. Decreasing ability to increase oxygen delivery in response to stimulation is associated with increasing mortality.

Optimisation of the 'High Risk' surgical patient:

Shoemaker in a series of observational studies demonstrated a group of patients whom he deemed high risk and who had a 28-day postoperative mortality of 30 - 40%. He used simple clinical criteria to identify these patients (see above). Shoemaker went on to establish which of the commonly measured variables predicted outcome within this patient group. He examined over 30 variables in several thousand patients and demonstrated that only variables related to blood volume and flow had prognostic value. Survivors of high-risk surgery demonstrated supra normal values for cardiac index (CI), oxygen delivery (DO₂) and oxygen consumption (VO₂). Following on from this work several studies have examined the hypothesis that these supra normal values should be applied as therapeutic goals in prophylactically 'optimising' high-risk patients before surgery.

	Survivors	Normal Population
Cardiac index	4.5 l/min /m ²	2.8 -3.5 l/min/m ²
Oxygen delivery	600 ml/min/m ²	400-500 ml/min/m ²
Oxygen consumption	170 ml/min/m ²	120-140 ml/min/m ²

Studies aimed at optimising high-risk patients towards supra normal values either pre-operatively or immediately post-operatively showed reduced mortality and morbidity in the treatment group. Interestingly the same therapeutic goals applied to patients in established critical illness or sepsis lead to an increased mortality in the treatment group.

The preoperative visit.

The preoperative visit should focus around two basic questions namely;

- **Is this patient as fit as he or she can be to undergo this procedure ? If not....**
- **What are the risks/benefits of delaying surgery whilst treatment is undertaken ?**

This approach may lead to the seemingly anomalous situation that an elderly man with optimally treated heart failure and stable but severe respiratory failure may be accepted for surgery whereas a young fit patient with a 'minor' chest infection is not. The former patient is 'as fit as he can be' the latter is not.

Adequate time must be allowed to assess the patients preoperatively if delays and cancellations are to be prevented. For instance, many elderly patients benefit from treatment of preoperative cardiac failure,

arrhythmias and chest infections, but this may take several days. Pre-assessment clinics are ideal places to pick up such problems, but often difficult to organise at a time, which is close enough to the proposed operation date.

The house surgeon, nurse practitioner or medical student clerking the surgical patient is often the first person to detect and draw attention to the abnormalities likely to cause problems with anaesthesia.

General Aspects

After introducing yourself, a general review of the patient is undertaken. Check the name, the proposed operation, the hospital number and the patient chart for indications of previous problems and pathology. Take time to answer any questions the patient may still have about the operation and its effects, especially the amount of pain that he or she may suffer and how it can be alleviated in the postoperative period. In particular, make note of:

Complications (patient and blood relatives) with previous anaesthetics

These may range from nausea and vomiting to severe anaphylaxis with anaesthetic drugs. Pharmacogenetic problems such as porphyria, absence of plasma cholinesterase and malignant hyperthermia (see later) may be detected from the history and require further investigation. If the patient has not had a previous anaesthetic or only a minor one, then a history of specific anaesthetic problems in the immediate blood family should be sought.

Smoking

This is associated with increased cardiovascular and respiratory pathology in proportion to the 'pack-year' history (number of packs of 20 per day multiplied by the number of years of smoking). Smokers have an increased incidence of post-operative pulmonary complications, especially after upper abdominal surgery where the incidence of clinically significant respiratory tract infection is about 70%, five times higher than non-smokers. Blood levels of carbon monoxide (COHb) in heavy smokers are increased 3 fold up to 15% in some cases, resulting in a reduction in oxygen carrying capacity equivalent to the loss of 2 g dl⁻¹ of Hb. Should the patient be advised to stop smoking prior to surgery? To significantly reduce the incidence of postoperative chest infection after upper abdominal surgery takes 3 to 6 months abstinence. This would only be feasible in compliant patients with non-urgent surgery but is nevertheless a worthwhile goal to achieve. Acute cessation of smoking (for 12 hours or more) is also beneficial as it reduces COHb levels (half life 60 minutes) and is equivalent, in terms of blood oxygen carriage, to a one or two unit blood transfusion!

Alcohol and drug abuse

High alcohol intake and long-standing sedative or analgesic therapy increases requirements of drugs used in anaesthesia, usually by hepatic enzyme induction. Studies have shown markedly increased opioid requirements for postoperative pain relief in opioid addicts. Knowledge of this preoperatively will allow a suitable dose strategy to be devised. Recent work has demonstrated very clearly the value of discontinuation of alcohol a month before major abdominal surgery in moderate to heavy drinkers (Chapter 13).

Obesity

This is a serious obstacle to anaesthesia and surgery for several reasons:

- **Practical procedures** such as venous access, airway control and intubation, local anaesthetic procedures and moving the patient are more difficult.
- **Increased demand upon the heart** with the possibility of hypertension (difficult to measure by cuff and auscultation) and left ventricular failure being prominent associations.
- **Functional residual capacity** is lowered by the weight of abdominal wall fat restricting diaphragmatic movement. There is increased risk of hypoxia and respiratory complications.
- **Sleep apnoea** is a common accompaniment together with an increased sensitivity to the respiratory depressant effects of opioids.

- **Lowering of oesophageal cardiac sphincter tone**, together with the increased weight of abdominal contents, predisposes to regurgitation of abdominal contents. Antacid therapy (see later) should be prescribed but endotracheal intubation (ETI), with a cuffed tube to prevent aspiration, is often required, even for minor procedures.
- **Pressure areas** (see later) must be assiduously padded during surgery to prevent nerve trapping and pressure necrosis (Chapter 11)
- **Associated conditions** may be present such as diabetes, myxoedema and Cushing's syndrome.

Surgical problems are also common such as: increased difficulty due to fat, poor wound healing and a higher incidence of deep vein thrombosis and pulmonary embolus. Anti-thrombotic therapy (e.g. subcutaneous heparin, elastic stockings) should be carried out as a routine during the perioperative period.

Dehydration or hypovolaemia

These make induction and maintenance of anaesthesia very hazardous. They must always be corrected prior to anaesthesia with appropriate intravenous infusions.

Anaemia and Bleeding Disorders

Long-standing anaemia is remarkably well tolerated; in the days prior to erythropoetin, chronic renal failure patients often presented with haemoglobin (Hb) values as low as 6 g dl⁻¹. This chronic anaemia was "tolerated" because of a compensatory increase in cardiac output and 2-3 dpg, which increase the ability of haemoglobin to off load oxygen to the tissues (Chapter 15). However, in acute anaemia, compensation is usually inadequate; the Hb level should be brought up to 9 g dl⁻¹ by specific therapy (such as iron, erythropoetin and folate) in elective cases, or by transfusion of packed red cells in urgent and emergency cases. Estimation of Hb concentration is only necessary if there are clinical indications of anaemia, such as the presence of significant pallor and shortness of breath on exertion, or if the operation is likely to be associated with significant (> 15% of estimated blood volume) loss.

A sickle-screening test is performed prior to surgery in all patients of afro-Caribbean descent. A negative result indicates that no further assessment is needed. In routine cases the test must be done early as a sickle positive result can indicate a more serious problem, which can only be definitively diagnosed by Hb electrophoresis. The latter test may not be immediately available and takes several hours to perform resulting in unnecessary delays in the operating schedule. Haemoglobinopathies, especially sickle cell disease (SCD), should be diagnosed and treated in collaboration with a haematologist before anaesthesia. Traditionally, in preparation for major surgery the patient underwent exchange blood transfusion until the level of Hb-S fell to less than 30% of total. However, recent work has suggested that restoration of the Hb level to around 9 to 10 gdl⁻¹ (haematocrit 0.3) is all that is required. The haematocrit should certainly not be allowed to exceed 0.4 as this also increases the risk of sickling in the perioperative period. Following major surgery, the SCD patient is admitted to the HDU or ICU for close monitoring of cardiovascular and respiratory status. Sickle cell trait does not require pre-operative treatment, but throughout anaesthesia and recovery a higher fraction of inspired oxygen (FIO₂ > 0.4) should be used. Bleeding disorders are more a surgical than an anaesthetic problem but should be noted if regional techniques are planned. Pre-operative transfusion of concentrates of the missing factor may be indicated.

Drugs

A few drugs interact adversely with anaesthetic agents. Most regular medication should be given in the usual dosage right up to the last pre-operative hour, with a few exceptions.

Stop before surgery:

- **Long acting oral anti diabetic agents** should be stopped for up to 2 days pre-operatively because of the risk of hypoglycaemia e.g. chlorpropamide and tolbutamide. Most patients are now on the shorter acting drugs such as glicazide and metformin. These may be omitted on the morning of surgery. In patients undergoing anything but the most minor surgery, a change to insulin is made for the perioperative period to improve glycaemic control (see later).
- **Antidepressants** of the monoamine oxidase inhibitor (MAOI) group, now less commonly used, should be stopped 2 weeks pre-operatively because of their adverse interaction with pethidine and

other opioid analgesics and anaesthetic agents (Chapter 18). Careful discussion with the patient's GP and psychiatrist is mandatory to assess the risks to the patient of stopping therapy for this period (e.g. suicidal depression). The anaesthetist often has to deal with patients in whom MAOI therapy must be maintained. For major surgery, **lithium** salts should be stopped for 3 days pre-operatively because they may unpredictably potentiate competitive neuromuscular blockers. If possible, a lithium level should also be obtained (therapeutic 0.4 to 1.2 mmol.l-1, toxic > 1.5)

- **Anticoagulants** such as **warfarin** should be stopped at least 24 hours pre-operatively, and prothrombin time (International Normalised Ratio, INR) checked. It should be in the region of 1.6-2:1 with reference to control. If it exceeds 2:1 the operation should be postponed until this level is reached, but in an emergency a concentrate of Vitamin K dependent factors (PPSB, obtainable from the haematology department) is administered preceded by a small dose (1 mg.) of vitamin K. If necessary, change over to a heparin infusion to maintain anticoagulation. The effects of warfarin may be enhanced or reduced by many of the anaesthetic and analgesic agents, by alteration of plasma protein binding and liver inactivation. **Non steroidal analgesic drugs** (NSAIDS) decrease platelet adhesion by inhibition of thromboxane synthesis and may increase bleeding in susceptible patients. **Aspirin** should be stopped for 2 weeks prior to major cardiovascular, urological or plastic/reconstructive surgery. Other agents have a less marked and prolonged effect on platelet function but can still cause serious bleeding in the occasional patient.
- **Oestrogen containing contraceptives** ('the pill') have been implicated in causing an increased incidence of deep vein thrombosis, particularly in smokers. Current recommendations for major surgery suggest stopping 'the pill' for a month prior to surgery and utilising other means of contraception during the time up to surgery. If they are continued to the time of surgery, or in an emergency, anti thrombosis prophylaxis must be instituted.

The anaesthetist must also be aware of all other medication taken by the patient, which may affect the course of surgery and anaesthesia. In general, these should still be continued right up until the time of surgery.

Continue with treatment but be aware of the most important:

- **Corticosteroids**, if given for more than 6 weeks, can cause adreno-cortical (and hence cardiovascular) depression. Supplementation with i.v. hydrocortisone (100 mg. 4 hourly) is necessary in the perioperative period.
- **Anti-hypertensive agents**, including beta blockers, because the regulation of pulse and blood pressure is altered, particularly in response to blood loss.
- **Central analgesic and sedative drugs**, because their chronic use stimulates liver metabolism with consequent shorter duration and effect of anaesthetic agents.

Pharmacogenetic factors

As mentioned earlier, drugs used in anaesthesia may precipitate certain hereditary diseases associated with abnormal drug metabolism. Individual variation in response to drugs is a substantial clinical problem. Such variation ranges from failure to respond to a drug to adverse drug reactions and drug-drug interactions when several drugs are taken concomitantly. The clinical consequences range from patient discomfort through serious clinical illness to the occasional fatality. One UK study has suggested that about 1 in 15 hospital admissions are due to adverse drug reactions,¹ and a recent US study estimated that 106 000 patients die and 2.2 million are injured each year by adverse reactions to prescribed drugs.

Cytochrome P450s

The cytochrome P450s are a multigene family of enzymes found predominantly in the liver that are responsible for the metabolic elimination of most of the drugs currently used in medicine. Genetically determined variability in the level of expression or function of these enzymes has a profound effect on drug efficacy. In "poor metabolisers" the genes encoding specific cytochrome P450s often contain inactivating mutations, which result in a complete lack of active enzyme and a severely compromised ability to metabolise drugs. Thus, mutations in the gene encoding cytochrome P450 CYP2C9, which metabolises warfarin, affects patients' response to the drug and their dose requirements. Polymorphism not only affects drug disposition but can also be important in

the conversion of pro-drugs to their active form. For example, codeine is metabolised to the analgesic morphine by CYP2D6, and the desired analgesic effect is not achieved in CYP2D6 poor metabolisers.

Acute Intermittent Porphyria may be precipitated by anaesthetic agents such as barbiturates so these should be studiously avoided as an attack may be irreversible.

An hereditary **plasma pseudo-cholinesterase** deficiency or inactivity of is present in about 1 in 2000 people. Metabolism of suxamethonium is greatly prolonged leading to a requirement for postoperative sedation and ventilation for many hours.

Malignant hyperthermia (MH) is an hereditary disease which is only manifest if the subject is exposed to an initiating stimulus such as anaesthesia with suxamethonium, halothane or other precipitating drug. In MH there is failure of the sarcoplasmic reticulum in skeletal muscle to store Ca^{++} as a result of certain triggering agents. The resulting rise in Ca^{++} in the cell triggers excessive excitation/contraction coupling, which leads to muscle rigidity together with a massive increase in energy expenditure. The patient becomes tachycardic, tachypnoeic (if not paralysed), hypoxic and hypercarbic (easily detectable by pulse oximetry and capnography). Hyperthermia occurs relatively late. Unless MH is suspected, the triggering agent removed immediately and urgent measures taken, then a metabolic acidosis supervenes together with hypotension and the possible demise of the patient. Although it is an uncommon syndrome it can often be picked up from the history of unexplained pyrexia following previous surgery or a family member unexpectedly succumbing to minor surgery. Dantrolene sodium is a specific drug used both for prevention and treatment. It uncouples excitation/contraction coupling by interfering with the release of Ca^{++} from the sarcoplasmic reticulum. It must be readily available in the operating room. It is given in a dose of 1 mg. kg^{-1} i.v. slowly and repeated up to a maximum of 10 mg. kg^{-1} together with general supportive measures.

Cardiovascular system

History

Preoperative interrogation of the patient determines whether there are any indicators of cardiac disease such as chest pain and dyspnoea on exertion, presence of palpitations, orthopnea and paroxysmal nocturnal dyspnoea. This will indicate the need for more detailed systematic enquiry and examination and special tests.

Detection by history and examination of patients with congenital or acquired heart defects (such as ventriculo-septal defect) and prosthetic heart valves is extremely important. In these patients, certain procedures such as dental extractions, genitourinary surgery, gynaecological and obstetric procedures, upper gastro-intestinal tract endoscopy and respiratory tract operations (including tonsillectomy, adenoidectomy and instrumentation) all require antibiotic prophylaxis for the prevention of infective endocarditis. Regimes are tailored individually but include parenteral amoxycillin for those not allergic and vancomycin + gentamicin for those that are. The antibiotics are administered immediately prior to surgery with a top-up dose given 6 hours later. It is wise to consult with the medical microbiologist if in doubt (Chapter 11).

Examination

The presence of arrhythmias, hypertension, cardiac murmurs and enlargement, and cardiac failure should be looked for (see below).

Investigations

Although a 12 lead ECG is a useful preoperative screen it is not routinely performed prior to minor surgery unless there are specific symptoms and signs. An ECG should always be obtained prior to major surgery in all patients over the age of 40 or earlier if there are signs of cardiac disease. In equivocal cases of myocardial ischaemia with a normal ECG, exercise testing and echocardiography may be necessary.

It is particularly important to note:

History of myocardial infarction

Occasionally a routine ECG is the only indicator that there has been a previous infarction, in such cases it should be presumed to be recent. Expert cardiological advice and investigation may be needed in some cases. If there is definite evidence of a myocardial infarction having occurred in the previous six months, the operation should be postponed as the risks of perioperative re-infarction are very high (<>30%) with a high mortality (<>

50%). If surgery is absolutely necessary (or an emergency) specialised cardiac monitoring is undertaken (e.g. invasive arterial pressures and Swan-Ganz catheterisation of the pulmonary artery) to warn the anaesthetist of impending problems with myocardial oxygen supply/demand so that early action can be taken (see Goldman Index).

Evidence of heart failure

This includes dyspnoea, basal crepitations, ankle swelling, increased jugular venous pressure or gallop rhythm. Heart failure must be treated with digoxin, diuretics and angiotensin converting enzyme (ACE) inhibitors prior to elective surgery.

Dysrhythmias

Are there more than five ventricular ectopic beats per minute? In supraventricular arrhythmias such as atrial fibrillation, the ventricular rate should be controlled with digoxin or amiodarone prior to surgery. Ventricular arrhythmias warn of underlying cardiac pathology and although they are often left untreated preoperatively, the anaesthetist has anti-arrhythmics ready intraoperatively.

Hypertension

Untreated hypertension increases the likelihood of perioperative cardiovascular instability, but the risks have probably been exaggerated. Nevertheless, most authorities recommend preoperative treatment of a diastolic pressure greater than 100 - 110 mm Hg. Hypertensive patients are definitely more labile at induction (big drop in BP), ETI (big rise in BP) and maintenance (big swings in BP due to blood loss and surgical stimulation). The anaesthetic technique is designed to minimise these changes.

Angina pectoris

This is not a serious risk factor in the absence of previous myocardial infarction. Neither hypertension nor angina figures in the Goldman index.

It should be noted that there is no evidence that regional analgesic technique are safer than general anaesthesia in patients with cardiovascular disease. These preoperative cardiovascular risk factors have been combined in composite cardiac risk indices, such as the Goldman Index (Table 1)

Table 1 : The Goldman Index: A score of 13 or more indicates major risk, over 25 the risk is very serious.

Risk Factor	Score
Heart Failure	+ 11
MI in the last three months	+ 10
Not in sinus rhythm	+ 7
More than 5 VEs per minute	+ 7
Age over 70 years	+ 5
Emergency operation	+ 4
Aortic stenosis	+ 3
Major intra-abdominal/thoracic surgery	+ 3
Respiratory, hepatic or renal disease	+ 3

Respiratory system

History

Acute and chronic respiratory disease is justifiably worrying for the anaesthetist, so a detailed history should be taken including presence of chronic cough productive of sputum, wheeze and shortness of breath on exertion. Asking how far the patient can walk without shortness of breath, or asking the patient to count numbers in a single expiration easily assesses the seriousness of the situation. If the maximum uninterrupted walk is less than 50 metres, or the patient is unable to count up to 10 in a single breath, or there has been more than one hospital admission due to respiratory disease, then pulmonary function tests are performed. The number of previous hospital admissions related to the respiratory condition is important.

Examination

Clinical examination looks for central cyanosis, finger clubbing, use of accessory muscles of ventilation, the extent of chest expansion, presence of wheeze, areas of collapse/consolidation, pneumothorax and presence of secretions.

Investigations

These include Hb, urea and electrolytes, chest X ray and ECG. Simple respiratory function tests are now available which can be performed at the bedside using small micro electronically based instruments.

Spirometry

- **Peak expiratory flow rate (PEFR)** is a useful screening test; a value below 100 l.min⁻¹ suggests serious ventilatory impairment in an adult. Coughing and clearing of bronchial secretions is unlikely to be effective if the PEFR is less than 100 - 150 l.min⁻¹. A value over 300 l.min⁻¹ shows that ventilatory function is unlikely to be seriously compromised following surgery.
- **Forced expiratory volume in one second (FEV1)** is less than 50% of normal if there is a significant bronchospastic component.
- **Forced vital capacity** is less than 50% of normal if there is a significant loss of functional lung tissue (e.g. emphysema) or a restrictive condition such as fibrosing alveolitis.

If both FEV1 is < 50% and FVC is less than 50% of predicted, arterial blood gas analysis must be performed. These two parameters are combined in a useful diagram, which can be used to classify basic respiratory pathologies (see Figure 1 below).

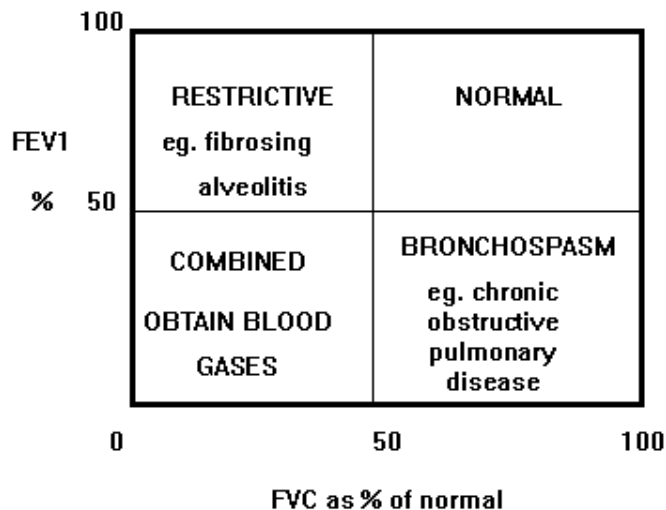


Figure 1 Classification of underlying respiratory disease and the need for arterial blood gases.

Reversibility of significant bronchospasm is attempted preoperatively, using suitable bronchodilators and chest physiotherapy instituted to maximise the available respiratory reserve prior to surgery.

Arterial blood gases

The predicted post-operative course is best correlated with the resting PaO₂ and PaCO₂ values when breathing air (Chapter 8).

Three degrees of severity may present, with different post-operative prognoses :

- (1) PaO₂ > 7.5 KPa (55 mmHg) and normal PaCO₂: reasonable prognosis
- (2) PaO₂ < 7.5 KPa and normal PaCO₂: requirement for short term post-operative ventilation should be anticipated following major upper abdominal/thoracic surgery
- (3) PaO₂ < 7.5 KPa and PaCO₂ > 7.5 KPa (55 mmHg): poor prognosis, with almost certain requirement for prolonged post-operative ventilation following major surgery

Chronic respiratory patients benefit from regional analgesic techniques if suitable for the operation. If general anaesthesia must be given, competitive neuromuscular blockers (NMB) should be kept to a minimum, because the smallest interference with respiratory muscle function often leads to severe respiratory failure (Chapter 16).

Respiratory problems of particular importance for anaesthesia are:

Acute respiratory tract infection: paediatric patients, in particular, frequently present for surgery with clinically obvious upper respiratory tract infections and, as a result, have an increased risk of airway problems in the perioperative period. It is important to distinguish local rhinitis from laryngo-tracheo-bronchitis or pharyngitis/laryngitis, i.e. cough, sore throat, hoarseness accompanied by fever, malaise and vomiting indicating systemic infection. In such cases, the operation should be delayed whilst treatment is instituted.

Asthma: intractable bronchospasm ranks high in the list of contributory causes of death under anaesthesia. Long-term bronchodilator therapy is continued right up to induction of anaesthesia. Antihistaminic agents such as promethazine and oral theophylline may be added to the premedication and salbutamol inhaled immediately prior to induction. The anaesthetic must be conducted with careful avoidance of all drugs and mechanical stimulation known to trigger bronchospasm. Endotracheal intubation is avoided if possible as it is a significant stimulus to bronchospasm, especially if anaesthesia is too light. Intravenous atropine (10 - 20 ug.kg⁻¹) or glycopyrrolate (5 - 10 ug.kg⁻¹) effectively prevents vagal reflexes; beta-blockers, even if beta-1 selective, must not be used.

Chronic obstructive pulmonary disease: major surgery, particularly upper abdominal and intrathoracic, has profound effects on ventilatory function, even in the normal patient without respiratory disease. Patients with limited functional reserve are obviously at risk of serious postoperative respiratory complications. Preoperative physiotherapy, antibiotics and bronchodilators are necessary prior to major surgery to lessen the risk and severity of postoperative chest infection. This obviously necessitates careful screening in the clinic and timely admission to hospital to allow this to take place. Unlike asthma, most of the lung function impairment in COPD is fixed. However, there is often some degree of reversibility, and many patients will obtain symptom relief from using inhaled bronchodilators.

Approaches to management include:

- Eradication of acute and chronic infection with appropriate antibiotics
- Relief of bronchospasm with a bronchodilator
- Chest physiotherapy to improve sputum clearance and bronchial drainage
- Reversal of uncompensated or borderline cor pulmonale with diuretics, digitalis, improved oxygenation, and correction of acidaemia by more efficient ventilation
- Correction of dehydration and electrolyte imbalance
- Cessation of smoking, if possible for 3 months, to improve mucociliary clearance and decrease sputum production.
- Abstinence from smoking for at least 12 hours to reduce carboxyhemoglobin levels, resulting in improvement of blood oxygen content and increasing the release of oxygen in haemoglobin.
- consider steroid therapy in the week prior to elective surgery for patients with wheezing despite optimal bronchodilator therapy. It has also been recommended that systemic steroid preparation be used preoperatively in patients with moderate to severe asthma and a history of requiring steroids in the past.

Neuromuscular disease

Myopathies: myotonic syndromes (such as dystrophia myotonica) cause a generalised contracture in response to suxamethonium. Responses to competitive NMBs may be either decreased or abnormally prolonged.

Myasthenia gravis: the use of competitive NMBs is usually contraindicated; a normal dose can cause incapacitating paralysis for more than 48 hours. Post-operatively the patient must be managed in the ITU.

Diabetes

Introduction

Diabetic patients fall into one of three classes: those managed on diet alone, those taking oral hypoglycaemic drugs, and those taking insulin. They are all at an increased perioperative risk because of the cardiovascular, renal and neurological changes associated with the disease.

History, examination and investigations

Assessment of the patient involves taking note of the quality of glucose control and the presence of associated cardiovascular, neurological and renal complications of diabetes. These include ischaemic heart disease, autonomic and peripheral neuropathy and renal failure. Minimum investigations include Hb, urea and electrolytes and glucose and ECG. Diabetics with autonomic neuropathy often complain of postural hypotension and are at increased risk of serious cardiac arrhythmias during surgery under general anaesthesia.

Management

In minor (non-stressful) surgery, only patients on insulin or oral therapy require special management, mainly because of the fasting period surrounding the operation. Oral hypoglycaemics should be omitted prior to surgery to avoid the risk of hypoglycaemia.

All diabetic patients need special attention during major surgery because stress increases insulin requirements (partly due to release of catecholamines). A 5 to 10% dextrose drip (with 20 mmol. potassium chloride) should be instituted pre-operatively and a constant infusion of soluble insulin started using a syringe pump (50 units insulin in 50 mls. 0.9% sodium chloride). The hourly rate of insulin administration should initially be based on the patient's normal daily requirements (usually 1 - 6 units (mls) per hour), and adjusted at two or four-hour intervals depending upon blood glucose levels obtained from portable glucose monitors. This regime should be continued during the operation and post-operatively until the patient has recovered from operative stress and resumed a normal diet.

Renal disease

History, examination and special investigations

A full preoperative examination should concentrate on detection of complications of chronic renal disease such as hypertension and ischaemic heart disease. Patients may present with difficult anaesthetic problems, e.g. cardiovascular disease (ischaemia, left ventricular failure and hypertension), diabetes, severe anaemia, high plasma potassium (avoid suxamethonium) and multiple drug therapy including immuno-suppression for transplantation. Minimum preoperative investigations include Hb, urea and electrolytes, ECG and chest radiograph (Chapter 17).

Management

Patients on regular haemodialysis should be dialysed in the 24 hours preceding surgery, thus avoiding fluid overload. The activated coagulation time (ACT) should be checked and sufficient time should be allowed for the residual effects of heparin to wear off prior to surgery. Patients with pre-existing chronic renal impairment (raised urea and creatinine, but not requiring dialysis) usually tolerate badly the preoperative period of fluid restriction. They often exhibit an inability to conserve urinary sodium and can become fluid depleted in the perioperative period. This can even be severe enough to precipitate acute on chronic renal failure. An infusion of 0.9% sodium chloride should be commenced preoperatively to avoid this complication.

Anaesthetic drugs are available which do not rely on the renal route for their elimination. Inhalational agents such as desflurane or isoflurane, mostly eliminated through the lung, are good supplements. If competitive neuromuscular blockers must be used, atracurium, cis-atracurium or vecuronium are preferred.

Liver disease

History, examination and investigations

In assessing the patient with liver disease, it is important to determine what effects it is having on the functions of the liver and this is covered in detail in Chapter 17.

Anatomical difficulties

This is mainly directed towards spotting difficulties with the airway (e.g. ability to tightly apply a facemask and feasibility of ETI), prior to induction of anaesthesia. e.g.

Mouth opening: is it sufficient to allow passage of a laryngoscope, airway or laryngeal mask?. The Mallampati score is a useful system to classify and predict intubation difficulty as shown in Table 2 below.

Table 2 Mallampati's Modified Classification

Grade	Description
I	Faucal pillars, soft palate and uvula visible
II	As above, but uvula masked by base of tongue
III	Only the soft palate visible
IV	Soft palate not visible

Trismus due to infection, jaw fixation and temporo-mandibular pathology may limit mouth opening to such an extent as to make ETI impossible. Awake fibre optic laryngoscopy via the nasal passages or tracheostomy under local anaesthesia may be the only safe option. If the uvula and posterior pharyngeal wall cannot be visualised, ETI may be very difficult

Neck movements: the extent of neck flexion and extension ('sniffing the morning air') should be established. Neck movements may be severely limited (and dangerous) in patients with rheumatoid arthritis (particularly young women with rheumatoid nodules). Radiological preoperative assessment is essential using lateral and antero-posterior neck x-rays. If necessary, the neck should be stabilised by a collar and the ETI performed on the awake patient using sedation and topical analgesia.

Spine: if epidural or spinal analgesia is anticipated, the lumbar spine should be examined for anatomical abnormalities and mobility. Severe spinal deformity, such as kyphoscoliosis can lead to severe respiratory embarrassment in the postoperative period.

Epilepsy

Most anti epileptic agents, such as phenytoin and the barbiturates, induce hepatic enzymes, thus enhancing the ability of the liver to metabolise anaesthetic drugs. Higher doses of intravenous anaesthetics may be required for both induction **and** maintenance of anaesthesia. Anticonvulsant treatment is continued right up to the time of premedication and restarted as soon as is practicable (i.m. or oral) post-operatively. Anaesthetic drugs, which are liable to precipitate convulsions such as methohexitone and enflurane, are avoided (Chapter 18).

Pregnancy

Only urgent surgery should take place, as there is an increased incidence of spontaneous abortion from the second trimester onwards, particularly if surgery is performed in the region of the uterus, e.g. appendicectomy. In the first trimester, drugs implicated in causing defects in organogenesis should be avoided. Thiopentone, suxamethonium, pancuronium, pethidine and halothane are examples of safe, well-tried agents that may be used in early pregnancy. After the 16-18th week the risk of regurgitation of acid stomach contents at induction increases steeply.

Overall assessment of fitness for anaesthesia and surgery

The American Society of Anesthesiologists (ASA) has produced a classification of patients depending on their general condition before operation. This scale bears some correlation with morbidity and mortality due to operation or anaesthetic, and is useful as a means of recording and conveying to others the state of the patient. Thus, having examined the patient and noted the preoperative pathology it should be possible to assign the patient to one of the following categories. For instance, patients attending a day surgery centre for surgery under general anaesthesia should usually be in ASA classes I or II.

ASA I Normal healthy patient

ASA II Patient with mild systemic disease, which is adequately, treated, e.g. diabetes, chronic bronchitis and hypertension.

ASA III Severe systemic disease limiting normal activity, such as angina on exertion, chronic renal failure on dialysis and chronic obstructive pulmonary disease (COPD) with dyspnoea.

ASA IV Incapacitating systemic disease, which is a constant, threat to life e.g. angina on minimal exertion, cardiac failure and COPD with dyspnoea at rest.

ASA V Moribund, not expected to survive 24 hours with or without operation

E Signifies that the operation is to be performed as an emergency. Generally speaking this places the patient in the next highest risk category.

Premedication

This is a traditional measure still thought by some to be essential for all patients undergoing surgery. It has its origins in the days of gaseous induction with di-ethyl ether, which was often 'stormy' and could cause intense salivation, coughing, breath holding and production of copious tracheal secretions. Combination of an opioid and anti-sialogogue decreased the likelihood of these problems on induction. Nowadays, with modern anaesthetic techniques, these drugs are rarely necessary, and the main purpose of premedication is to relieve anxiety.

Indications

The main indications for premedication all begin with 'A' and are outlined below. They can all be given either preoperatively on the ward (i.m., oral or p.r.) or by i.v. increments immediately prior to induction. Heavy premedication reduces requirements for anaesthetic drugs intra-operatively, but may also be responsible for delayed awakening at the end of the procedure. Premedication is used much less than formerly. Regimes usually include a benzodiazepine such as temazepam or an opioid and anti-emetic combination such as pethidine and promethazine.

Anxiolysis: the major requirement of pre-medication is usually achieved by a combination of preoperative assurance by the anaesthetist together with benzodiazepines as appropriate. A combination of an opioid and phenothiazine is equally effective but must be given parenterally.

Analgesia: this is rarely necessary prior to surgery unless the patient is already in pain, e.g. appendicitis and fractured neck of femur. Intraoperative analgesia is best achieved by i.v. administration of opioids. NSAIDs are increasingly utilised for postoperative analgesia, especially in day surgery patients. Although they can be given parenterally at or immediately after induction, a popular form of administration is by suppository and ideally this should be given an hour or so prior to anaesthesia.

Amnesia: prior to major surgery, an amnesic component is useful in specific cases to reduce recall of unpleasant procedures carried out prior to induction of anaesthesia, e.g. insertion of major vascular catheters and awake intubation. This state is best achieved by a combination of lorazepam and hyoscine as premedication or as midazolam given in i.v. increments on arrival in the anaesthetic room

Anti-sialogogue: it is usual to administer atropine, hyoscine or glycopyrrolate prior to anaesthesia for reduction of secretions in specific cases such as for infants and for patients having upper airway/ GI tract endoscopy. An unpleasantly dry mouth is the commonest side effect of these agents; hyoscine and to a lesser extent atropine cross the blood brain barrier, exerting a depressant effect that can be excessive in the elderly and the very young.

Anti-vagal: atropine and glycopyrrolate (less so hyoscine) are also anti-vagal drugs. They are useful to prevent bradycardia in infants (where cardiac output is mainly determined by rate, so bradycardia must be avoided at all costs) and patients receiving beta-blockers. The incidence of bradycardia in patients undergoing certain procedures such as laparoscopy, especially if non-vagolytic neuromuscular blocking drugs are used has led to the routine use of these drugs in these cases.

Antacid: these include acid buffering agents such as sodium citrate and H2 antagonists such as ranitidine. They are administered as a routine in many centres to lower gastric acidity in order to reduce the risk of acid aspiration (see preoperative starvation below).

Autonomic blockade: the response to induction of anaesthesia on the cardiovascular system reflects the autonomic responses to anaesthetic drugs and to intubation of the trachea. Intubation causes the most dramatic changes, with hypertension and tachycardia occasionally requiring the use of blocking drugs; bradycardia with hypotension due to a vagal reflex is uncommon. Pre-operative beta-blockade may be indicated in patients with thyrotoxicosis, ischaemic heart disease or intracranial space occupying lesions.

Antiemesis: an anti emetic is usually included with opioid premedication to reduce the incidence of nausea associated with these drugs and with surgery.

Preoperative starvation

The dangers of pulmonary inhalation of acid gastric contents and particulate matter include severe bronchospasm, increased shunting of deoxygenated blood and acute respiratory distress syndrome (ARDS). To prevent this feared complication, the patient must abstain from food for 6 hours preoperatively and clear fluids from 2 to 4 hours preoperatively to ensure an empty stomach. Despite these recommendations, 30% of normal patients still have sufficient gastric volume and acidity to cause problems.