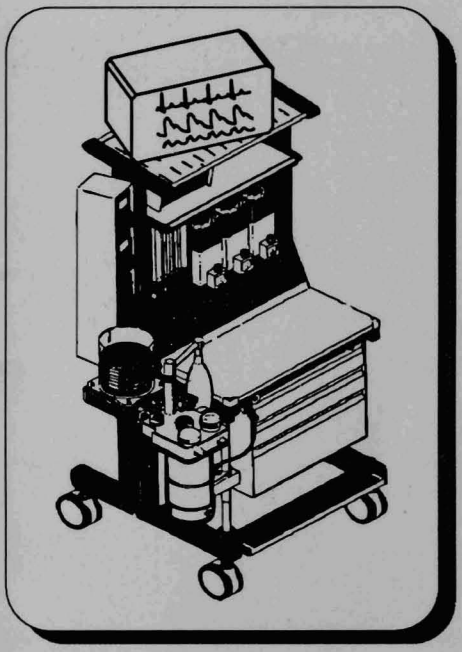
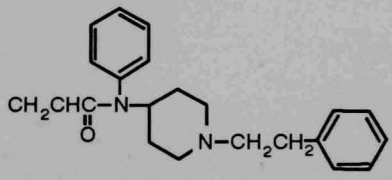
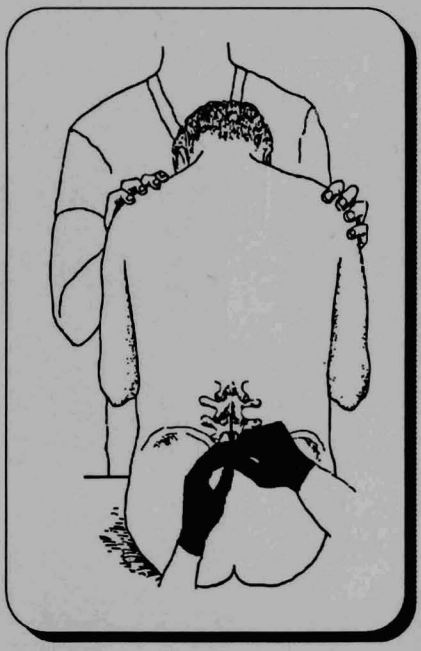
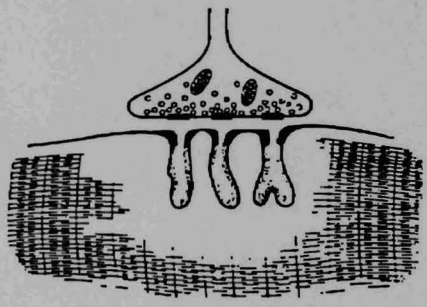
Anaesthesia for Medical Students









Pat Sullivan M.D.

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Introduction

Specialists in the fields of medicine and surgery may ask why medical students should be exposed to the specialty of anesthesia. We believe that there are basic concepts and technical skills that every physician should possess, and that these concepts and skills are best taught by our specialty.

Medical school curricula across North America are repeatedly criticized for lacking the teaching of both acute and chronic pain management. In addition, students who pursue a career in surgery, emergency medicine or internal medicine are expected to have the skills to manage a patient's airway. However, they usually have had no formal teaching in these basic skills. Finally, medical school curricula in North America are rapidly changing. Students are now asked to commit themselves to a specialty during the third year of their medical school training. We believe that this process is unfair. We also recognize that a student with no prior exposure to anesthesia is unlikely to choose anesthesia as a career.

This manual was written with contributing authors from the Departments of Anesthesia at the Ottawa Civic and General Hospitals for medical students spending two weeks of their clinical rotation in the specialty of anesthesia. Six specific objectives are used to focus the students reading. The text is highlighted by two asterisks (**) for material that is essential and that the student must know, and one asterisks (*) for material which the student should know. All other material is provided for background reading which the student may know. The manual is to be used as a primary reference for lectures on monitoring in anesthesia, and on acute and chronic pain management. The problem-based tutorial question will also be on material covered in this manual.

The student who completes the anesthesia rotation should have acquired confidence in airway management skills including mask ventilation and tracheal intubation, as well as securing intravenous access. Important concepts for the student to attain during their rotation include:

1. Preoperative assessment.
2. Basic principles of managing acute and chronic pain disorders.
3. The appropriate use of local anaesthetic agents.
4. Analgesic options for women in labour.
5. Basic neonatal assessment and resuscitation.
6. Intravenous fluid and blood component therapy including the potential complications of a blood product transfusion.

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Preface

The first public demonstration of ether was by W.T.G. Morton in the Etherdome of the Massachusetts General Hospital in 1846. Ether anaesthesia became widely available and would soon be followed by chloroform and nitrous oxide. Surgeons were not particular about who poured the ether or chloroform so long as someone was there to do the job. It was not until the early 1920's that physicians began to show interest in anaesthesia as a specialty. By the end of World War II the infant specialty was firmly established and university training programs began.

The emphasis has traditionally been on postgraduate teaching. Why has undergraduate anaesthesia teaching been neglected or de-emphasized? It was because the medical school curriculum was controlled by older, traditional disciplines that were unwilling to relinquish time for competing specialties. This was complicated by the fact that anaesthetists originally worked only in the operating room, and found it difficult to be freed from that responsibility to undertake teaching outside the operating room. Anaesthesia has expanded to include other services which include Intensive Care, Acute and Chronic Pain Services, Malignant Hyperthermia Diagnostic Services, and a Pre-admission Unit. Anaesthetists have developed many skills which are valuable to physicians, regardless of their discipline. They have become specialists in applied physiology, pharmacology and resuscitation of acutely traumatized patients. The importance of imparting these skills and knowledge to medical students has been realized by those responsible for medical school curricula. Accreditation bodies are demanding that anaesthetists teach medical students.

When the new curriculum, founded on problem-based learning, was adopted in the Faculty of Medicine at the University of Ottawa, anaesthesia was given responsibilities in the program. Each student must spend two weeks in an anaesthesia rotation and many anaesthetists participate in small group sessions. Dr. Patrick Sullivan found that an anaesthesia manual, which would meet the needs of medical students submerged in a new curriculum, was not available. The manual he and his co-authors have written covers all of the important material a medical student must and should know. It is best taught by anaesthetists because it falls almost exclusively in their domain. The organization of the manual makes it essential reading for students rotating through anaesthesia who want to optimize their brief exposure to anaesthesia, which has so much to offer.

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Anaesthesia Rotational Objectives

There are **six specific knowledge and skills objectives*** for the two week anaesthesia rotation:

1. **To become aware of anaesthetic considerations in the preoperative evaluation and preparation of the patient.**

This will be accomplished by conducting several preoperative assessments, including:

a. Taking and recording a pertinent history.
b. Performing an appropriate physical examination, including assessment of the airway, the respiratory and cardiovascular systems, and other systems as indicated.
c. Reviewing relevant laboratory data.
d. Preparing a problem list and assigning appropriate ASA physical status.
e. Prescribing appropriate premedication, including continuing relevant current medications, and demonstrating knowledge of the principles of managing specific medications (eg. insulin,anticoagulants).

2. **To learn appropriate airway and ventilatory management.**

The student will demonstrate proper airway and ventilatory management of the unconscious patient by:

a. Describing and identifying basic oropharyngeal and laryngotracheal anatomy.
b. Describing the indications, benefits and risks of airway management by mask and endotracheal intubation.
c. Identifying and stating appropriate sizes of masks, oral and nasal airways, laryngoscope blades and endotracheal tubes.
d. Identifying and overcoming upper airway obstruction with mask ventilation using various masks, oral and nasal airways, jaw thrust and or chin lift maneuvers.
e. Successfully preparing appropriate equipment, positioning and intubating several patients with minimal supervisor intervention.
f. Correctly identifying within 30 seconds those patients in whom endotracheal intubation was not successful.
g. Recognizing and discussing the need for controlled ventilation using physical signs, cardiovascular parameters, respiratory measurements, and/or arterial blood gases.

h. Discussing the various methods of monitoring the adequacy of ventilation.
i. Prescribing appropriate parameters for mechanical ventilation.
j. Describing and identifying criteria for extubation.

3. To acquire skills necessary to prescribe and conduct appropriate fluid and blood component therapy, including establishing vascular access.

This will be demonstrated by:
a. Identifying common sites for venous access.
b. Demonstrating skill at establishing venous access by:
   - using sterile technique.
   - Successfully inserting several peripheral catheters of various calibres.
   - Protecting the venipuncture site and immobilizing the catheter.
c. Describing the indications and complications of central venous access.
d. Prescribing perioperative fluid and electrolyte replacement, taking into account such factors as NPO status, preoperative bowel prep, NG suction, fever, blood losses, and third space losses.
e. Discussing perioperative indications for blood administration, and learning rational use of blood products, and the potential complications of blood product administration.
f. Correctly interpreting data from the following monitors of volume status:
   - examination of the patient.
   - pulse and blood pressure.
   - urine output.
   - invasive monitoring (CVP, PCWP, Arterial pressure waveforms, cardiac output).

4. To learn local anaesthetic pharmacology appropriate to general medicine by:

a. Classifying commonly used agents according to amide and ester linkage.
b. Listing commonly used local anaesthetics for:
   - topical use
   - local infiltration
   - peripheral nerve blocks
   - iv (Bier's) block
   - epidural anaesthesia
   - spinal anaesthesia
c. Listing acceptable doses of at least two agents used for topical and local infiltration anaesthesia.
d. Describing the diagnostic criteria for, and management of:
   - local anesthetic toxicity.
   - inadvertent intravascular injection of local anaesthetic.
   - allergic reaction to a local anaesthetic.

5. To understand the management of pain in the peripartum period and the initiation of neonatal resuscitation.

This will be demonstrated by:
a. Discussing indications, contraindications and adverse effects of various modes of obstetrical pain relief.

- mask analgesia with nitrous oxide and/or volatile anaesthetic agents.
- narcotic analgesia (im, or iv).
- epidural anaesthesia.
- spinal anaesthesia.

b. The student will develop skills in assessment and management of the healthy newborn by:
- administering oxygen by mask.
- performing oropharyngeal and nasopharyngeal suction.
- performing an initial physical examination.
- assigning Apgar Scores.
- recognizing newborn distress.

c. The student will be able to describe therapeutic steps necessary to begin neonatal resuscitation.

6. To understand the principles of acute and chronic pain management.

This will be achieved through the provided reading material in the anaesthesia manual, a pain clinic rotation, and a discussion of modalities for acute pain management including:

a. iv narcotic infusions.
b. non-narcotic analgesics.
c. iv and epidural PCA (patient controlled analgesia).
d. peripheral nerve blocks.

Reading material in the anaesthesia manual and discussion of the diagnosis and management of common chronic pain syndromes will focus on:

a. Reflex sympathetic dystrophy.
b. Fibrositis.
c. Chronic low back pain.
d. Post herpetic neuralgia.
e. Cancer pain.

ANAESTHESIA CURRICULUM: KNOWLEDGE/SKILLS/ATTITUDE

Knowledge:

The following topics will be covered either in the manual, or in seminar format and problem solving sessions during the 12-week surgical - anaesthesia rotation.

Preoperative evaluation and preparation.
Anaesthetic - Surgical risk assessment.
Hypoxia.
Oxygen Therapy.
Intubation-indications/complications.
Principles of mechanical ventilation.
Shock.
Fluid Therapy.
Blood component therapy.
Acute and Chronic Pain management.
Obstetrical anaesthesia-analgesia.
Basic neonatal resuscitation.

Skills:

1. Airway maintenance maneuvers in the unconscious patient.
2. Artificial airway insertion.
3. Mask ventilation.
4. Endotracheal intubation and extubation.
5. Spontaneous, manual, and controlled modes of ventilation.
6. Venous cannulation.
7. Prescription, identification and administration of blood components, including equipment assembly.††
8. Arterial blood gas sampling.††

9. Spinal anaesthesia (Lumbar puncture).††
10. Nasogastric tube insertion.††

†† Skills number 1 to 6 must be achieved during the rotation. Students may acquire skills number 7 to 10 depending on clinical opportunity and the students' interest level.

Attitude:

We hope that your two-week rotation will stimulate a thirst for knowledge and understanding of the fascinating physiology and pharmacology that occurs in the patient undergoing surgery. Anaesthesia is a somewhat unnatural if not magical state. It is normal to feel technically challenged during your rotation as you acquire vascular access and airway management skills. Each of you can expect to experience (as all doctors have), a humbling but hopefully rewarding, technical learning curve. You should be aware of your difficulties, your response to them, and the response of your patient and other medical personnel to your difficulties. We ask that your eyes and senses not be clouded by technical monitors, but rather be open to the overall care of the patient. We demand a commitment of excellence in your care and concern for the well-being of the patient and their family. We expect punctuality and honesty as a basis of good medicine.

While students may view anaesthesia as a specialty with limited patient contact, they should ensure that opportunities for communication with the patient and family do not slip by. Fact-gathering encounters do not have to be devoid of reassurance, kindness or a comforting touch. We expect both positive and negative experiences during your rotation to be discussed openly with us, to ensure the best possible rotation for future students.

Resources:

Our University of Ottawa Anaesthesia Manual will be distributed to all students, and will be used as the basic reference text for the rotation. Additional reference material will be available in each hospital's anaesthesia library.

Topics covered in this manual have been classified as either ***must know***, ***should know***, or ***may know*** material. Material designated as ***must know*** will be identified by two asterisks (**), and will have a greater emphasis in content and weighting in the multiple choice, short answer, and OSCE questions at the end of the surgical anaesthesia rotation. Material assigned to the ***should know*** portion of each chapter will be identified by one asterisk (*). All other topics covered in the manual provide a general background for the student during their anaesthesia rotation, and are topics which the student ***may know***. A passing grade can be achieved with a good comprehension of the ***must know*** material, while an honours mark may be awarded to students correctly answering material covered in the ***should know*** and ***may know*** sections of the manual.

A computerized anaesthesia simulator will be available as an option during the students rotation. (The simulator includes models of pharmacology, pharmacokinetics, critical incidents, as well as cardiovascular and respiratory physiology).

The hospitals' anaesthesia library and main libraries will be available for reference during the rotation.

Notes:

Evaluation:

The rotation evaluation will be based on four components.

I. Participation during problem solving sessions.
II. One or more examinations using a multiple choice format, short answer examination format, or OSCE examination.
III. A clinical profile record.
IV. A review of the anaesthesia simulator problems (optional).

Anaesthesia Overview

Modern general anaesthesia is based on the ability to provide adequate analgesia and amnesia during surgical procedures. Neuromuscular-blocking drugs may be utilized to facilitate surgical exposure by providing profound muscle relaxation. The anaesthesiologist attempts to achieve both analgesia and amnesia, with or without muscle relaxation, while maintaining the patient's normal physiological functions. The challenge in anaesthesia is to maintain a balance between the stress of the surgical procedure and the cardiorespiratory depressant effects of deepening levels of anaesthesia (figure 2.1). The anaesthesiologist uses both skills in clinical examination and a host of technical monitors to provide ongoing feedback on the patient's physiological status and anaesthetic requirements. Table 2.1 lists options available to the anaesthesiologist for providing analgesia, amnesia and muscle relaxation.

A state of general anaesthesia may be induced with the injection of anaesthetic drugs, or by the inhalation of a mixture of anaesthetic vapours (figure 2.1). With general anaesthesia, muscle relaxants may be used to facilitate both tracheal intubation and muscle relaxation.

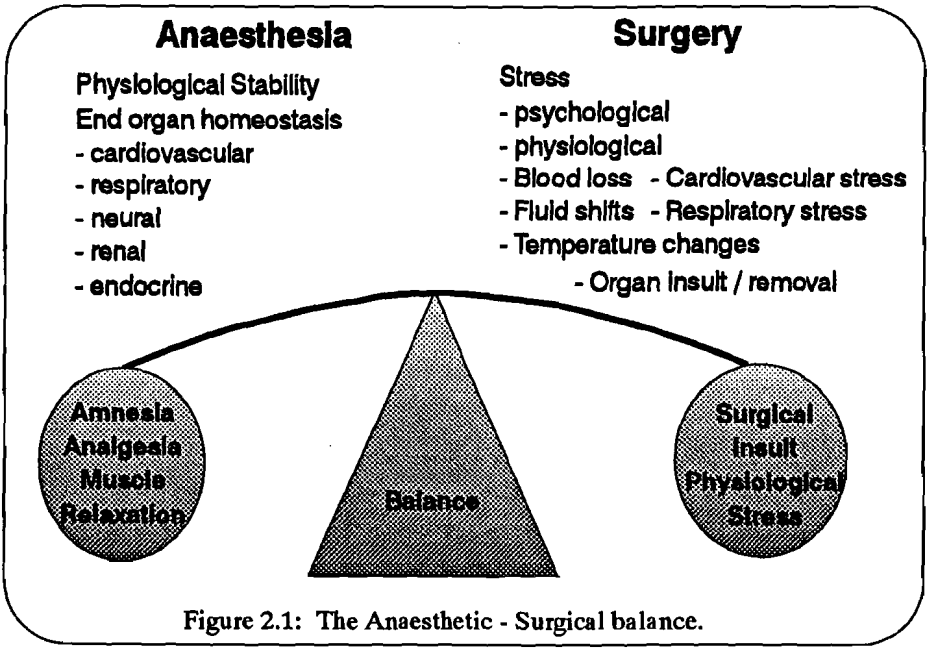

Figure 2.1: The Anaesthetic - Surgical balance.

Muscle relaxants are frequently used to facilitate surgical access, and are essential for thoracic and abdominal operations. As muscle relaxants have no effect on the state of consciousness, additional anaesthetic medications must be given to ensure both amnesia and analgesia. The use of muscle relaxants avoids the need for excessive amounts of other anaesthetic agents that would otherwise be required to achieve the same degree of muscle relaxation. Because muscle relaxants also affect the muscles of respiration, positive pressure ventilation is frequently used to maintain normal minute ventilation when they are given. When muscle relaxants are not used, the patient may be allowed to spontaneously inhale anaesthetic vapours to maintain the anaesthetic state. If efforts at spontaneous ventilation are inadequate, manually assisted or controlled mechanical ventilation may be used by the anaesthetist. Controlled mechanical ventilation is generally used only when the trachea has been intubated.

Table 2.1: Anaesthetic Options*.

Anaesthetic Options	
Local Anaesthesia Alone.	
Local Anaesthesia with intravenous conscious sedation.	eg. iv Propofol, midazolam, fentanyl and or music for sedation.
Neurolept-analgesia.	Used infrequently. Achieved with high doses of droperidol with a opioid (such as fentanyl) for analgesic supplementation.
Regional Anaesthesia, with or without sedation.	eg. Spinal Anaesthesia Epidural Anaesthesia Brachial Plexus Block Intravenous 'Bier' Block Peripheral Nerve Blocks
General Anaesthesia. (see figure 2.2)	May be combined with regional anaesthesia, peripheral nerve blocks or local anaesthesia.
Others	Acupuncture Biofeedback techniques (Lamaze) Inhalational agents (eg. Entonox = 50:50 mixture of nitrous oxide and oxygen). im, po, iv sedatives, narcotics, neuroleptics, or antiemetics

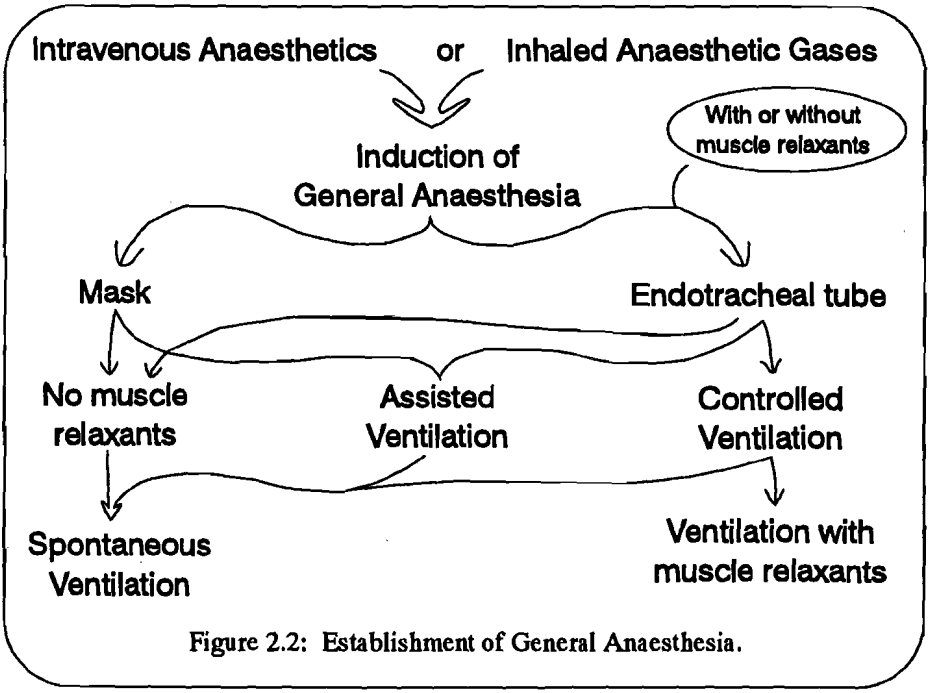

Figure 2.2: Establishment of General Anaesthesia.

Spontaneous and assisted ventilation may be used in conjunction with a tracheal tube, laryngeal mask airway, or simple face mask (figure 2.2).

Modern general anaesthesia uses combinations of medications in an attempt to minimize each drug's side effects, and maximize individual benefits. Hence, rather than using halothane alone to provide anaesthesia for abdominal surgery, the anaesthetist often chooses a series of medications to match the patient's needs. These medications may include opioids to blunt the pain response to surgery, barbiturates to induce the anaesthetic state, and volatile anaesthetic agents such as nitrous oxide and isoflurane to maintain the anaesthetic state. Other common anaesthetic drugs used during general anaesthesia include antiemetics, neuromuscular blocking agents, and neuromuscular antagonists.

CHAPTER 3

Preoperative Evaluation and Risk Assessment

GREG BRYSON M.D., FRCPC AND JOHN B. KITTS M.D., FRCPC

Preoperative assessment is essential for the safety of anaesthesia. Physicians who have had no exposure to the specialty of anaesthesia are ill-equipped to evaluate, prepare, and institute measures to minimize the patient's risk in the perioperative period. This chapter provides a framework for physicians who need to understand their patients' risk of undergoing a surgical procedure, and the measures that can be used to optimize their patients' condition prior to surgery.

Preoperative evaluation serves many purposes. First, it offers the anaesthetist an opportunity to define the patient's medical and surgical problems, and plan the anaesthetic technique. Second, further investigation, consultation, and treatment can be arranged for patients whose condition is not optimal. Finally, the anaesthetist can provide information and reassurance for the patient during this stressful time.

An organized approach to the preoperative evaluation will allow the anaesthetist to perform a focused evaluation of the patient's medical and surgical condition, and to address issues relevant to the safe and effective performance of surgery. The preoperative evaluation does not replace the role of the primary care provider, and should not be used to address issues that are not relevant to the performance of anaesthesia and surgery.

The preoperative visit should include the following steps:

I. Problem Identification
II. Risk Assessment
III. Preoperative Preparation
IV. Plan of Anaesthetic Technique

I. PROBLEM IDENTIFICATION**

Identification of the problems a patient brings to the operating room is one of the most vital, yet easily neglected, components of the perioperative management of the surgical patient. A system-oriented approach to the patient is helpful in completing a thorough preoperative assessment. As is the case elsewhere in medicine, the preoperative evaluation should progress through history (including a review of the

patient's chart), physical examination, and laboratory investigation.

Anaesthetic drugs and techniques have profound effects on human physiology. Hence, a focused review of all major organ systems should be completed prior to surgery. The anaesthetist pays special attention to symptoms and disease related to the cardiovascular, respiratory, and neuromuscular systems as they will directly manipulate these systems during surgery. Because one of the goals of the preoperative evaluation is to ensure that the patient is in the *best* (or optimal) *condition*, it is important not only to identify symptoms, but also to document their severity and to determine their stability or progress. Patients with unstable symptoms should be postponed for optimization prior to elective surgery.

Cardiovascular:
Patients with *ischemic heart disease* are at risk for myocardial ischaemia or infarction in the perioperative period. A thorough history should ascertain whether angina is new or has recently changed from a previously stable pattern. A description of the patient's exercise tolerance must also be included. Patients with a history of a recent myocardial infarction (< 6 months) or unstable angina are poor surgical candidates, with a high risk of significant morbidity or mortality.

Assessment of cardiac risk is discussed later in this chapter. As many anaesthetic agents are also myocardial depressants, a history of *congestive heart failure* or *cardiomyopathy* should be directly sought. *Valvular heart disease* presents a special set of concerns to the anaesthetist. This includes unfavourable and even dangerous alterations in haemodynamics brought on by the anaesthesia, particularly major regional techniques (see chapter 15: Local and regional anaesthetics). Consider the risk of subacute bacterial endocarditis (SBE) in these patients.

Although less common with new anaesthetic drugs, *arrhythmias* are frequently seen in the operating room. In the preoperative visit, identify a past history of arrhythmia or symptoms suggesting the need for a pacemaker. The patient with *hypertension* will require special attention to perioperative antihypertensive therapy and fluid and electrolyte balance.

Respirology:
Cigarette smoke has several adverse effects, including alteration of mucus secretion, clearance, and decrease in small airway calibre. It also may alter the immune response. The chronic smoker should be encouraged to abstain from smoking for at least 8 weeks prior to the operation,[1] but stopping smoking for even 24 hours may produce benefits in cardiovascular physiology[2] and carboxyhemoglobin levels.

Patients with chronic *obstructive pulmonary disease (COPD)* are at increased risk of perioperative respiratory complications. Anaesthesia, surgery and postoperative analgesia all predispose the patient with COPD to respiratory depression, atelectasis, retained secretions, pneumonia and respiratory insuff-

iciency or failure. The patient with *asthma* is at particular risk as manipulation of the airway and cold dry anaesthetic gases are potent triggers of intraoperative bronchospasm. Determine the presence of cough and the colour and amount of sputum. Ensure that there is no acute upper respiratory infection.

The patient's exercise capacity should be evaluated by asking questions such as how they manage around stairs at home, and walking to local stores. Are they able to walk several blocks comfortably at a normal pace? Do they avoid stairs? If they routinely uses stairwells, how many flights are they able to complete? Do they have to rest in the stairwell? Is this the result of fatigue, shortness of breath, or chest pain?

Restrictive lung disease will be worsened by upper abdominal or thoracic surgery, and place the patient at increased risk for perioperative failure. Any disease process which leads to an *altered control of breathing* (obstructive sleep apnea, CNS disorders, etc.) may lead to profound respiratory depression from the drugs used in the perioperative period, and may require postoperative monitoring in a critical care setting. Potential *airway* problems are of particular concern to the anaesthetist, and must always be evaluated (see chapter 6: Intubation and Anatomy of the Airway).

Neuromuscular:

If the patient has an intracranial lesion, seek early signs and symptoms of *raised intracranial pressure* such as headaches, nausea, vomiting, confusion and papilledema. *Pituitary lesions* may cause endocrine abnormalities. A history of *TIA's* or *CVA's* suggests significant cerebrovascular disease. The anaesthetist should ask the patient about a history of *seizures*, and determine the type, frequency and time of last occurrence. Note any anticonvulsant medications the patient is receiving.

The patient with a history of *spinal cord injury* is at risk for a number of perioperative complications including respiratory failure, arrhythmias, autonomic hyperreflexia, hyperkalemia, pathologic fractures and pressure sores. It is important to document the date and level of the neurological injury, as the incidence of many of these complications are dependent on such variables. Patients with *lower motor neuron lesions* of any kind are at risk for unusual responses to anaesthetic drugs (see chapter 12: Muscle Relaxants - Succinylcholine), and regional anaesthesia should be considered only after careful documentation of the patient's nerve deficits.

Disorders of the *neuromuscular junction* such as myasthenia gravis, myasthenic syndrome, etc., will cause unpredictable responses to neuromuscular-blocking drugs. Lastly, patients with *muscular dystrophies* and underlying myopathies are known to have both an increased association with malignant hyperthermia and an increased risk of postoperative respiratory failure (see chapter 24: Uncommon Anaesthetic Complications - Malignant Hyperthermia).

Endocrine:
Patients with *diabetes mellitus* require careful management in the perioperative period, as the stress of surgery and perioperative fasting can cause marked swings in blood glucose. Diabetics frequently have widespread end organ damage involving the cardiovascular, nervous and renal systems.

Patients with *thyroid disease* may experience difficulties under anaesthesia. Profound hypothyroidism is associated with myocardial depression and exaggerated responses to sedative medications. Hyperthyroid patients are at risk for perioperative thyroid storm. Thyroid goitres may compress the airway and involve the recurrent laryngeal nerve leading to vocal cord palsy. These place the patient at risk for airway obstruction.

Patients with *phaeochromocytoma* are particularly challenging for the anaesthetist, surgeon, and internist involved in their care. These patients are at risk for extreme swings in blood pressure and heart rate in the perioperative period, and require intensive preoperative therapy with adrenergic blocking drugs. Patients at risk for *adrenal suppression* (history of exogenous steroid therapy) may not be able to increase their own corticosteroid production to match the imposed stress of surgery. The incidence of adrenal suppression is not predictable, and depends on the potency and frequency of steroid dose and on the length of steroid therapy. As a general rule, corticosteroid supplementation is provided for patients who have required steroids for more than one week in the last six months.

GI-Hepatic:
Patients with *hepatic disease* frequently present problems with fluid and electrolyte imbalance, coagulopathies and altered drug metabolism. Patients with *gastroesophageal reflux* (GER), as well as those at risk for GER, are prone to regurgitation of gastric contents and aspiration pneumonitis during the perioperative period (see chapters 9 & 24: Rapid Sequence Induction & Unusual Anaesthetic Complications - Aspiration Pneumonitis). These patients should receive anti-reflux prophylaxis preoperatively.

Renal:
Disorders of *fluid and electrolyte balance* are common in the perioperative period, and management of any possible electrolyte deficiency or excess may be part of the anaesthetic management of the patient. Generally all fluid and electrolyte disorders should be corrected prior to elective surgery.

Patients with *renal failure*, both acute and chronic, frequent the OR. The anaesthetist must be prepared to deal with their fluid and electrolyte disorders, dialysis requirements and altered drug metabolism. Pay careful attention to the patient's dialysis schedule, as important changes in blood volume and serum potassium levels occur pre- and post-dialysis. If possible, plan elective surgery so that the patient receives dialysis either the night before surgery, or on the morning of surgery. Patients with renal insufficiency are at risk for deterioration of their renal function, and