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Update in Anaesthesia

Education for anaesthetists worldwide

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The Journal of the World Federation of Societies of Anaesthesiologists

Update in
Anaesthesia

Editor's Notes

Welcome to *Update in Anaesthesia*, volume 25, number 1 that contains another selection of clinical overview articles of relevance to anaesthetists working in all types of healthcare settings around the world. The prime focus of *Update* has always been to provide educational materials to those with little access to other resources for whom the WFSA provide the printed version of each edition at no cost to the reader. The internet has lead to an expansion in our readership, now comprising anaesthetists from the full range of healthcare settings, who access the electronic version of the journal via the WFSA website, www.anaesthesiologists.org. We have traditionally targeted our articles to deal primarily with areas of anaesthesia and critical care that are less reliant on pharmaceutical and technological development, and this will not change. We will however try to cover the full scope of each topic, including recent advances that may not be appropriate to all healthcare settings, aiming to keep all anaesthetists informed of the development of our specialty globally.

Update free on the web

After several months spent finalising the layout and structure of the educational resources section of the WFSA website, the bulk of our archives of full editions and individual articles of *Update* are now available to view and download as PDF files. Tansel Tiknaz, under the guidance of Peter Kempthorne, has generated a user-friendly resource at www.update.anaesthesiologists.org which will give far easier access to our growing library of educational articles. The same site also houses the archive of *Anaesthesia Tutorial of the Week* that, for ease of use, utilises a similar organisational and browsing structure to *Update*. Articles, tutorials and editions can be browsed by topic or a Google-powered search engine can be used to search for certain words or terms of interest. Most of the individual articles are a small file size, however some of the newer editions of *Update* have are relatively larger files. Please contact me via email if you have any comments or suggestions regarding this section of the website.

Update 25,2

Update 25,2, scheduled for publication at the end of this year, will focus on emergencies in anaesthesia. The format for this edition will be to reproduce the best available guidelines and algorithms from around the world. Each algorithm will be accompanied by a commentary by an anaesthetist with expertise within that field, with particular attention paid to the appropriateness and usefulness of the algorithm in poor-resource settings. To our knowledge such a compendium of evidence-based guidelines from different learned societies around the world has not previously been published. We hope that this resource will be practically useful as a source of vital information that is immediately available to aid resolution of crisis situations in theatre.

World Anaesthesia Society

A brief word about the World Anaesthesia Society - members of the WAS were the driving force behind the development of *Update in Anaesthesia* during the 1990s and so, even though funding for publications has always come from the WFSA, the journal was published under the WAS banner. Although it remains true that WAS members contribute significantly to the production of *Update*, the journal has now been formally adopted as the official educational journal of the WFSA and hence the WAS logo has been removed. The WAS still exists and is thriving as a Specialist Society of the Association of Anaesthetists of Great Britain and Ireland (AAGBI). The major focus of the WAS activity is to organise twice-yearly seminars, one in early summer at the AAGBI and one as a lunch-time satellite seminar at the AAGBI Winter Scientific Meeting in London. We hope to establish a new homepage as part of the AAGBI's website in the near future.

I would be delighted to receive requests for topics to be covered in future articles that are of particular relevance to your practice and will endeavour to get these articles commissioned as soon as possible. If you have an area of interest and expertise that you feel you could write about, please consider writing and submitting an article. We continue to receive a variety of communications describing original audit and research work, some of which are published in this edition.

I hope that this edition of Update proves useful. If you live and work in a country with limited resources please apply to Carol Wilson by email (worldanaesthesia@mac.com) or by mail to Dr Bruce McCormick, Department of Anaesthesia, Royal Devon and Exeter NHS Foundation Trust, Barrack Road, Exeter, Devon EX2 5DW, UK to receive the printed version of future editions of *Update*.

Bruce McCormick
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News from the WFSA

The WFSA - one year on

It is just over one year since the World Congress in Cape Town and time to review what has been achieved in that time.

Communication

A major effort has been undertaken to improve communication with member societies. We have a new and much improved website (www.anaesthesiologists.org) thanks to our webmaster, Dr Peter Kempthorne of New Zealand. With help from colleagues throughout the world, most items are translated into French, Spanish and Chinese. Reports and items of interest are updated frequently. Important links to other groups are maintained. In particular, it is very easy to access our educational publications. If you have ideas and suggestions for the website, please let us know.

Instead of producing our own newsletter, the WFSA now sends out regular updates for publication in society newsletters throughout the world. This has proved to be very effective with some societies publishing the bulletin on their website.

Education

Dr Jannicke Mellin-Olsen of Norway, Chair of the Education Committee, has continued the work with training centres and two more should open later this year. The second International School for Instructors in Anesthesiology (ISIA) will begin in October. The 'spin-off' from the first school has been fantastic with each set of graduates developing courses and workshops in their own countries.

Publications

Dr Iain Wilson, Chair of Publications, will also write a Newsletter update later this year. The activity of this committee continues to grow and *Update in Anaesthesia* goes from strength to strength. The weekly, peer-reviewed, *Anaesthesia Tutorial of the Week*, is very popular and easily accessed through our website. Plans are in hand to produce a textbook of anesthesia suitable for use in less well-resourced environments.

Safety and Quality

The last News from the WFSA described the activities of this committee led by Professor Alan Merry. The focus on providing pulse oximeters, wherever anesthesia is given, continues. Together with our partners in the World Health Organization, we will be commencing pilot projects in October.

Scientific Committee

Professor Philippe Scherpereel has been busy getting this committee started. His first project was to mentor a group in St Petersburg, Russia, to develop their own malignant hyperthermia laboratory. He has also begun a programme of WFSA Symposia at major regional congresses.

Professional Wellbeing

Dr Gastao Duval Neto of Brazil is leading a working group looking at issues related to professional wellbeing. These are assuming even greater importance than before due to the stressful environments in which we work. This group will be bringing forth suggestions as their work progresses.

Other Activities

Under this heading we can mention a whole variety of activities.

- With financial assistance from Baxter, we have organized a scholarship programme for young African anesthesia providers to attend the 4th All Africa Anesthesia Congress in Nairobi, Kenya.
- We have made contact with many other world organizations, such as our sister world society in obstetrics and gynecology, FIGO, with the object of finding out what we can do to work together to improve maternal health. The Chair of our obstetric committee, Dr Paul Howell, will be presenting at their world congress later this year so we hope this will lead to major cooperation between the two societies.
- We continue to work with WHO on a variety of issues as well as pulse oximetry, including essential care at the district hospital, requirements for a department of anesthesia and publications.
- WFSA has presented a report on its activities at the Working Group on the Global Burden of Surgical Disease where it was well received. We have embarked on several cooperative activities with this group which also includes WHO representatives, surgeons and public health experts.

So overall it has been a busy and productive year. As always we are grateful to Ruth Hooper in our London office who keeps everything running smoothly. We love to hear from our members so please feel free to contact any of the officers or Mrs Hooper at wfsahq@anaesthesiologists.org with suggestions, comments or new ideas.

Angela Enright
President
World Federation of Societies of Anaesthesiologists

Editorial

Guest Editorial

The World Health Organization Patient Safety Global Pulse Oximetry Project

The WHO Surgical Safety Checklist was published in 2008 following the World Health Organization's Safe Surgery Saves Lives project led by Atul Gawande.[1] Several WFSA member societies have championed the use of the checklist, and in a number of countries, including the UK, the checklist is being introduced to all hospitals. Evidence to support the use of the checklist to improve surgical safety was published earlier this year in the *New England Journal of Medicine*.[2]

One requirement of the checklist is that a pulse oximeter is attached to the patient before induction of anaesthesia, and saturation monitoring is continued until the patient has recovered consciousness. This practice is routine in many countries, where oximetry is mandatory during anaesthesia, but is difficult to achieve in other countries where there are limited resources. In recognition of the fact that anaesthesia safety is a key element of surgical safety, the WHO Global Pulse Oximetry Project was started in 2009 so that every operating theatre in the world can be equipped with a pulse oximeter. An international expert group selected by the WHO has produced specifications for a robust, high quality, low cost oximeter. An oximeter will be selected and tested towards the end of 2009, following the WHO tendering process. It is hoped that purchasing arrangements will be in place during 2010. The project will also address the logistics of introducing new equipment to the hospital setting including maintenance and supply of spare parts, replacement probes and batteries - all regular problems in many rural hospitals.

The WFSA has been particularly active in producing training materials for the project. Materials will be supplied in a variety of formats and will include a manual, e-learning and a video. It will be possible to use the resources for self-learning or they can be taught in the classroom. We plan to pilot the training materials during workshops at the All Africa Anaesthesia Meeting in Nairobi in September 2009, and they will be translated into French by Dr Isabelle Murat and Spanish by Dr Gonzalo Barreiro. Other language versions are also planned. The provision of education alongside the introduction of oximetry is important and a systematic approach has been developed that will help practitioners to quickly identify and manage causes of hypoxia and low perfusion in the anaesthetized patient. Additionally, it will be important to train users in basic maintenance of equipment to ensure longevity of the monitors.

This ground-breaking project will save many lives in areas of the world where resources are challenged and mortality from anaesthesia may be very high.[3] However, for the project to succeed we need to ensure that demand for oximeters is realized, particularly in parts of the world where anaesthetists routinely work without them. This will need hospitals, Ministries of Health and international donors to recognise the importance of the WHO Global Oximetry Project for perioperative safety. Anaesthetists will be key to raising the profile of this project nationally in their countries, but also locally within their hospitals and communities. Surgeons, obstetricians and patients will also need to assist in the advocacy of the project.

More information about the project can be found on the WHO website which will continue to be updated as developments take place.[4]

This project is without doubt the largest anaesthesia safety initiative ever undertaken, and we call for all WFSA member societies to put their energies behind it to ensure success. In time, the use of pulse oximeters will spread beyond the operating theatre and benefit many other patients.

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Update in
Anaesthesia

Thoracic Paravertebral Block

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Summary
The thoracic paravertebral block was first described in the treatment of chronic pain. More recently, the technique has also been used to provide surgical analgesia for a variety of applications, including thoracic, breast, and general surgery. It is possible to provide analgesia lasting into the postoperative period, and certain procedures may be performed without the need for general anaesthesia.

INDICATIONS

Thoracic paravertebral block (PVB) can afford considerable analgesia for a range of surgical operations where the afferent input from the chest wall is largely unilateral.

This includes:

- **Thoracic surgery** – thoracotomy, lung resection, pleuradesis etc,
- **Breast surgery** – mastectomy, wide local excision with or without axillary clearance, breast reconstruction and breast augmentation,
- **General surgery** – open cholecystectomy, herniorrhaphy,
- **Trauma** – fractured ribs.

Paravertebral blocks have been used for some time and are well established in thoracic surgery. However, they commonly employ a catheter placed by the surgeon at the time of operation, under direct vision. There has been recent interest in the role paravertebral blocks in the anaesthetic management of other surgical specialties, particularly in breast surgery. Surgical treatment for cancer is common and, although general anaesthesia is not usually a problem, postoperative pain and nausea are common and contribute to delayed recovery. There are a number of randomised trials showing improved analgesia and reduced opiate requirements with PVB compared to general anaesthesia and wound infiltration.[1] It has also been suggested that PVB may reduce the incidence of chronic pain after major breast surgery.[2,3] Other authors have successfully used PVB as an alternative to general anaesthesia, allowing a reduction in recovery intervention and the potential for substantial cost savings.[4,5] Finally, there are also a limited number of individual case reports describing the avoidance of general anaesthesia by employing PVB for anaesthesia in patients with significant co-morbidities. This option facilitates palliative surgery or surgery for patients with severe concurrent disease and is an important consideration.

ANATOMY OF THE PARAVERTEBRAL SPACE

The thoracic paravertebral space is triangular in shape and found adjacent to each vertebral body along the spinal column (Figure 1). The space is defined medially by the vertebral body and the intervertebral disc and foramina, antero-laterally by the pleura and posteriorly by the superior costotransverse ligament, running between adjacent transverse processes. Above and below, the space communicates freely with adjacent levels. The paravertebral space is also in communication with the vertebral foramina. The ventral and dorsal primary rami traverse the space, carrying sensory afferents and form the spinal nerves. In addition, the space contains the sympathetic trunk which communicates with the spinal nerves via the gray and white rami communicantes. Thus local anaesthetics introduced into this space may produce sensory, motor and sympathetic blockade over several dermatomes.

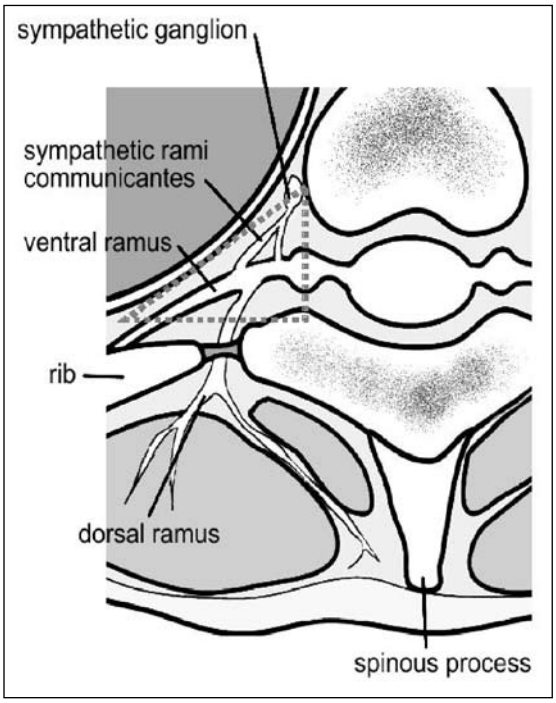

Figure 1. *A sagittal section through the spinal column, demonstrating the contents and position of the paravertebral space (dotted grey line)*

Thoracic PVB produces analgesia by blockade of the sensory input via the ventral and dorsal primary rami of the thoracic spinal nerves. The ventral primary rami afferents carry sensation via the intercostal nerves. The

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anterior and lateral cutaneous branches of the intercostal nerves supply the chest wall anteriorly and laterally.

TECHNIQUE FOR PVB

Obtain consent before starting. It is essential to ensure that full resuscitation facilities are available and that monitoring including ECG, pulse oximetry and blood pressure measurement is in place. Intravenous access should be secured.

Equipment

Skin preparation (e.g. chlorhexadine 2%), skin marker, Tuohy needle (22G), extension tubing, 20ml Leur-lock syringe, 0.5% bupivacaine (Figure 2).

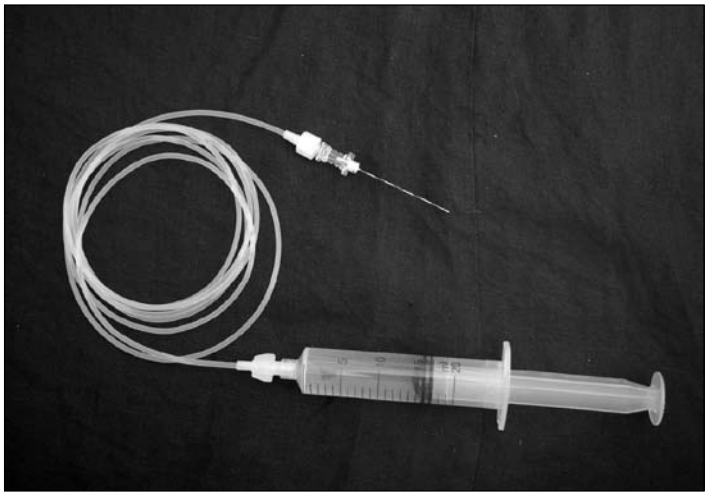

Figure 2. *A 20ml Leur-lock syringe and primed extension tubing connected to a 22G Tuohy needle*

PVB may be performed awake, in which case the sitting position may be preferable, or with the patient anaesthetised in the lateral position. The site of surgery determines the level of PVB as shown in Table 1.

Table 1. *Dermatomal sites for different surgical procedures*

Surgery	Dermatomes	Level of PVB
Thoracotomy	T3 – T9	T3 – T9
Breast surgery	T1 – T6	T1 – T5
Cholecystectomy	T4 – L1	T6 – T12
Inguinal herniorrhaphy	T10 – L2	T10 – L2

Use the scapula and the processus prominens as landmarks. The processus prominens is the most prominent upper thoracic vertebral prominence and is the spinous process of T1. The most inferior palpable part of the scapula lies at the level of T7.

Locate the spinous processes corresponding to the required levels of block and make a mark 2.5cm lateral to each of them (Figure 3). Under aseptic conditions, a skin wheal of local anaesthetic is placed at each mark. If sedation is used, then supplemental oxygen should be administered.

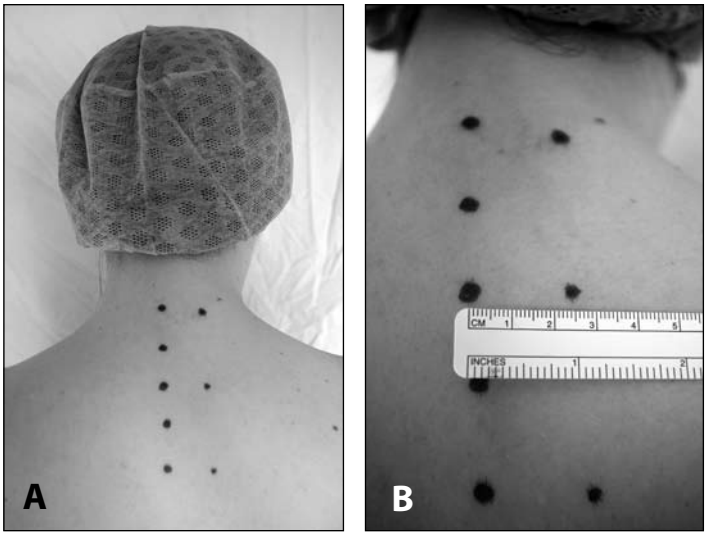

Figure 3. *(A) The spinous processes of T1–T5 are marked. (B) Skin puncture sites 2.5cm lateral to T1, T3 and T5 are also shown*

A 22G Tuohy needle is used, connected to a 20ml syringe by extension tubing. The extension tubing and needle are flushed with local anaesthetic solution prior to insertion. The skin is pierced at the point marked and directed perpendicular to the skin surface. The transverse process is usually contacted at a depth between 2 to 5cm. (Figures 4 and 5). To avoid pushing the needle to far, it can be grasped at a suitable point along its length.

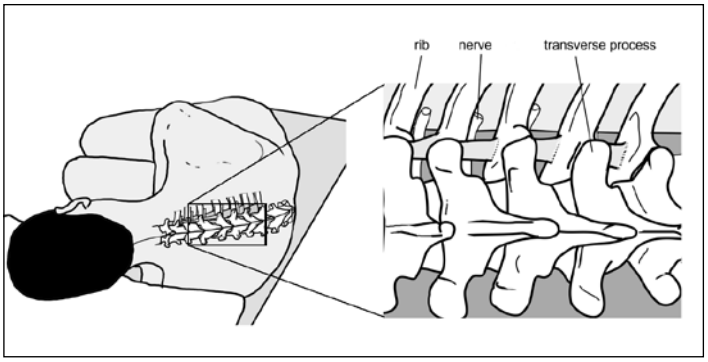

Figure 4. *Patient under general anaesthesia positioned for paravertebral block. The superior costotransverse ligament lies between the transverse process and the rib below*

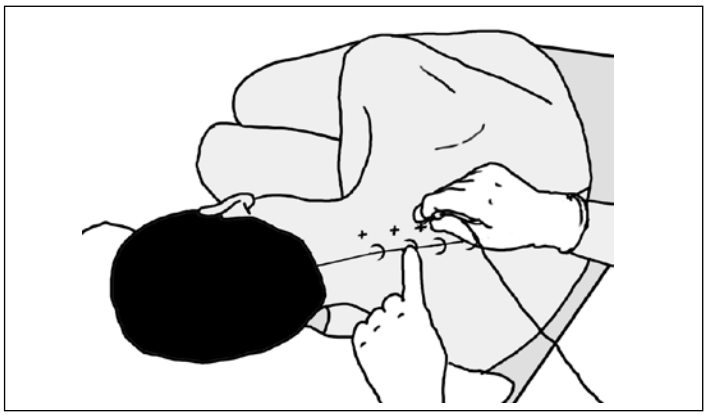

Figure 5. *Showing needle entry 2.5cm lateral to the adjacent spinous process*

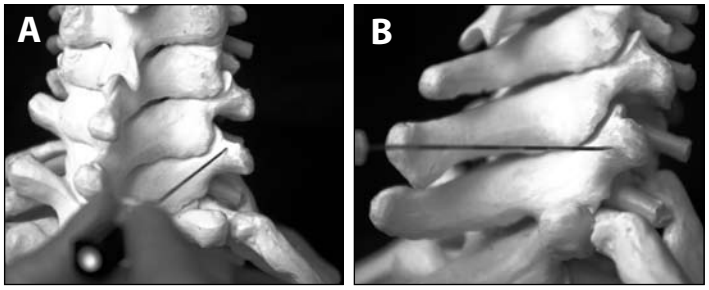

Figure 6. *Showing the needle contacting the spinous process*

If bone is not contacted, the needle should be withdrawn and re-directed superiorly, and if still not successful, inferiorly.

When the needle contacts bone (Figure 6), the depth is noted, the needle is then withdrawn and re-directed inferiorly to 'walk-off' 1cm past the inferior edge of the transverse process (Figure 7). A 'click' can sometimes be felt as the needle passes through the superior costotransverse ligament. It is imperative to locate the transverse process before advancing the needle any further to prevent inadvertent pleural puncture.

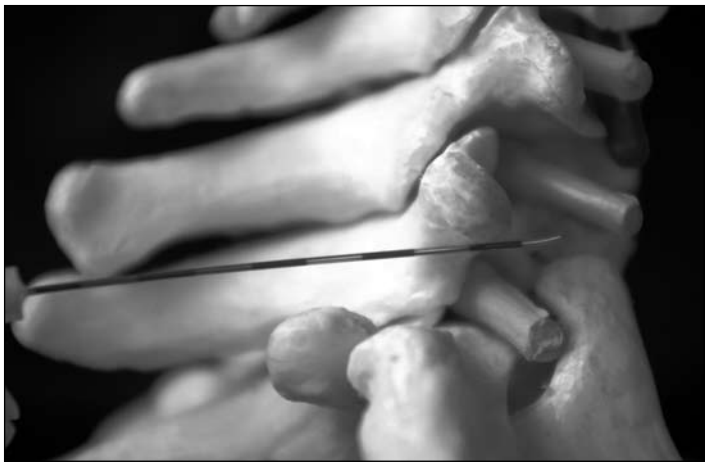

Figure 7. *'Walking off' the inferior edge of the transverse process and advancing 1cm*

Medial redirection should be avoided because of the risk of neuroaxial blockade. Following aspiration to exclude intrathecal or intravascular placement, local anaesthetic can be injected. The classic technique described by Moore and Katz, involves repeating the block at each required level, depending on the surgical site involved. This can be modified by performing a block at every other level, or one single injection.

For major breast surgery, a block from T1–T6 is required. This can be performed with multiple injections of 4ml 0.5% bupivacaine at each level, or 7ml injections at T1, T3 and T5. Alternatively a single injection of 15ml of 0.5% bupivacaine will produce a unilateral somatic block over 3 to 4 dermatomes, and can produce satisfactory analgesia depending on the incision. However for wider dermatomal spread multiple injection sites are more reliable and the authors suggest a compromise by performing the block at every second level.

The procedure normally takes between 5 and 15 minutes and is simple to perform. Surgical analgesia usually occurs within 20–30 minutes.

To increase the duration of the block it is possible to insert a catheter and run a continuous infusion or administer intermittent boluses of local anaesthetic.

ADVANTAGES OF PVB

- Simple and quick to learn
- Avoids the potential complications of a thoracic epidural
- Reduced postoperative pain
- Lower postoperative analgesic requirements
- Reduced postoperative nausea
- Reduced incidence of chronic pain after breast surgery.

CONTRAINDICATIONS

Absolute

- Cellulitis or cutaneous infection at site of needle puncture
- Empyema
- Tumour occupying the paravertebral space
- Allergy to local anaesthetic drugs.

Relative

- Coagulopathy
- Kyphoscoliosis - deformity may predispose to pleural puncture
- Previous thoracotomy - scarring may cause adhesions to the parietal pleura and increase the risk of pneumothorax.

COMPLICATIONS

- Sympathetic blockade and hypotension
- Horner's syndrome is frequent, short duration and of no lasting consequence, but patients should be warned. Incidence is between 5 and 20%
- Vascular puncture
- Haematoma
- Pneumothorax. The incidence is between 0.01 to 0.5%. Risk of bilateral pneumothorax should be considered if performing bilateral blocks. If pleural puncture occurs, a chest radiograph should be obtained to exclude pneumothorax A chest radiograph is not routinely required otherwise.
- There is one single report of a haemothorax, using a loss of resistance technique.[6]

FINAL REMARKS

Variations on this technique have been described, including the use of a low resistance syringe to identify the paravertebral space via a loss of resistance. Use of nerve stimulation has been described with good results using an initial current of 3-5mA. It is suggested that as the movements are difficult to see an assistant places a hand in the axilla to feel movement of the intercostal muscles. Lastly, there is increasing interest in the use of ultrasound, firstly to identify and measure the depth to the paravertebral space and secondly to perform the block under real-time ultrasound, which requires a curvilinear probe.[7]

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Update in
Anaesthesia

Acute Pancreatitis - A Clinical Overiew

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Summary
Severe acute pancreatitis can be a devastating illness. The principles of management are mainly supportive therapy, however it is vital that the patient benefits from strict attention to detail in their daily critical care management. Rapid recognition and instigation of therapy for complications, such as infection, bleeding or obstruction can lead to good outcomes.

INTRODUCTION

Acute pancreatitis is characterized by upper abdominal pain and elevated levels of pancreatic enzymes in the blood. This is associated with varying degrees of endocrine and exocrine dysfunction.

The disease may be mild and self-limiting or may rapidly progress to multi-organ dysfunction (MODS) with or without sepsis, and ultimately to death. It is usually possible to establish a cause that is treatable.

Management of the more severe forms is labour- and resource-intensive and very time-consuming, but long-term follow-up reveals a good quality of life, although many suffer from long-term exocrine and endocrine problems.

CAUSES AND PATHOGENESIS

The pathogenesis of pancreatitis is not fully understood. Of the numerous conditions known to cause pancreatitis (see Table 1), gallstones and chronic alcohol abuse account for 75 percent of cases in the United States. There is great geographical variation and the degree of inflammatory response to certain causative agents may have genetic predisposition, making prognosis different in various ethnic groups. For example, alcoholic pancreatitis in Soweto, South Africa has a high mortality.

The mortality in the first two-week period is usually due to systemic inflammatory response syndrome (SIRS) and organ failure; thereafter it is usually due to sepsis and its complications.

Advances in diagnostic and therapeutic interventions have lead to a decrease in mortality from acute pancreatitis, especially in those with severe, often necrotizing, pancreatitis. While the overall mortality in all hospitalized patients with acute pancreatitis is approximately 10 percent, the mortality in the subset with severe acute pancreatitis may be as high as 30 percent.

Mechanical obstruction to the ampulla can be caused by a number of different conditions, but is most commonly caused by the passage of a gallstone

Table 1. *Causes of acute pancreatitis*

Mechanical	Gallstones, biliary sludge, ascariasis, ampullary or peri-ampullary cancer, duodenal stricture or obstruction
Toxic	Ethanol, methanol, venom
Metabolic	Hyperlipidaemia, hypercalcaemia
Drugs	HIV therapy, e.g. didanosine, pentamidime Antibiotics, e.g. metronidazole, tetracyline Diuretics, e.g. thiazides, furosemide Immunosupressive, e.g. aziathiaprine Neuropyschiatric, e.g. valproate Anti-inflammatories, e.g. salicylates
Infection	Viruses, e.g. Coxsackie, Mumps, Hepatitis B, HIV, HSV Bacteria, e.g. Mycoplasma, Legionella, Leptospira Fungi, e.g. Aspergillus Parasites, e.g.Toxoplasma, Cryptosporidium
Trauma	Blunt abdominal, iatrogenic e.g. ERCP
Congenital	Anatomical defects
Vascular	Ischaemia, vasculitis
Misc	Hypothermia, pregnancy, post renal transplant

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through from the common bile duct. Cholecystectomy and clearing the common bile duct of stones prevents the recurrence of the disease.

Approximately 10 percent of chronic alcoholics develop attacks of clinically acute pancreatitis that are indistinguishable from other forms of acute pancreatitis. Alcohol may act by increasing the synthesis of enzymes by pancreatic acinar cells to synthesize the digestive and lysosomal enzymes that are thought to be responsible for acute pancreatitis.

Causes such as hyperlipidaemia (often co-existing with alcoholism) and drug induced pancreatitis can usually be identified from the history, but the diagnosis should only made having carefully excluded biliary disease.

Up to 30% of attacks may still be unexplained following normal biochemical and ultrasound investigation. The recurrence rate in this group of patients is rare. Further extensive investigation is probably not indicated.

CLINICAL FEATURES

Acute pancreatitis is an important cause of acute upper abdominal pain. Because its clinical features are similar to a number of other acute illnesses, it is difficult to base a diagnosis only on symptoms and signs. The disease varies in severity and the diagnosis is often missed.

Demographics

- Acute gallstone pancreatitis is more common in women, acute alcoholic pancreatitis is more common in men
- Incidence increases with age
- Pancreatitis in the first two decades indicates infection (mumps) or a hereditary cause such as hyperlipidaemia.

Symptoms

- Acute upper abdominal pain - epigastric, diffuse or right-sided
- Often preceded by some episodes of biliary colic after a meal
- Often starts two to three days after cessation of drinking alcohol heavily
- Onset can be quite rapid but not as rapid as a perforated viscus, and can last for days
- 50% patients have a band-like radiation to the back
- Associated with nausea and vomiting, agitation and restlessness
- Can be relieved by bending forward
- Can present as coma and shock
- Sufferers usually seek medical help.

Physical signs

- Varying clinical signs depend on disease severity
- From mild epigastric tenderness to distension, guarding and rebound. Often seems less impressive than degree of patients discomfort
- Discolouration in the flank (Grey-Turner's sign) or the periumbilical region (Cullen's sign) occurs in 1% of cases but is not diagnostic. These signs reflect retroperitoneal haemorrhage and are associated with a poor prognosis.
- Obstruction of the common bile duct, due to gallstones or oedema of the head of the pancreas, can lead to jaundice
- An epigastric mass due to pseudocyst formation may become palpable in the course of the disease
- There may also be findings of underlying disorders such as hepatomegaly in alcoholic pancreatitis, xanthomas in hyperlipidemic pancreatitis, and parotid swelling associated with mumps
- Focal chest signs for pleural effusions.

INVESTIGATIONS AND SEVERITY SCORING SYSTEMS

Acute pancreatitis can be suspected clinically, but requires biochemical and radiology tests to confirm the diagnosis. Clinical, biochemical and radiological features need to be considered together since none of them alone is diagnostic of acute pancreatitis.

Most attacks of acute pancreatitis are mild, with recovery occurring within five to seven days. Death is unusual in such patients. In contrast, severe necrotizing pancreatitis is associated with a high rate of complications and significant mortality. A subgroup of patients develop early severe acute pancreatitis, characterized by extended pancreatic necrosis with organ failure at admission. Identification of this group is vital.

Early detection of this high-risk group has led to the development of scoring systems to help identify those who will require a higher degree of intervention.

Biochemical tests

Pancreatic enzymes

Early in the acute phase of an attack, there is continued synthesis of pancreatic enzymes, but their exocrine secretion is obstructed. As a result these enzymes are released into the systemic circulation. Other organs also release these digestive enzymes, resulting in false positives tests.

Serum amylase rises within 6–12 hours of an acute attack and is rapidly cleared from the circulation. It is usually elevated for 3-5 days during an acute attack. It is also elevated in other conditions such as visceral perforation, so cannot be used alone in the diagnosis. It is also known that daily measurement of these enzymes is a poor predictor of clinical progress or prognosis. In severe cases, with marked necrosis production and serum levels of amylase may be normal.

Other enzymes are elevated but have no real advantage over amylase. They include *serum lipase* and *urinary amylase*.

Markers of immune activation/inflammation

A C-reactive protein level greater than 150mg.dl^{-1} at 48hrs can discriminate severe from mild disease.

Radiological features

Abdominal plain X-ray

- Important as can exclude bowel obstruction or perforation
- Often unremarkable in mild disease
- Localised ileus in small bowel represents "sentinel loop" sign
- "Colon cut-off" in severe disease represents spasm of descending colon from localised pancreatic inflammation at splenic flexure.
- 'Ground glass' appearance may represent ascites.

Chest X-ray

- Look for elevated hemidiaphragm, pleural effusion, atelectasis or features of ARDS
- Bilateral pleural effusions are indicators of severe disease

Abdominal USS

- Excellent for the detection of gallstones and biliary tree obstruction
- Often limited by presence of overlying bowel gas
- Unable to accurately assess degree of pancreatitic inflammation

CT Scan

- Most important test for establishing diagnosis of pancreatitis, establishing severity and detecting complications

Table 2. *Ranson criteria to predict severity of acute pancreatitis*

0 hours	
Age	>55
White blood cell count	>16,000mm^{-3}
Blood glucose	>200mg.dl^{-1} (11.1mmol.l^{-1})
Lactate dehydrogenase	>350u.l^{-1}
Aspartate aminotransferase (AST)	>250u.l^{-1}
48 hours	
Hematocrit	Fall by 10 percent
Blood urea nitrogen	Increase by 5mg.dl^{-1} (1.8mmol.l^{-1}) despite fluids
Serum calcium	<8mg.dl^{-1} (2mmol.l^{-1})
PaO_2	<60mmHg (7.9kPa)
Base deficit	>4mEq.l^{-1}
Fluid sequestation	>6000ml

The presence of 1 to 3 criteria represents mild pancreatitis; the mortality rate rises significantly with four or more criteria. Adapted from Ranson JHC, Rifkind KM, Roses DF,et al. Surg Gynecol Obstet 1974; 139: 69.

- Patients should be scanned after 48 hrs, with oral and intravenous contrast. This enables an estimation of degree of unenhanced pancreatic necrosis.

Alcoholic versus gallstone pancreatitis

The differentiation between alcoholic and gallstone pancreatitis has important therapeutic implications, since elimination of the cause in either condition may prevent further attacks. Recurrent attacks of acute pancreatitis suggest an alcoholic aetiology, but patients who have unrecognized gallstones may have recurrent biliary colic, pancreatitis, or cholecystitis. Thus, removing the gallbladder in biliary pancreatitis is imperative. For this reason, abdominal ultrasonography should be performed in every patient with a first attack of acute pancreatitis, to search for gallstones in the gallbladder.

SEVERITY SCORING SYSTEMS

A number of disease-specific scoring systems have been developed, but none are ideal.

Clinical assessment of severity

Clinical assessment looking for signs of shock, peritonitis and respiratory failure is just as effective, although this only detects approximately 40-50% of cases of severe acute pancreatitis. The two most popular scoring systems are the Ranson and Glasgow scales, which can only be completed 48 hours after onset of symptoms and can only be used once.

Table 3. *Glasgow system to predict severity of acute pancreatitis*

Poor prognostic factors in patients with acute pancreatitis	
White blood cell count	>15,000mcl^{-1}
Serum glucose concentration	>180g.dl^{-1} (10mmol.l^{-1}) with no history of diabetes
Blood urea nitrogen	>45mg.dl^{-1} (16mmol.l^{-1}) with no response to fluids
PaO_2	<60mmHg (7.9kPa)
Serum calcium concentration	<8mg.dl^{-1} (2mmol.l^{-1})
Serum albumin concentration	<3.2g.dl^{-1} (32 g.l^{-1})
Lactate dehydrogenase	>600u.l^{-1}
Aspartate aminotransferase (AST)	>200u.l^{-1}

The presence of three or more of these criteria within the first 48 hours is indicative of severe pancreatitis. Adapted from: Corfield AP, Williamson RCN, McMahon MJ et al. Lancet 1985; 24: 403

CT Scan assessment of severity

Table 4. *CT findings and grading of acute pancreatitis (CT severity index - CTSI) CT severity index equals unenhanced CT score plus necrosis score: maximum = 10, 6 = severe disease. Adapted from Balthazar EJ, Robinson DL, Megibow, AJ, Ranson JH. Radiology 1990; 174: 331.*

Grading based upon findings on unenhanced CT

Grade	Findings	Score
A	Normal pancreas - normal size, sharply defined, smooth contour, homogeneous enhancement, retroperitoneal peri-pancreatic fat without enhancement	0
B	Focal or diffuse enlargement of the pancreas, contour may show irregularity, enhancement may be inhomogeneous but there is no peripancreatic inflammation	1
C	Peripancreatic inflammation with intrinsic pancreatic abnormalities	2
D	Intrapancreatic or extrapancreatic fluid collections	3
E	Two or more large collections of gas in the pancreas or retroperitoneum	4

Necrosis score based upon contrast enhanced CT

Necrosis, percent	Score
0	0
<33	2
33-50	4
≥50	6

CLINICAL MANAGEMENT

The clinical management of severe acute pancreatitis (SAP) relies on a number of key points:

1. Early recognition of severe disease, which has a higher mortality.
2. Fluid resuscitation and organ support with appropriate monitoring.
3. Pain management.
4. Removal of underlying predisposing cause e.g. gallstones.
5. Prevention and early recognition of complications.
6. Nutrition.
7. Novel therapies.
8. Surgical intervention where indicated.

Many organisations have issued guidelines to simplify the management of SAP, most are very similar although some have different views on specific issues relating to the prevention of infection (see below).

Early recognition of severe disease

The main determinants of poor outcome are the degree of necrosis (may be limited by better fluid management) and the development of ongoing organ failure. Clinical assessment should focus on the early detection of organ dysfunction with frequent monitoring of vital signs. This should be directed at evaluation of intravascular volume status and the early detection of hypoxemia with pulse oximetry or blood gas analysis.

Although there are a number of disease-specific scoring systems (described in Tables 2 - 4 above), frequent clinical assessment is the gold standard. Elevated serum biomarkers such as C-reactive protein do seem to be associated with disease severity or prognosis. However there is a delay of approximately 48 hrs, limiting its role as an early predictor.

Finally, appropriate radiological investigations are important. Ultrasound will determine whether gallstones are present or whether the stone has passed with the detection of a dilated biliary tree. CT scan with contrast will allow an estimation of the degree of pancreatic necrosis. A degree of necrosis greater than 30% is associated with a higher rate of complications and a worse outcome.

Fluid resuscitation and organ support with appropriate monitoring

SAP causes disruption of the pancreatic ducts. There is subsequent exudation of non-specific serine proteases into the peritoneum and subsequently the plasma. This causes activation of the kinin, coagulation and cytokine cascades, inducing a marked systemic pro-inflammatory response. The microcirculation is disrupted, exudation of intravascular fluids and inflammatory cells occurs, and severe hypovolemia follows. In the absence of adequate fluid resuscitation and cardiovascular optimisation this will result in tissue ischaemia and regional hypoperfusion and end-organ damage.

Invasive monitoring of the arterial and central venous pressures to guide fluid resuscitation is considered mandatory, if available. Regular measurement of oxygen saturations and hourly urine volume may enable early detection of pulmonary and renal dysfunction. Fluid resuscitation is particularly important because patients with necrotizing pancreatitis may accumulate vast amounts of fluid in the injured pancreatic bed. Approximately 250 to 300 ml of intravenous fluids per hour are required for 48 hours if the patient's cardiac status permits. Inadequate fluid can lead to a worsened degree of pancreatic necrosis. Direct myocardial depression can result from the disease process, occasionally necessitating the introduction of dobutamine to aid splanchnic perfusion, which is particularly susceptible to hypoperfusion in SAP, although there is no evidence of a mortality benefit.

The optimal resuscitation fluid for acute pancreatitis, crystalloid (salt) or colloid (protein- or starch-containing), isotonic or hypertonic, has not been clarified from existing trials.

Effective pain control

Severe abdominal pain is the main symptom and adequate analgesia is essential. This can be provided by systemic opioids (usually using patient controlled analgesia – PCA) or thoracic epidural.

Traditionally there has been some concern over sphincter of Oddi spasm with morphine, but recently this has been shown to be clinically irrelevant. Either morphine or fentanyl delivered as a PCA or continuous infusion is acceptable. Regular paracetamol and non-steroidal anti-infammatory drugs may be used.

Removal of underlying predisposing cause

Patients with gallstone pancreatitis with obstructive jaundice or biliary sepsis should have ERCP (endoscopic retrograde cholangio-pancreatography) and an endoscopic papillotomy.

Prevention and early detection of complications

Infection

The most serious complication is local pancreatic infection, occurring in approximately 30% of patients with SAP. It is generally regarded as a late complication. The important organisms causing infection in necrotizing pancreatitis are predominantly gut-derived, including Escherichia coli, Pseudomonas, Klebsiella, and Enterococcus. The majority of infections (about 75 percent) are monomicrobial. Fungal and gram-positive organisms are uncommon, and have been associated with prolonged antibiotic use. It is not clear whether fungal infection has worse outcomes than gram-negative infection.

Common strategies to limit infection include:

- Enteral feeding, which limits line sepsis, maintains gut integrity and limits bacterial translocation
- Selective decontamination (SDD) of the digestive tract with non-absorbable antibiotics
- Prophylactic systemic antibiotics.

The role of systemic antibiotics remains controversial despite a large number of studies. Results have been inconclusive, probably due to the heterogeneity of the patient population, and due to poor tissue penetration of some of the antibiotics used in earlier trials. Current practice is to give intravenous antibiotics with good pancreatic penetration, such as meropenem, in the presence of organ failure or shock. The duration of therapy tends to be 7 days. Clinicians should be aware of the possibility of a higher rate of infection with fungal or resistant organisms, with prolonged courses of systemic antibiotics.

Nutrition

Adequate nutrition is vital in the critically patient with severe disease. In SAP most patients have abdominal pain and ileus is common. There is a concern that enteral feeding may stimulate pancreatic secretion, therefore worsening auto-digestion. Studies are revealing that enteral feeding is safe and may reduce complications. Pancreatic enzyme release is inversely proportional to the distance from the pylorus, when patients are fed distal to the ligament of Treitz (connects the duodenum to the diaphragm at the junction of the 2nd and 3rd parts of duodenum). There is some evidence that jejunal feeding does not stimulate the pancreas at all.

The advantages of enteral feeding are the maintenance of gut integrity, reducing bacterial translocation and the avoidance of intravascular dwelling catheters.

Placement of naso-jejunal tubes can be difficult due to pancreatic swelling and obstruction, and may require endoscopic or fluoroscopic guidance.

A recent study has suggested the concern over gastric feeding causing pancreatic secretion is unjustified and nasogastric feeding may well be as safe and beneficial, if tolerated.[1]

Novel medical therapies

The protease inhibitor gabexate mesilate and the somatosatin analogue octreatide were both the subject of recent meta-analyses.[2] They both showed a modest benefit, but these therapies are unlikely to be regarded as cost-effective.

In randomized studies, a number of other measures have been shown to be ineffective. These include nasogastric decompression, histamine H_2-receptor antagonists, anticholinergics, glucagon, and plasma and peritoneal lavage.[3] A platelet activating factor antagonist, lexipafant, improved mortality in an initial study but not in a subsequent larger trial and is therefore not currently recommended.[4]

Surgical or radiological drainage

If a patient remains unwell or clinically deteriorates, developing organ failure and signs of sepsis, the patient must undergo CT scanning with contrast to exclude infection of the pancreatic bed or a significant collection. There may be another source of sepsis.

The former practice of early open debridement or necrosectomy is no longer considered optimal. The current trend is for conservative management with repeated CT-guided microbiological sampling with subsequent antimicrobial therapy or attempted radiological drainage. Often these long-term patients have multiple abdominal drains.

Some patients, treated conservatively, may still require delayed surgical intervention for management of disconnected duct (disruption of pancreatic duct due to necrosis) which may lead to recurrent pancreatitis and/or fluid collections. Growing experience suggests that such an approach may be associated with a reduction in mortality.

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Update in
Anaesthesia

Pulmonary Function Tests and Assessment for Lung Resection

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Summary

This article describes the steps taken to evaluate patients' fitness for lung resection surgery. Examples are used to demonstrate interpretation of these tests. It is vital to use these tests in conjunction with a thorough history and examination in order to achieve an accurate assessment of each patient's level of function. Much of this assessment for surgery will be conducted by the surgeon and a multidisciplinary team. Involvement of the anaesthetist at an early stage and good communication with the surgeon are important. The particular features of each patient and their disease dictate the extent of surgery and therefore the requirements for their perioperative care.

INTRODUCTION

The aim of this article is to describe the tests available for the assessment of patients presenting for lung resection. The individual tests are explained and we describe how patients may progress through a series of tests to identify those amenable to lung resection.

Pulmonary function testing is a vital part of the assessment process for thoracic surgery. However, for other types of surgery there is no evidence that spirometry is more effective than history and examination in predicting postoperative pulmonary complications in patients with known chronic lung conditions. Furthermore specific spirometric values (e.g. the FEV_1) cannot be taken as prohibitive for non-cardiothoracic surgery.[1-3] Exercise testing of cardiopulmonary reserve is increasingly used to assess patients undergoing major surgery.

In addition to preoperative assessment for lung resection surgery, pulmonary function testing is also indicated for assessing suitability for coronary artery bypass grafting and to formally diagnose chronic obstructive pulmonary disease (COPD).

THE ROLE OF LUNG RESECTION IN THE MANAGEMENT OF LUNG CANCER

In the UK the incidence of lung cancer is 77 per 100,000 males and 52 per 100,000 females, whilst the death rates are 54 and 30 per 100,000 respectively. There are 2400 lobectomies and 500 pneumonectomies performed in the UK each year, with in-hospital mortality 2-4% for lobectomy and 6-8% for pneumonectomy.[4]

Lung resection is most frequently performed to treat non-small cell lung cancer. This major surgery places large metabolic demands on patients, increasing postoperative oxygen consumption by up to 50%. Patients presenting for lung resection are often high risk due to a combination of their age (median age is 70 years)[5] and co-morbidities. Since non-surgical mortality approaches 100%, a thorough assessment of fitness for surgery is essential in order to ensure that none are denied a potentially life-saving treatment.[6]

Lung cancer treatment is primarily dictated by the histological diagnosis, i.e. whether it is a small cell or non-small cell (squamous cell, adenocarcinoma, large cell) tumour. Small cell cancer is more aggressive and at presentation has often already metastasized. Therefore outcome is poor and surgery is only rarely an option. The options for non-small cell cancer depend upon its stage or how advanced it is (see Table 1). A tumour is staged using information about its size, position and invasion of structures locally, whether any lymph nodes are involved, and if it has spread to other areas within or outside the thorax. Stage 1 is the least advanced and stage 4 the most advanced.

Table 1. *Overview of the treatment options in lung cancer*

Type of lung cancer	Stage	Treatment
Non-small cell *(e.g. squamous cell, adenocarcinoma, large cell)*	1 and 2	**Surgery** +/- chemotherapy Radiotherapy if unfit for surgery
	3	**Surgery may be possible** + chemo/ radiotherapy or chemo/radiotherapy alone
	4	Radiotherapy +/- chemotherapy
Small cell		Chemotherapy +/- radiotherapy *(Rarely surgery)*

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ASSESSMENT OF PATIENTS FOR LUNG RESECTION

Each patient's management requires planning by a multi-disciplinary team (MDT), which includes a respiratory physician, a thoracic surgeon, an oncologist and other staff such as physiotherapists and respiratory nurses. If the MDT feels that surgery is appropriate, then the surgeon will decide if the tumour is technically resectable based on chest Xray and CT scan images (Figure 1). Important factors include tumour that impinges on the chest wall, traverses the fissures between lobes or is in close proximity to major vessels. In some cases, and where available, a PET scan (positron emission tomography) may be performed to further identify the anatomy of the tumour and to clarify whether nodal spread or metastasis has occurred (Figure 2). As an anaesthetist it is important to view these scans in order to understand the planned surgery. For example:

- chest wall resection may be necessary,
- close proximity to the pleura with pleural resection may make paravertebral analgesia impossible,
- proximity to the pulmonary vessels or aorta makes major blood loss more likely.

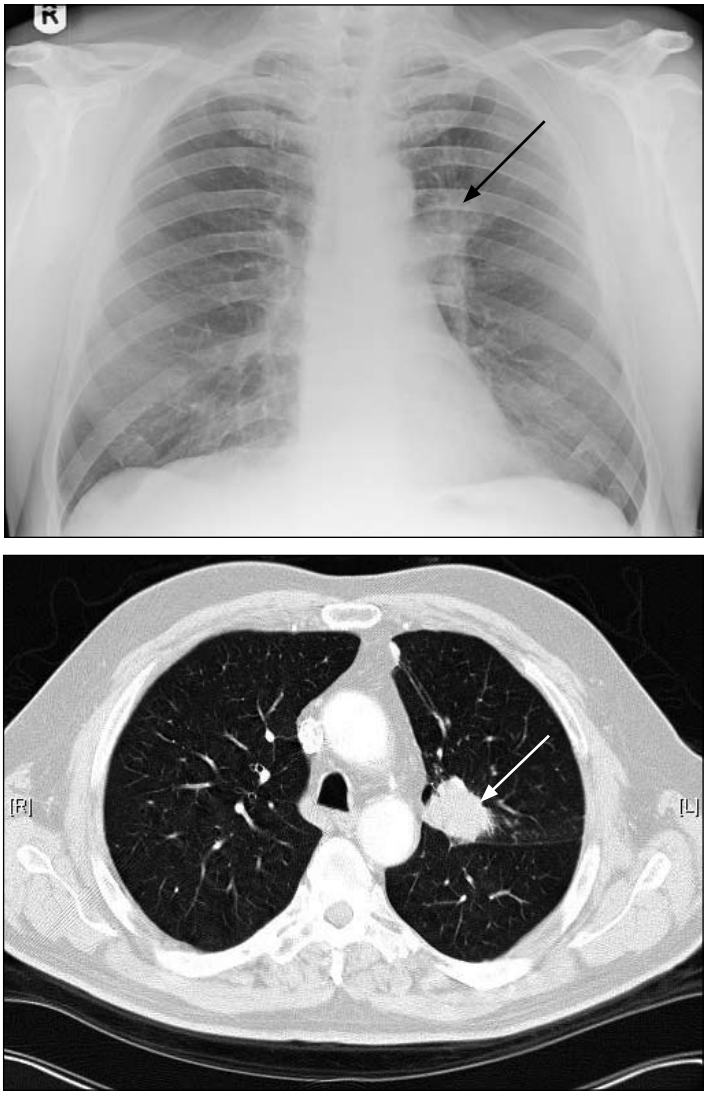


Figure 1. *Chest Xray and CT scans showing a left upper lobe tumour*

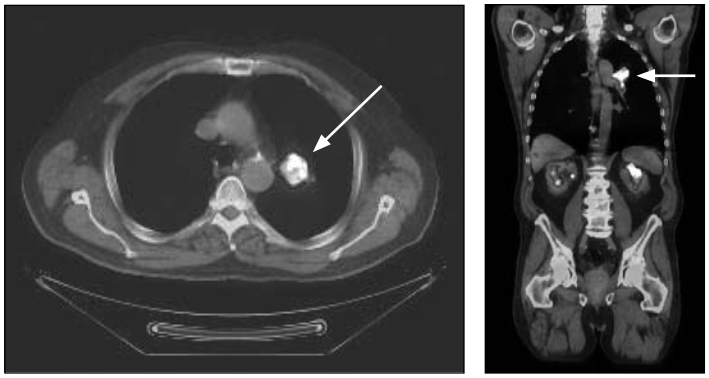


Figure 2. *A PET (positron emission tomography) scan shows the functional status of the body tissues and so highlights neoplastic tissues with a high rate of metabolism. Scans may be combined with CT images to reconstruct three dimensional images*

Where it is unclear whether mediastinal or hilar nodes are involved, superior (or cervical) mediastinoscopy, under general anaesthesia, may be performed. This requires a relatively straightforward anaesthetic that may contribute some information for the anaesthetist when assessing the patient's fitness to undergo major lung resection. Where a tumour is unresectable, the patient may be reassessed after *neo-adjuvant* chemotherapy.

PULMONARY FUNCTION TESTS

Whilst these investigations give an indication of a patient's fitness to undergo a surgical procedure, a thorough history and examination is essential to build up a true clinical picture. A patient's exercise tolerance may demonstrate that their functional ability has been underestimated by pulmonary function tests. Poor technique gives misleading results that may conflict with your clinical assessment. A more formal assessment of this is obtained by measuring oxygen saturations before, during and after a stair climb (see below). A history of chronic sputum production suggests that the ability of the patient to expectorate in the postoperative period will be critical.

Pulmonary function tests can be divided into those of ventilation and those of gas exchange. Exercise tests that assess cardiopulmonary reserve are also considered.

Indications for pulmonary function tests

- Diagnosis of a disease process
- Monitoring the response to therapy
- Documentation of the course of a disease process
- Preoperative assessment for lung resection, cardiac surgery or non-cardiothoracic surgery
- Evaluation of disability
- Evaluating disease prognosis.

ASSESSMENT OF VENTILATION

Peak Flow

This is the easiest test of ventilation to perform and an inexpensive portable peak flow meter is used. It is a measure of the peak expiratory flow rate during forceful expiration from vital capacity (i.e. at full inspiration). The main role for peak flow is to follow the course of obstructive diseases such as asthma and COPD, which

lead to a reduction in flow through the airways (and a reduced peak flow). It may be useful during exacerbations of these conditions and in assessing the response to treatment. The value obtained is assessed in comparison to the patient's previous results or to a predicted value, calculated using the patient's sex, age, and height. There is a normal diurnal variation of peak flow with the lowest levels occurring during the early hours of the morning.

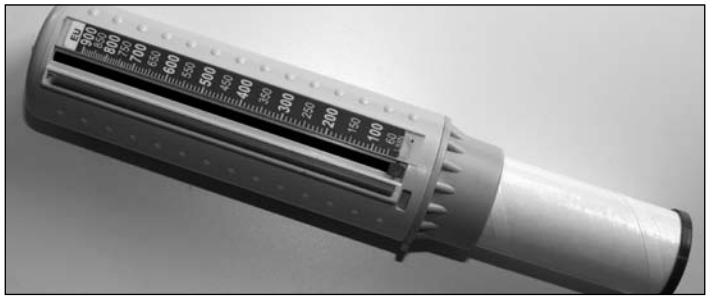


Figure 3. *A simple peak flow meter*

Spirometry

Basic measurements of the forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) can be obtained using a vitalograph, which is a relatively cheap and portable piece of equipment (Figure 4).

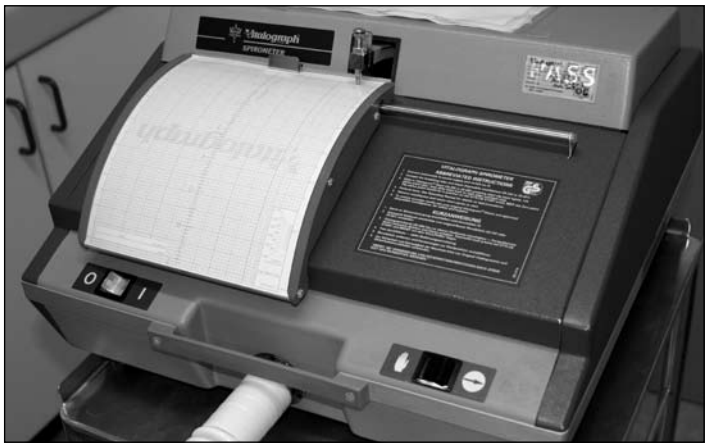


Figure 4. *A vitalograph consists of a bellows attached to a pen, with a motor, which moves a sheet of paper under the pen tip, as the subject exhales and fills the bellows. A typical reading is shown in Figure 5*

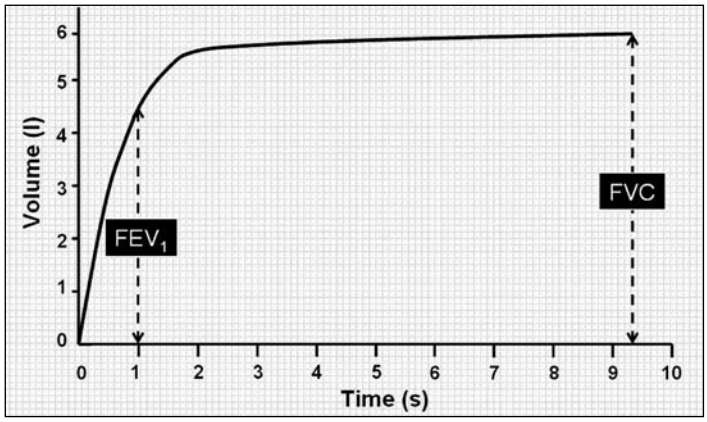


Figure 5. *A vitalograph recording from a normal subject. The arrows indicate the values for the forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC)*

The principle values obtained are:

The forced vital capacity (FVC)

The subject exhales from maximum inspiration (vital capacity) as quickly and completely as possible, and the total volume of air expired is measured. This tests the lungs ability to act as a bellows and is reduced by restrictive conditions affecting the thoracic cage (e.g. kyphoscoliosis), neuromuscular conditions (e.g. polio), changes within the pleura, or the lung itself (e.g. lung fibrosis).

The forced expiratory volume in one second (FEV_1)

The subject expires forcefully from vital capacity and the volume of air expired in the first second of expiration is measured. This value is altered by changes in airway resistance and, to a lesser extent, by respiratory effort. It is reduced in conditions such as asthma and COPD where the airways are narrowed. It clinical terms it provides some indication of how effectively an individual can generate a forceful outflow of air from the airways - i.e. a **cough**.

The FEV_1/FVC ratio

This is useful to differentiate between obstructive conditions where the ratio is reduced and restrictive conditions where it is not. The normal ratio is around 80%. In obstructive conditions, such as COPD, both FVC and FEV_1 are reduced, but the reduction in FEV_1 is greater.

The FEV_1 and FVC are expressed as absolute values and also as percentages of predicted values. The latter are more useful as they take height, age and sex into account. Spirometry may be performed before and after a dose of bronchodilator (or even a course of steroids) in order to determine the reversibility of the airway disease.

Some hospitals have more advanced equipment in a pulmonary function unit or laboratory (Figure 6). This equipment can be used to obtain additional information such as flow-volume loops (Figure 7). Other data on airflow at different lung volumes such as the FEF_{50} (the forced expiratory flow at 50% of vital capacity in $l.s^{-1}$), FEF_{75} and FEF_{25-75} (forced expiratory flow rates) may be more sensitive to detect airflow obstruction earlier in the disease process. A reduction in the FEF_{50} for example is a measure of small airway disease.

Figure 6. *Laboratory spirometry*

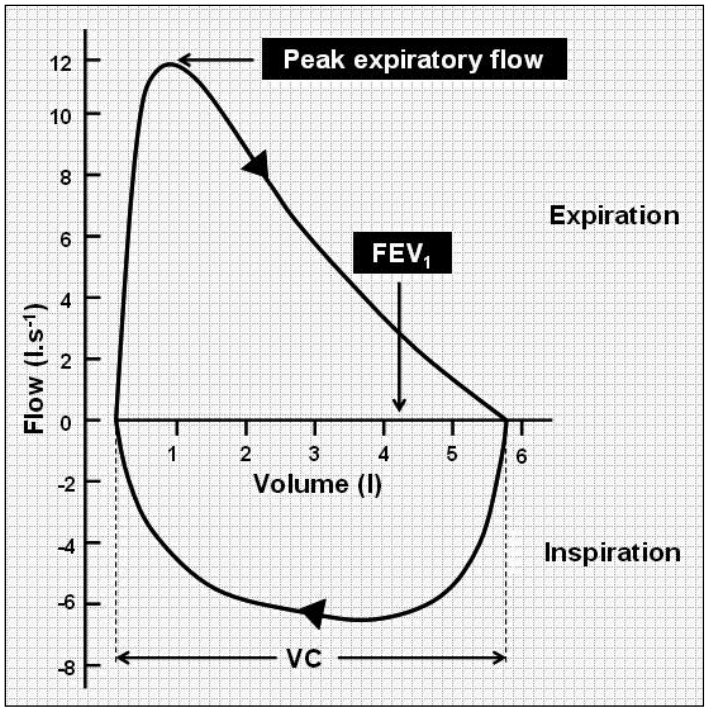


Figure 7. *A typical flow-volume loop for a normal subject obtained using a laboratory spirometer*

Some of the lung volumes that cannot be directly measured using spirometry can be estimated using body plethysmography. Examples are the total lung volume (TLV), the functional residual capacity (FRC) and the residual volume (RV). Figure 8 demonstrates these volumes and capacities. Patients with obstructive lung disease, who demonstrate an increased residual volume (RV) have hyperinflated lungs and are prone to gas-trapping (due to airway collapse) at the end of expiration during positive pressure ventilation (Table 1).

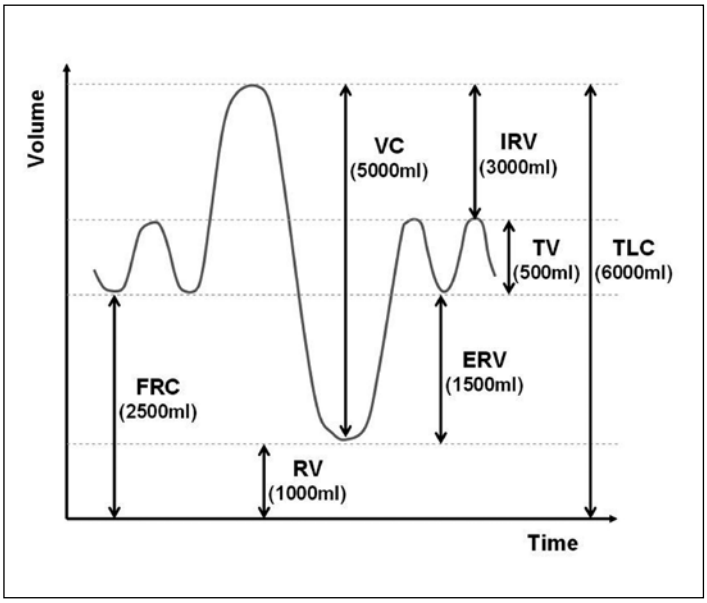


Figure 8. *Lung volume measurements. VC – vital capacity; IRV – inspiratory reserve volume; TV – tidal volume; TLC – total lung capacity; FRC - functional residual capacity; ERV – expiratory reserve volume; RV - residual volume*

Table 1. *An example of spirometry values for a patient with COPD. Note that both the FEV_1 and FVC are reduced, with the FEV_1 reduced to greater extent, resulting in a low FEV_1/FVC ratio. Note that the residual volume is increased suggesting hyperinflation and a tendency to 'gas-trapping' at end expiration.*

Parameter	Measured value	% of predicted value
FEV_1	1.17	44.6
FVC	2.60	74.9
Residual volume	2.93	112
FEV_1/FVC	45%	

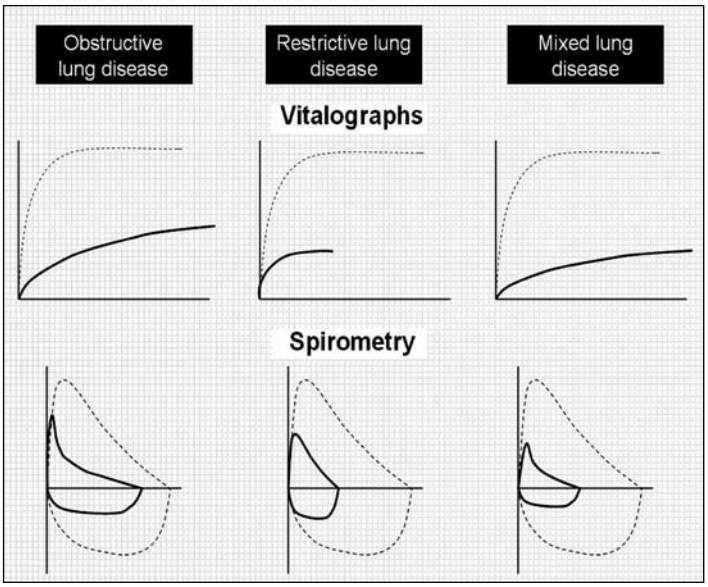


Figure 9. *Examples of typical spirometry loops seen with obstructive, restrictive and mixed (obstructive and restrictive) lung disease*

ASSESSMENT OF GAS EXCHANGE

Transfer factor (TLCO)

This is also referred to as diffusion capacity (DLCO - more accurately the D_LCO, the diffusion capacity of the lungs for carbon monoxide) and provides a measurement that indicates the functional surface area of the bronchial tree and the efficiency of the gas diffusion across the alveolar-capillary membrane. It must be performed in a laboratory, most commonly using a single breath of a mixture containing 10% helium and a low concentration of carbon monoxide (0.3%). The patient holds their breath for ten to twenty seconds and then exhales. The first 750ml of exhaled (dead space) gas is discarded and the following litre is analysed. Helium is not absorbed by the lungs, so the helium concentration in the expired gas can be used to calculate the initial concentration of carbon monoxide. Therefore the amount that has been absorbed across the alveolar-capillary membrane per minute is calculated. This represents the diffusing capacity in mmol. $kPa^{-1}.min^{-1}$. Carbon monoxide is used because of its high affinity for haemoglobin. This maintains low partial pressures in the blood so its uptake is primarily determined by diffusion across the alveoli.

TLCO is reduced by:

- Impaired diffusion - i.e. increased thickness (lung fibrosis),

- Decreased area (lung resection, emphysema),
- Reduction in the ability to combine with blood (e.g. anaemia).

The TLCO value is adjusted for alveolar volume and termed the transfer coefficient (KCO), with units of $mmol.kPa^{-1}.min^{-1}.litre^{-1}$. Where TLCO and KCO are reduced by similar amounts, the disease process is homogenous throughout the lungs. If TLCO is reduced more than KCO, it suggests that some areas of the lung have relatively preserved function, for example in smokers or those with emphysema.

Arterial blood gases and oxygen saturation

These give a picture of respiratory function as a whole and are affected by central mechanisms, cardiac function and metabolism as well as lung function. Absolute values of $PaCO_2$ do not correlate well with outcome, but hypoxia (O_2 saturation <90%) and oxygen desaturation on exercise (>4%) are associated with worse outcomes.

PULMONARY FUNCTION TESTS AND LUNG RESECTION

Broadly speaking, in terms of the FEV_1, the following patients require no further investigation, provided there is no evidence of interstitial lung disease or unexpected disability due to shortness of breath:[7,8]

FEV_1 > 1.5l	Suitable for lobectomy
FEV_1 > 2.0l or >80% predicted	Suitable for pneumonectomy

Below these values further interpretation of the spirometry readings is needed and a value for the predicted postoperative (ppo-) FEV_1 should be calculated. As the FEV_1 decreases, the risk of respiratory and cardiac complications increases, mortality increases and patients are more likely to require postoperative ventilation.

Calculating the predicted postoperative FEV_1 ($ppoFEV_1$) and TLCO (ppoTLCO)

Radiological imaging (usually a CT scan) identifies the area of the lung that requires resection. There are five lung lobes containing nineteen segments in total with the division of each lobe shown in Figure 10.

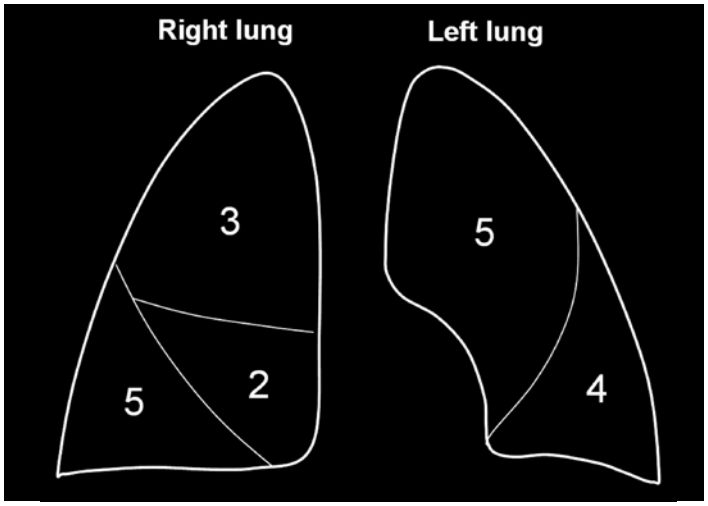


Figure 10. *The number of segments within each lung lobe*

Knowledge of the number of segments of lung that will be lost by resection allows the surgeon and anaesthetist to estimate the post-resection spirometry and TLCO values. These can then be used to estimate the risk to the patient of undergoing the procedure (Table 2). Note that resection of the left upper or right lower lobe, both of which have five segments, has the greatest impact on predicted post-resection values.

$$ppoFEV_1 = \text{preoperative } FEV_1 \times \frac{\text{number of segments left after resection}}{19}$$

In some instances, for example when the tumour is near to the hilum or in close proximity to the fissure between lobes, it may remain unclear whether surgery will involve single lobectomy, bi-lobectomy or pneumonectomy, until the surgeon has gained surgical access to the patient's chest. In this situation the anaesthetist and surgeon must have estimated in advance, which of these procedures the patient will be able to tolerate peri- and postoperatively.

Table 2. *Using $ppoFEV_1$ and ppoTLCO as a screening tool to assess suitability for lung resection*

$ppoFEV_1$ (% of predicted)	**Interpretation**
> 40	No or minor respiratory complications anticipated.
< 40	Increased risk of perioperative death and cardiopulmonary complications.[8]
< 30	Likely to require postoperative ventilation[9] and further increased risk of death/complications. Non-surgical management should be considered.[8]
ppoTLCO (% of predicted)	**Interpretation**
> 40%, $ppoFEV_1$ > 40% and O_2 saturation > 90% on air	Intermediate risk, no further pulmonary investigation required.
< 40%	Predicted represents increased respiratory and cardiac morbidity.[7,10]
< 40% and $ppoFEV_1$ < 40%	High risk-require cardiopulmonary exercise testing.
< 30%	Patient is likely to be hypoxic without supplementary oxygen.

All other combinations require cardiopulmonary exercise testing[7]

Case example 1

A 57-year-old man is booked for right thoracotomy and lung resection. He has lost 8kg in weight but is otherwise fit and well. Chest Xray and CT chest show a large right upper lobe mass with distal collapse/consolidation of most of the right upper lobe (Figure 11). Transmural biopsies from the right main bronchus via flexible bronchoscopy have confirmed the mass is a carcinoma.

His pulmonary function tests (Table 3) show that his spirometry values are near normal, but that his TLCO is significantly reduced to 55.5% of the predicted value for his sex, age and height.

The surgeon plans to perform a right upper lobectomy, but may consider upper and middle bi-lobectomy or pneumonectomy depending on his findings at thoracotomy. In terms of his ventilatory function, as indicated by his spirometry readings, he would be expected to tolerate lobectomy, or pneumonectomy without too much difficulty. However the calculations in Table 4a show that his predicted postoperative TLCO after pneumonectomy mean that adequate oxygenation will not be achievable without oxygen therapy.

However, his CT scan shows that the majority of his right upper lobe is severely affected by the disease process and so contributed little to his preoperative performance. Therefore the denominator in the calculations can be changed to 16 (the 3 segments of the right upper lobe are discounted). The new predicted post-pneumonectomy TLCO value is 31.2% (Table 4b) suggesting that although he is at high risk of preoperative complications, independent survival post-pneumonectomy is possible.

Table 3

	Actual	Predicted	% predicted
FEV_1	2.76	3.04	91%
FVC	3.74	3.80	98%
TLCO			55.5%

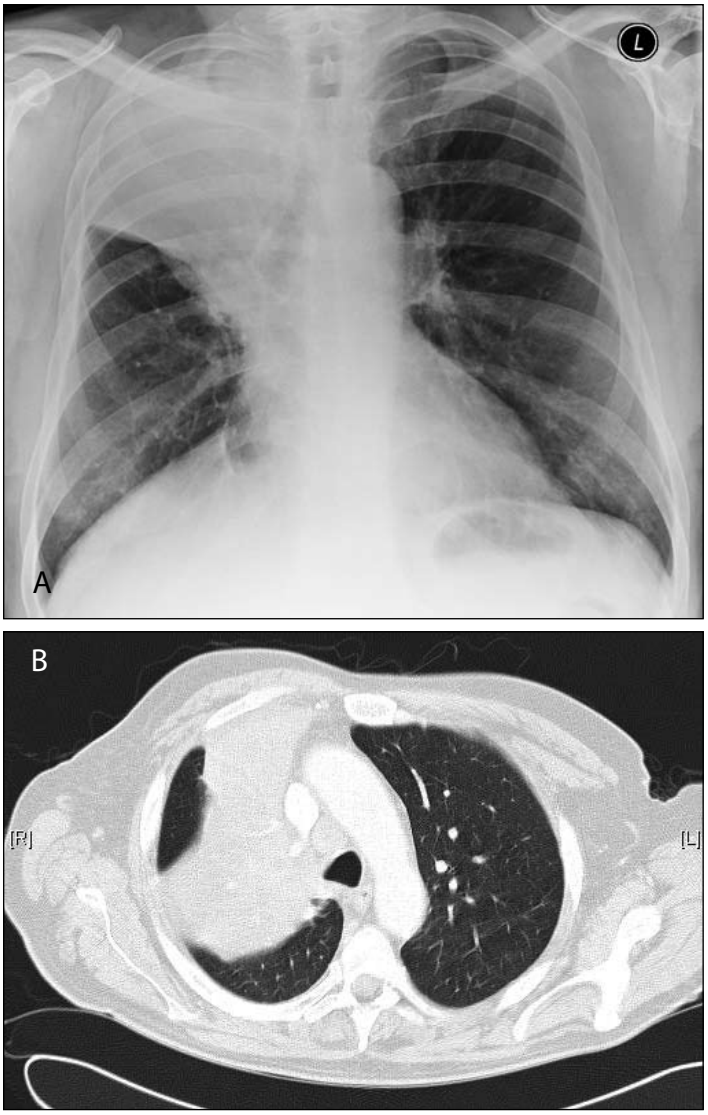


Figure 11. *(A) Chest Xray and (B) CT showing right upper lobe collapse/ consolidation secondary to a right upper lobe tumour*

Table 4a

Extent of lung resection	Lung remaining post resection	Predicted post-resection TLCO
R U lobectomy	16/19 segments remaining	46.7%*
R U & M lobectomy	14/19 segments remaining	40.9%
R pneumonectomy	9/19 segments remaining	16.1%

* calculated as 16/19 x preoperative TLCO (55.5%).

Table 4b

Extent of lung resection	Lung remaining post resection	Predicted post-resection TLCO
R U lobectomy (and assume RU lobe non-functional)	14/16 functional segments remaining	48.6%
R pneumonectomy (and assume RU lobe non-functional)	9/16 functional segments remaining	31.2%

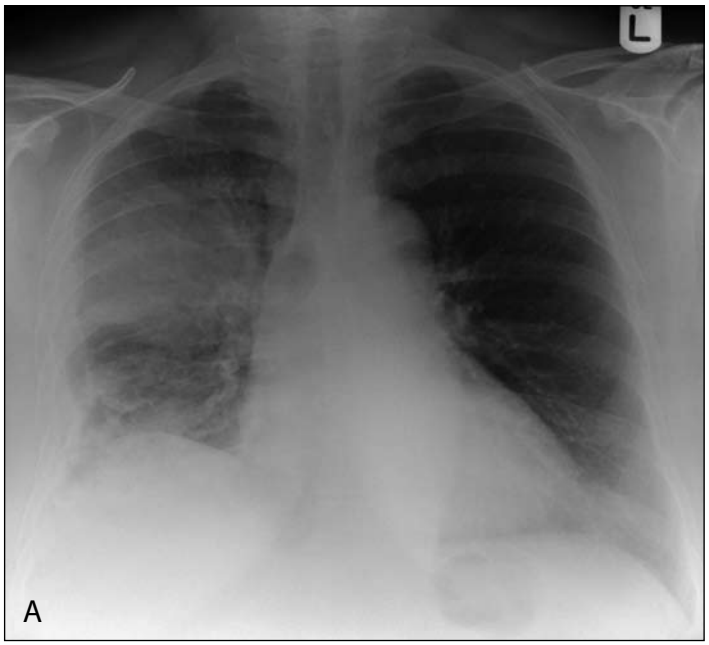
Use of ventilation isotope scans to calculate the predicted postoperative FEV_1 ($ppoFEV_1$) and TLCO

Where the relative contributions of the diseased and non-diseased lungs to overall function is unknown, ventilation scans (the ventilation part of a V/Q isotope scan) can be used. The patient inhales a radioactive labelled gas (xenon) mixture and the chest is scanned using a gamma camera. (For the perfusion part of the scan, as used to detect pulmonary emboli, a radioactive isotope is also injected and the lung scan repeated).

Case example 2

A 65-year-old woman requires pneumonectomy for non-small cell carcinoma of the right lung. Her preoperative pulmonary function tests are shown in Table 5 and predicted post resection levels of FEV_1 and TLCO are borderline.

However her CXR and CT suggest that significant parts of her right lung may be non-functional. This can be determined using a ventilation scan, which demonstrates that the relative contribution of her right and left lungs to ventilation (and therefore to spirometry testing) is 36% to 64%. Her predicted post-pneumonectomy values for FEV_1 and TLCO can then be calculated by multiplying the pre-resection values by 0.64 (64%). These values are 41.6% for the FEV_1 and 45.4% for the TLCO, representing far more acceptable values to proceed with pneumonectomy.



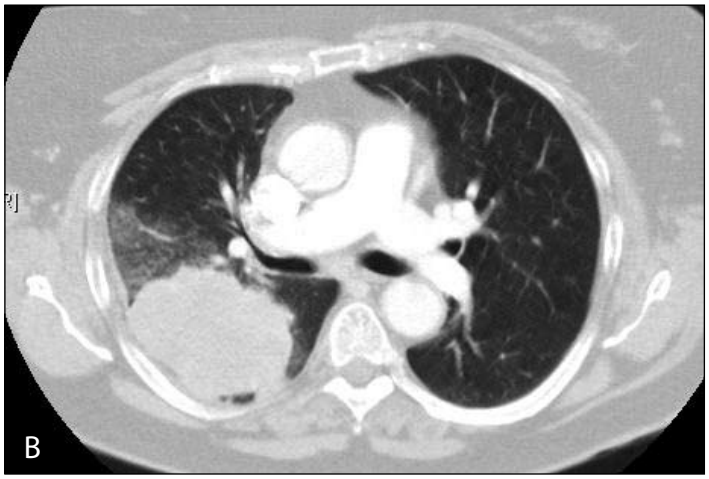


Figure 12. *(A) Chest Xray and (B) CT showing right upper lobe collapse/consolidation secondary to a right lung tumour*

Table 5

	Actual value	Predicted for age, sex, height	% predicted	Predicted post right pneumonectomy (9/19 segments remaining)
FEV_1	1.48	2.28	65%	30.8%
FVC	1.96	2.70	72%	34.1%
TLCO			71%	33.6%

OTHER TESTS

Maximum breathing capacity

Otherwise known as maximum voluntary ventilation this is the maximum volume of air that can be breathed when the subject inspires and expires as quickly and forcefully as possible. Less than 40% predicted represents a high risk for surgery.[11]

Exercise tests and oxygen uptake (Cardiopulmonary exercise testing)

The various tests outlined below give information on cardiopulmonary reserve. They range from simple tests requiring no equipment to complex tests requiring expensive machines.

Stair climbing and 6-minute walk test

This is a simple test that is easy to perform with minimal equipment required (see Table 6).

Shuttle walk

The patient walks between cones 10 meters apart. A tape player sets the pace by beeping at reducing intervals (increasing frequency). The subject walks until they cannot make it from cone to cone between the beeps, or 12 minutes has passed. Less than 250m or decrease SaO_2 > 4% signifies high risk.[7,8] A shuttle walk of 350m correlates with a VO_2 max of $11ml.kg^{-1}.min^{-1}$. A study looking at mortality after oesophagogastrectomy found zero 30-day mortality in patients who were able to shuttle walk at least this far.[14]

The obvious advantages of this technique are that it is cheap and easy to perform and gives reliable information that is directly related to clinical outcomes.

Table 6. *Summary of stair-climbing assessment of performance*

Performance	VO_2 max equivalent	Interpretation
>5 flights of stairs	VO_2 max > 20ml.kg^{-1}.min^{-1}	Correlates with, FEV_1 > 2l and low mortality after pneumonectomy
>3 flights of stairs		Correlates with FEV_1 of 1.7l and low mortality after lobectomy
<2 flights of stairs		Correlates with high mortality
<1 flight of stairs	VO_2 max < 10ml.kg^{-1}.min^{-1} [12]	
6min walk test < 600 meters	VO_2 max <15ml.kg^{-1}.min^{-1} [13]	

Cardiopulmonary exercise testing - CPEX

This provides a functional assessment of cardiopulmonary reserve. The subject exercises at increasing intensity on an exercise bike or treadmill, whilst inspired and expired O_2 and CO_2 are measured and an ECG is recorded. It is also possible to measure flow volume loops. The main values of interest are the maximum O_2 uptake (VO_2 max), and the anaerobic threshold (the level at which anaerobic respiration begins).

VO_2 max is the maximum oxygen uptake per kg body weight per minute. It is the most useful predictor of outcome in lung resection. The maximum oxygen uptake (VO_2 max) and maximum oxygen delivery to the tissues (DO_2 max) give us information about the body's physiological reserve and our ability to deal with the extra metabolic demands of surgery. VO_2 max and DO_2 max are dependent on the body's cardiac and respiratory systems. The point at which oxygen consumption exceeds oxygen uptake is known as the anaerobic threshold. It is the level at which the oxygen delivery required by the tissues to maintain aerobic metabolism is no longer met and anaerobic metabolism occurs. Above this level, energy production is much less efficient and lactic acid is produced, causing metabolic acidosis.

The information gained from CPEX testing allows quantification of the predicted risks of surgery, however this information is of limited value in the context of a disease process where mortality approaches 100% without surgery.

Table 7. *Interpreting the VO_2 max*

VO_2 max	Interpretation
20ml.kg.$^{-1}$min^{-1} or >15ml.kg.$^{-1}$min^{-1} and FEV_1 > 40% predicted	No increased risk of complications or death[15,4]
< 15 ml.kg.$^{-1}$min^{-1}	High risk[7,8]
< 10 ml.kg.$^{-1}$min^{-1}	40-50% mortality,[8] consider non-surgical management.[4]

CONCLUSIONS

We have described, with examples, the pulmonary function tests commonly performed to evaluate patient's fitness for lung resection surgery. It is valuable for the anaesthetist to understand the interpretation of these test results and also to know how they fit into the overall approach taken in the preparation of patients for thoracic surgery. Figure 13 shows a suggested sequence for these tests. These tests do not always give the full picture and anaesthetic assessment for lung resection surgery should include a thorough history and examination and, above all, good communication with the surgical team.

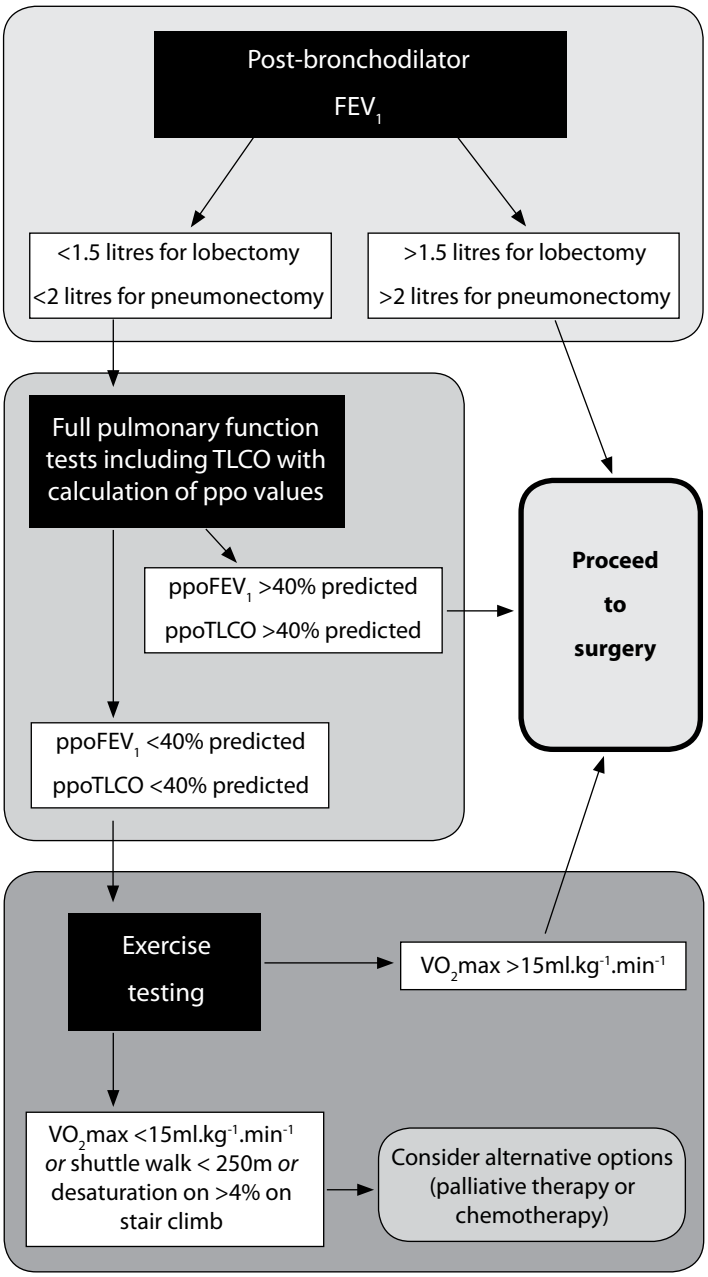


Figure 13. *An approach to assessment of suitability for lung resection (adapted from reference 4)*

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Update in
Anaesthesia

Paediatric Spinal Anaesthesia

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Summary

Spinal anaesthesia provides a good alternative to general anaesthesia in newborns with increased anaesthesia-related risk, and for infants undergoing lower abdominal or lower extremity surgery during the first 6 months of life. It is most successful as a single shot technique, limited to surgery lasting less than ninety minutes. Spinal anaesthesia in children requires the technical skills of experienced anaesthesia providers.

INTRODUCTION

Spinal anaesthesia consists of inserting a spinal needle into the subarachnoid space and, when a free flow of cerebrospinal fluid (CSF) is obtained, injection of a solution of local anaesthetic directly into the CSF.

Spinal anaesthesia (SA) was first described in children in 1909[1] but did not become part of routine practice until the 1980's when regional anaesthesia increased in popularity. The particular advantage suggested for SA in children was the avoidance of general anaesthesia (GA) in those at risk of postoperative apnoea. Several studies demonstrated that SA had a particular role in high-risk former preterm neonates undergoing inguinal herniorraphy.[2]

APPLICATIONS OF SPINAL ANAESTHESIA

SA remains popular for ex-premature infants, specifically those undergoing inguinal herniorraphy. These patients often have a history of apnoea of prematurity, bronchopulmonary dysplasia and chronic lung disease. The incidence of postoperative apnoeas correlates with gestational age at birth, the post-conceptional age at surgery, weight, anaemia and a history of apnoeas. General anaesthesia increases the risk of apnoea and bradycardia, and ex-premature infants remain at risk until after 60 weeks post-conception.[3,4]

Outside the neonatal period, SA has been used for general surgery (rectal biopsy, incision of rectal abscess), urological surgery (orchidopexy, circumcision), lower limb orthopaedic surgery,[5] and may be of particular use in developing countries as an alternative to general anaesthesia.

SA has also been suggested for patients in whom GA may pose a significant risk such as those with facial dysmorphia and difficult intubation, muscular dystrophy, family history of malignant hyperthermia or a full stomach with aspiration risk.[5]

SA has also been described in combination with GA in children undergoing complex surgery. For instance, preoperative morphine SA associated with GA in scoliosis surgery is associated with reduced blood loss and better pain control.[6,7] SA has been used in association with GA during cardiopulmonary bypass in neonates to blunt the stress response, protect hemodynamic status and reduce perioperative morbidity and mortality,[4,9] although its use in this situation is not common. SA has also been described for use in chronic pain management.[4,8]

CONTRAINDICATIONS TO SA

There are a number of specific contraindications to SA in children that are listed below:

- Coagulation abnormalities
- Systemic sepsis or local infection at the puncture point
- Uncorrected hypovolaemia
- Parental refusal or an uncooperative child
- Neurological abnormalities such as spina bifida, increased intracranial pressure
- Procedures lasting more than 90 minutes.

ANATOMICAL CONSIDERATIONS

A line connecting the top of the iliac crests crosses the spinal axis at the L5-S1 level in neonates and infants up to one year of age and at the L4-L5 level in older children.[5] The spinal cord ends approximately at L3 level at birth and at L1-L2 level in children over one year old.

The distance between the skin and the subarachnoid space is influenced by age – from 10 to 15mm in newborns.[10] The distance between skin and subarachnoid space can be related to height or weight using the formulae:

Distance from skin to subarachnoid space (cm) = 0. 03 x height (cm)

Distance from skin to subarachnoid space (cm) = (2 x weight) + 7(mm)[11]

The subarachnoid space in newborns is very narrow (6 to 8mm) and successful lumbar puncture in this population requires great precision and avoidance of lateral deviation.

Cerebrospinal fluid is a clear body fluid that occupies the subarachnoid space and the ventricular system of the brain and spinal cord. Cerebrospinal fluid volume at different periods of life is shown in Table 1.

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Table 1. *CSF volume in children*

	Cerebrospinal fluid volume (ml.kg^{-1})
Neonates	10
Infants less than 15kg	4
Young children	3
Adolescent /Adult	1.5 - 2

The volume of distribution of drugs injected into the subarachnoid space is higher in infants and neonates than in adults and consequently the injected dose is relatively greater in infants and neonates.

PHYSIOLOGICAL EFFECTS OF SPINAL ANESTHESIA

Hemodynamic consequences of SA

Cardiovascular changes related to the SA are less common in children than in adults. In children under 5 years of age, minimal changes in heart rate and blood pressure have been reported.[5,12,13] In older patients (>8 years old), the sympathetic block can induce bradycardia or hypotension. A few studies of SA in newborns have noted hypotension ten minutes after injection of the local anaesthetic. Cardiovascular changes due to spinal block are generally short lasting and respond to a bolus of intravenous fluid (10ml.kg^{-1}).[14] Cardiovascular stability in infants undergoing SA is probably related to smaller venous capacitance in the lower limbs leading to less blood pooling, and to relative immaturity of the sympathetic nervous system resulting in less dependence on vasomotor tone to maintain blood pressure.

Respiratory effects of SA

Respiratory effects of SA are generally seen in association with high motor block above T6.[5] Children with severe chronic lung disease should receive supplemental oxygen or Continuous Positive Airway Pressure (CPAP) during SA.

TECHNIQUE OF SA IN CHILDREN

Preoperative preparation

The technique should be explained fully to the parents (and child if appropriate), with a description of risks and benefits. Informed consent should be obtained.

A full blood count including platelet count and coagulation screen should be performed preoperatively (prothrombin time, PT), activated partial thromboplastin time (APTT) where clinically indicated.

The child should be fasted as for GA (4 to 6 hours for milk and 2 hours for clear liquid). If possible, topical anaesthesia is used by application of EMLA (Eutectic Mixture of Local Anaesthetics) on the lumbar area, 60 to 90 minutes prior to SA. Premedication with oral or rectal atropine (20 mcg.kg^{-1}) is given.

Operative management

In the operating room, routine monitoring and standard intravenous infusion are started. Some anaesthesiologists have suggested placing the intravenous cannula in an anaesthetized lower extremity after performing the subarachnoid block. We advise placing it prior to SA puncture. Although cardiopulmonary complications are unlikely following SA, they are possible and the presence of a cannula will allow more rapid intervention.

There should be an assistant for the anaesthetist to help with preparation of the equipment, positioning and holding the child during insertion of the SA. All drugs and equipment should be prepared and checked prior to starting. Full barrier aseptic technique should be used, with a sterile work surface for equipment. The operator should use sterile gloves, gown and mask and the patient's skin should be cleaned with an alcoholic solution such as 2% chlorhexidine (+/- iodine). The skin should be allowed to dry and a sterile sheet should be placed over the child with a hole to reveal the field. The dose of local anaesthetic solution is calculated according to the weight of the child and is shown in Table 2;[5] the drugs should be drawn into a 1-2ml syringe as appropriate and placed on the sterile work surface in preparation for use.

Both the sitting or lateral decubitus position have been described for lumbar puncture.[4,5] We have great experience of the lateral position for awake neonates or infants but careful attention must be directed at maintaining patency of the airway which may be compromised with overzealous positioning (Figure 1). The lateral position may be easier than the sitting position for older patients for whom intravenous sedation with a benzodiazepine such as midazolam may be indicated.

Table 2. *Dose of local anaesthetic for SA in children*

Weight	**< 5kg**	**5 to 15kg**	**> 15kg**
Isobaric or hyperbaric bupivacaine 0.5%	1mg.kg^{-1} (0.2ml.kg^{-1})	0.4mg.kg^{-1} (0.08ml.kg^{-1})	0.3mg.kg^{-1} (0.06ml.kg^{-1})
Isobaric or hyperbaric tetracaine 0.5 %		0.4mg.kg^{-1} (0.08ml.kg^{-1})	0.3mg.kg^{-1} (0.06ml.kg^{-1})

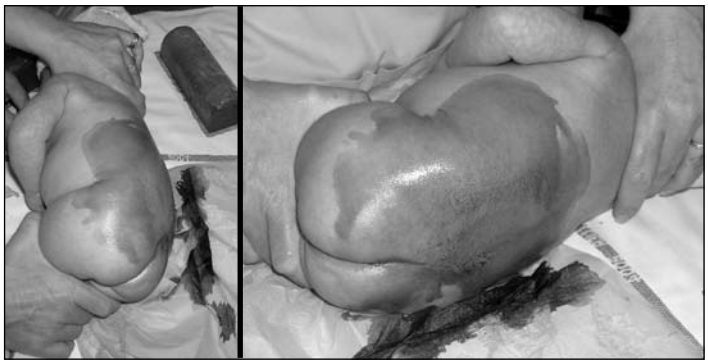

Figure 1. *Lateral position to perform SA in 4kg newborn*

Lumbar puncture is performed at L3-L4 or L4-L5 level. Various sizes and lengths of needles are available depending on the child's age. We use a 25G or 26G needle with stylet for neonates and infants (Figure 2). Using a needle without a stylet is not recommended since epithelial tissue can be deposited in the intrathecal space and may cause dermoid tumours of the neural axis.

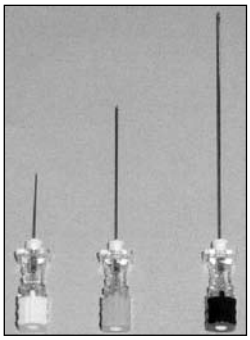

Figure 2. *Different types of SA needles*

A free flow of cerebrospinal fluid should be obtained when the spinal needle is advanced into the intrathecal space. The local anaesthetic syringe is attached and the anaesthetic solution is injected over 30 seconds (Figure 3). The legs should not be lifted after the spinal injection has been administered, otherwise an excessively high block will develop.

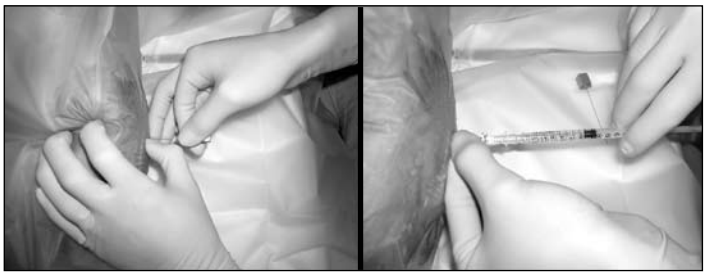

Figure 3. *Lumbar puncture and LA injection with 1ml syringe*

SA may produce a degree of sedation in newborns and infants so additional intravenous sedation is not required.[15] Intravenous sedation should be avoided if at all possible in infants at risk of apnoea. We find that a dummy in dipped sucrose or honey will help to settle these infants.

Postoperative care

In our hospital, children are discharged from the post anaesthesia care unit when the block disappears, i.e. free lower limb movement returns. Children are allowed to feed on demand, provided there are no surgical restrictions. All infants younger than 60 weeks post conception are monitored on the ward for 24 hours after SA.

COMPLICATIONS OF SA

There are a number of potential complications of SA that are listed below:

- Potential traumatic puncture with spinal damage. Careful technique with the appropriate equipment and a trained assistant is essential
- Respiratory (+/-cardiovascular) insufficiency due to high SA or secondary to intravenous sedation. Resuscitation measures must be taken (ABC) - tracheal intubation and volume resuscitation may be required.
- Convulsions due to overdose of local anaesthetic. All doses should be calculated carefully and checked with another practitioner.
- Post dural puncture headache. This has been reported in children >8 years old, but the incidence in younger children is unknown, in part since headaches in infants and young children are difficult to assess.[5,16]
- Infectious complications such as meningitis. The incidence like meningitis is very low – careful aseptic technique must be used at all times and multidose ampules of local anaesthetic must never be used. We suggest repeating lumbar puncture in patients who develop fever after SA.[4,5]
- Neurological injury due to injection of incorrect solutions. Great care must be taken at all times in preparation and checking of drugs.

CONCLUSION

In our experience, the incidence of serious complications associated with SA is very low even in small premature infants. We think that this technique provides a good alternative to general anaesthesia in newborns with increased anaesthesia-related risk and for infants undergoing lower abdominal or lower extremity surgery during the first 6 months of life. SA may be used to avoid GA in patients outside the neonatal period, if needed combined with intravenous sedation. SA is most successful as a single shot technique, limited to surgery lasting less than 90 minutes. SA in children requires the technical skills of experienced anaesthesia providers. Neonates and infants are at high risk of complications during surgery, irrespective of the type of anaesthesia, and the presence of clinician trained in paediatric anaesthesiology is mandated.

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Update in
Anaesthesia

HIV and Anaesthesia

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Summary

Human immunodeficiency virus (HIV) infection and the acquired immunodeficiency syndrome (AIDS) are major global health concerns. The most recent WHO/UNAIDS report (2008) has estimated that there are 33 million people worldwide living with this infection, with 2.7 million new infections acquired in 2007. Given that approximately 25% of HIV-infected patients will require surgery during the time of their illness, it is important for anaesthetists to understand the implications of anaesthesia in the HIV-infected patient. This requires a basic understanding of HIV infection itself, the clinical symptoms and organ involvement in HIV infection, the pharmacology of anti-retroviral agents (ARVs), as well as implications for regional anaesthesia, the child with HIV and issues surrounding infection control. With this basic understanding we will be better equipped to formulate a plan for anaesthetising the HIV infected patient.

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PATHOGENESIS DIAGNOSIS AND CLASSIFICATION

HIV is a single-stranded RNA virus of the lentivirus subfamily of the retrovirus family. Two subtypes have been identified, HIV-1 and HIV-2. Like other retroviruses, HIV contains the enzyme reverse transcriptase that enables viral RNA to be transcribed to DNA, which then becomes incorporated into the host cell genome and is able to replicate freely. Inhibition of this viral replication process is the target of antiretroviral agents (ARVs). HIV preferentially infects T helper lymphocytes (CD4 T cells) and leads to their progressive quantitative and qualitative destruction, making the host more susceptible to opportunistic infections and malignancies.

Several modes of infection exist including sexual intercourse (60-70%), mother to child transmission (during pregnancy, labour and breast-feeding) (20-30%), contaminated blood, blood products and organ donations (3-5%) and contaminated needles (2-3%). This leads to the identification of several high-risk groups including: promiscuous hetero- and homosexuals, patients with other sexually transmitted diseases, intravenous drug users, haemophiliacs, and patients from endemic areas.

HIV infection is classified according to its associated clinical symptoms (see Table 1 below), as well as the severity of immunological depression reflected by age-related CD4+ T cell counts. The diagnosis of advanced HIV infection is made when the patient is in stage 3 or 4 and/or has advanced immunodeficiency. Severe clinical conditions and/or severe immunodeficiency are known as AIDS.

Table 1. *Clinical staging of HIV infection*

Stage	Associated symptoms
1 Asymptomatic	No symptoms
	Persistent generalised lymphadenopathy
2 Mild symptoms	Moderate weight loss (<10% body weight)
	Recurrent upper respiratory tract infection
	Viral or fungal skin infection
	Oral or skin lesion
3 Advanced symptoms	Severe weight loss (>10% body weight)
	Chronic diarrhoea
	Persistent fever
	Oral lesions or candidiasis
	Pulmonary tuberculosis
	Severe bacterial infections
	Anaemia, neutropenia, thrombocytopenia
4 Severe symptoms: AIDS	Wasting syndrome (weight loss >10% body weight with wasting or body mass index <18.5)
	Chronic diarrhoea
	Persistent fever
	Encephalopathy, nephropathy, cardiomyopathy
	Recurrent bacterial infections
	Opportunistic infections
	Malignancy

MULTISYSTEM INVOLVEMENT

To enable a thorough preoperative assessment it is important to be aware which organ systems can be involved in the HIV infected patient, both as a direct consequence of HIV infection due to opportunistic infection or neoplasm, as well as related to other causes such as side effects of the ARV medications.

Cardiovascular system

The cardiovascular system may be involved in a number of ways in HIV infection. There may be pericardial,

myocardial, endocardial or vascular lesions, as well as neoplasm. These may be directly related to HIV infection or to the side effects of ARVs, chemotherapy or anti-infective agents. Important and common cardiovascular complications include the following:

- Dilated cardiomyopathy
- Pericardial effusions
- Endocarditis and valvular lesions
- Acute coronary syndrome
- Vasculitis
- Pulmonary hypertension.

Respiratory system

Both the upper and lower airway can be involved in HIV infection. These complications can be due to primary HIV infection, associated malignancies, opportunistic infections or side effects of medication. The following respiratory complications are seen:

- Airway obstruction (by Kaposi sarcoma or infections)
- Bronchitis
- Sinusitis
- Pneumonia
- Pneumonitis
- Atypical infections (commonly tuberculosis, other mycobacteria and fungal infections).

Gastrointestinal system

Commonly encountered complications of the gastrointestinal tract associated with HIV infection and its treatment include:

- Difficulty or pain on swallowing
- Increased gastric emptying times
- Bleeding tendency on airway instrumentation/nasogastric tube insertion
- Diarrhoea with associated electrolyte dysfunction & dehydration
- Hepatobiliary impairment
- Pancreatitis.

Renal system

Acute and chronic renal disease can be associated with HIV and the causes of renal impairment can be multifactorial:

- Drug-induced nephrotoxicity, hypertension & diabetes
- HIV-associated nephropathy.

These potential complications necessitate the avoidance of nephrotoxic drugs, dose adjustment of renally excreted drugs and the need for adequate hydration to prevent further deterioration of renal function.

Neurological system

HIV can involve the neurological system by direct infection, inflammation, demyelination or a degenerative process. It can also be secondary to opportunistic infections, neoplasms or immune deficiency. This can involve all structures including the meninges, brain, spinal cord, peripheral nerve or muscle. Also recognised are:

- Neurocognitive impairment (with implications for consent)
- Encephalopathy
- Autonomic neuropathy
- Seizures.

Full neurological examination pre-operatively with appropriate documentation is essential especially if regional anaesthesia is being considered.

Haematological system

The following are commonly seen during HIV infection:

- Anaemia
- Neutropenia
- Thrombocytopenia
- Persistent generalised lymphadenopathy
- Haematological malignancies
- Coagulation abnormalities.

Endocrine & metabolic system

Common side effects of ARVs include:

- Lipodystrophy (truncal obesity, buffalo hump, peripheral wasting)
- Metabolic syndrome (raised plasma triglycerides, cholesterol, glucose)
- Disorders of the hypothalamic–pituitary–adrenal axis including Cushing's syndrome and Addison's disease
- Hyponatraemia due to syndrome of inappropriate antidiuretic hormone or adrenal failure
- Hypo- or hyperthyroidism
- Lactic acidosis

ANTIRETROVIRAL THERAPY

The use of a combination ARVs or highly active antiretroviral therapy (HAART) has been a major advance in the treatment of HIV infection. These drugs are classified into four classes according to the mechanisms of inhibition of viral replication: reverse transcriptase enzyme inhibitors, protease enzyme inhibitors, integrase inhibitors and entry inhibitors (see table below).

Adherence to antiretroviral therapy is of paramount importance, with adherence levels of below 95% being associated with increases in viral load and drug resistance. This naturally has implications for interruption of ARV therapy due to perioperative fasting. Fasting times should be kept to an absolute minimum.

Adverse effects

Many adverse side effects are associated with ARVs and should be

Table 2. *Summary of antiretroviral drugs*

Drug class	Available drugs
1. Reverse transcriptase inhibitors	
Nucleoside/nucleotide analogues (NRTIs)	Abacavir (ABC)
	Didanosine (ddI)
	Emtricitabine (FTC)
	Lamivudine (3TC)
	Stavudine (d4T)
	Zidovudine (AZT, ZDV)
Non-nucleotide reverse transcriptase Inhibitors (NNRTIs)	Delavirdine (DLV)
	Efavirenz (EFV)
	Etravirine (ETR)
	Nevirapine (NVP)
2. Protease inhibitors (PIs)	Atazanavir (ATV)
	Darunavir (DRV)
	Fosamprenavir (FPV)
	Indinavir (IDV)
	Lopinavir (LPV)
	Nelfinavir (NFV)
	Ritonavir (RTV)
	Lopinavir/ritonavir (LPV/r)
	Saquinavir (SQV)
	Tipranavir (TPV)
	Amprenavir (APV)
3. Integrase inhibitors	Raltegavir (RAL)
4. Entry inhibitors	
Fusion inhibitors	Enfuviritide (ENF, T-20)
CCR 5 antagonists	Maraviroc (MVC)

looked for during preoperative assessment. They can be divided broadly into four groups:

- *Mitochondrial dysfunction*: lactic acidosis, hepatic toxicity, pancreatitis, peripheral neuropathy
- *Metabolic abnormalities*: fat maldistribution and change in body habitus, dyslipidaemia, hyperglycaemia and insulin resistance, bone disorders e.g. osteopaenia, osteoporosis and osteonecrosis
- *Bone marrow suppression*: anaemia, neutropenia and thrombocytopenia
- *Allergic reactions*: skin rashes and hypersensitivity responses.

Drug interactions

Anaesthetic drugs may interact with ARVs. Anaesthetic agents may induce pharmacodynamic changes to affect the efficacy and toxicity of ARVs, and pharmacokinetic effects of ARVs can affect the absorption, distribution, metabolism and elimination of anaesthetic drugs. Pharmacodynamic interactions can be managed by avoiding anaesthetic agents such as halothane or methoxyflurane that cause hepatic or renal dysfunction. Propofol and NRTIs may both potentially promote mitochondrial toxicity and lactic acidosis and it may be wise to avoid propofol infusions in patients receiving ARVs.

Pharmacokinetic interactions are more complicated and are primarily due to liver enzyme induction or inhibition, particularly the CYP450 3A4 enzyme. Protease inhibitors (PIs) and NNRTIs are the most commonly implicated group of ARVs in drug interactions. Enzyme induction or inhibition can affect the action of several classes of anaesthetic drugs:

- *Opioids*. The effects of fentanyl may be enhanced by ritonavir due to both liver enzyme inhibition and induction. Enzyme inhibition reduces fentanyl clearance and enzyme induction increases metabolism to active metabolites such as nor-mepiridine.
- *Benzodiazepines*. Saquinavir may inhibit midazolam metabolism.
- *Calcium channel blockers* may have enhanced hypotensive effects due to enzyme inhibition.
- *Local anaesthetics* such as lignocaine may have increased plasma levels due to enzyme inhibition.
- *Neuromuscular blocker* effects may be prolonged, even a single dose of vecuronium for instance.

These interactions are complicated and multiple and databases exist that describe these interactions in detail (www.hiv-druginteractions.org), although evidence for interactions with anaesthetic drugs specifically is relatively sparse.

Perioperative management of ARVs

Due to increasing problems of drug resistance in the treatment of HIV, it is recommended that ARV therapy be continued throughout the perioperative period if at all possible. Naturally this needs to be compatible with surgery and the patient's gastrointestinal function. Some ARVs are available in liquid form enabling administration via

feeding tube or gastrostomy. Parenteral preparations are limited to zidovudine and enfuvirtide only.

REGIONAL ANAESTHESIA

The presence of HIV infection is not an absolute contraindication to regional anaesthesia and there is no evidence that HIV progression is increased by central neuraxial blockade. However, the presence of HIV complications may pose relative contraindications to regional anaesthesia:

- Myelopathy
- Vertebral or spinal neoplasms
- CNS infections
- Coagulopathy.

It is essential to conduct a full preoperative neurological assessment and to document any neurological deficit.

BLOOD TRANSFUSION

There is evidence that allogeneic blood transfusion in the HIV infected patient can lead to transfusion-related immunomodulation (TRIM) and can result in an increase in HIV viral load. Blood should therefore only be transfused where unavoidable to maintain patient safety.

THE CHILD WITH HIV

More than 80% of HIV-infections in children are due to transplacental exposure to maternal HIV during the perinatal period. 13% of HIV-infected children are exposed during blood transfusions and 5% from blood products for treatment of coagulation disorders. Paediatric AIDS is a disease of early childhood with 50% of cases displaying clinical manifestations by 1 year of age and 80% by 3 years of age. The disease affects many systems as described previously in adults, but the clinical manifestations do differ from adults in several ways:

- Pulmonary disease is the leading cause of morbidity & mortality.
- Lymphoid interstitial pneumonitis (chronic lung disease) is more common.
- Cardiac abnormalities are noted in both asymptomatic HIV infection as well as advanced AIDS.
- Most children infected with HIV will have neurological abnormalities including progressive encephalopathy with signs of developmental delay, progressive motor dysfunction, loss of milestones and behavioural changes.
- Opportunistic infections of the central nervous system are less common than in adults.
- Children with HIV often fail to thrive, primarily from chronic infectious diarrhoea and mucocutaneous candidiasis in 75%.
- Lymphadenopathy is a common presenting feature.
- The type of surgery in children infected with HIV is different from that of adults. Three common operations in adults with HIV are lymph node biopsy, splenectomy and partial colectomy. In children, therapeutic and diagnostic procedures predominate (such as central venous catheter placement, gastrostomy tube placement, lung and liver biopsies). Common surgical procedures of childhood such as tonsillectomy or herniorrhaphy may also be required.

PAIN

Pain is common in advanced HIV disease and can be very difficult to treat. The aetiology of this pain can be multifactorial, including opportunistic infections such as herpes simplex, HIV-related arthralgia, peripheral neuropathy and drug-related pain. This can have impact also on the treatment of postoperative pain relief and will necessitate a multimodal approach.

CRITICAL CARE

HIV-infected patients may require intensive care treatment in one of many circumstances related to HIV disease and for medical and surgical conditions unrelated to HIV. Overall mortality rates for HIV-infected patients requiring intensive care have improved from approximately 70% in the early 1980s to 30-40% at present. New diagnosis of HIV in the ventilated, sedated patient who is unable to consent to testing presents an ethical problem. No evidence exists as yet to support whether or not the initiation of ART may improve outcome in the critically ill HIV patient.

INFECTION CONTROL

Healthcare workers should adopt universal infection control precautions for all patients to protect themselves against blood-borne infections as in areas of high HIV prevalence many patients will be asymptomatic and may be classified as ASA 1-2. The cumulative risk of contracting HIV over an anaesthetic career can be as high as 4.5% in areas of high prevalence. This may occur due to a needlestick injury, particularly if there is a high volume of blood injected, such as with hollow needles or deep punctures (transmission risk of 0.3%). Risk of transmission via the mucocutaneous route (splashing of a mucosal surface or broken skin by body fluid) is 0.03%. All healthcare workers should be immunised against hepatitis B.

Some precautions that should be taken to reduce the risk of HIV transmission to healthcare workers:

- Dispose of sharps safely
- Do not re-sheath needles
- Wear gloves
- Use disposable equipment where possible
- Clean reusable equipment promptly and properly.

If a healthcare worker suffers a needle stick injury or is exposed to potentially infected blood or body fluid, the following steps should be taken:

First aid

- Needle stick or contaminated wound – encourage bleeding from the skin wound and wash the area with copious soapy water or disinfectant.
- Contaminated intact skin – wash with soap and water.

- Contaminated eyes – gently rinse eyes while open with saline or water.
- Contaminated mouth – spit out any fluid, rinse the mouth with water and spit out again.

If the patient is known to be HIV positive, the healthcare worker should receive post-exposure prophylaxis as soon as possible after exposure (ideally within the first 1-2hrs).

If tuberculosis is suspected or likely in a patient, the healthcare worker should wear a tight fitting facemask to reduce the risk of transmission (ideally a high quality particulate mask if available e.g. N95 or HEPA). Anaesthetic breathing equipment should be decontaminated after use to protect future patients.

ANAESTHETIC MANAGEMENT PLAN

A multisystem and multidisciplinary approach is recommended. Thorough preoperative assessment for status of HIV infection includes:

- History, including risk factors
- Physical examination
- Laboratory tests
- Assess organ involvement
- Drug history and side effects.

Investigations should include:

- Full blood count
- Clotting function to exclude coagulation abnormalities (consideration of use of TEG/platelet mapping if available)
- Biochemical tests including glucose, electrolytes, renal & liver function to exclude possible metabolic, liver or renal disturbances
- Viral load and $CD4^+$ count
- Chest radiography to screen for opportunistic infections and tuberculosis
- Cardiac evaluation with electrocardiography and echocardiography (if possible) to screen for cardiomyopathy.

Preparation of theatre and personnel:

- Infection control preparation including universal precautions with gloves, aprons, visors etc.
- Sharp object collection devices with appropriate sharps handling (no re-sheathing of needles)
- Staff fully aware of protocols in the event of occupational exposure:
  - Rinse & wash affected area with soap & water
  - Recipient lab tests: HIV, acute hepatitis panel
  - Determine infectious status of source.
- Availability of post exposure prophylaxis to be started as soon as possible following accidental exposure (ideally within 1 hour of exposure).
  - Hepatitis B immune globulin and/or hepatitis B vaccine
  - Achieve early identification of chronic hepatitis C disease
  - HIV PEP protocol with 3 or more ARVs if known HIV positive donor or high-risk patient or with 2 or more ARVs if low risk. These ARVs are given for 4 weeks or until source person is found to be negative for HIV.
  - Follow up with counselling and HIV testing for at least 6 months post exposure (tests done at baseline, 6 weeks, 12 weeks and 6 months).

Perioperative considerations for the patient with HIV:

- Minimise interruptions in ARV therapy as possible to diminish drug resistance
- Consider drug interactions with ARV with use of drugs affected by hepatic enzyme inhibition and/or induction
- Strict aseptic technique to be exercised as HIV infected patients are immunocompromised and are susceptible to bacterial infections
- The anaesthetic plan should be tailored to the individual patient and the type of surgery as appropriate.

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Update in
Anaesthesia

Extubation after Anaesthesia: A Systematic Review

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Summary

Almost all tracheal intubations are performed with the expectation of subsequent extubation. However there is a relative lack of guidance and research regarding this key aspect of anaesthetic care. Respiratory complications around extubation arise in 12% of elective cases, compared to 4.6% in the same patient group at induction.[1] If coughing is discounted as a complication, the incidence was still higher for the extubation period. The American Society of Anesthesiologists closed claims project shows that, in the management of the patient with a difficult airway, 12% of claims relate to extubation events.[2] We present a systematic review of the available evidence for management of extubation.

METHODOLOGY

The electronic database PubMed was searched up to June 2009. The search contained the following MeSH headings: extubation, cough, laryngospasm, post-operative residual paralysis and was limited to human studies in core clinical journals. All titles and abstracts were reviewed and papers focusing on all aspects of extubation relating to anaesthesia were chosen. Those concerned with extubation in intensive care were not included. Randomised controlled trials, cohort studies, case control studies, cross-sectional studies, case series and expert opinion were selected for analysis. Studies were then assessed using the method described by the Scottish Intercollegiate Guidelines Network (Table 1). Initially studies were assigned a level, dependent on their place in a hierarchy of study types. Next a quality rating was assigned to each study design with particular attention to the risk of bias within the methods used. A grade of recommendation was then made on the strength of evidence available.

Table 1. *Scottish Intercollegiate Guidelines Network grading for recommendations in evidence based guidelines. RCT – randomised controlled trial*

Levels of evidence	
1^{++}	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias.
1^{+}	Well conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias.
1^{-}	Meta-analyses, systematic reviews or RCTs, or RCTs with a high risk of bias.
2^{++}	High quality systematic reviews of case-control or cohort studies or high quality case control or cohort studies with a very low risk of confounding bias or chance, and a high probability that the relationship is causal.
2^{+}	Well conducted case-control or cohort studies with a low risk of confounding bias or chance, and a moderate probability that the relationship is causal.
2^{-}	Case-control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal.
3	Non-analytic studies, e.g. case reports, case series.
4	Expert opinion.
Grade of recommendations	
A	At least one meta-analysis, systematic review, or RCT rated as 1^{++} and directly applicable to the target population or a systematic review of RCTs or a body of evidence consisting principally of studies rated as 1^{+} directly applicable to the target population and demonstrating overall consistency of results.
B	A body of evidence including studies rated as 2^{++} directly applicable to the target population and demonstrating overall consistency of results or extrapolated evidence from studies rated as 1^{++} or 1^{+}.
C	A body of evidence including studies rated as 2^{+} directly applicable to the target population and demonstrating overall consistency of results or extrapolated evidence from studies rated as 2^{++}.
D	Evidence level 3 or 4 or extrapolated evidence from studies rated as 2^{+}

RESULTS

The search produced a total of 6267 citations in PubMed. In addition papers were included from a process called snowballing (using cited references from original bibliographies to extend the search). In total, 46 studies were included in the systematic review.

Paralysis and reversal

Inadequate reversal of paralysis results in a greater likelihood of airway obstruction. Importantly inadequate reversal may still be present when there is adequate spontaneous ventilation.[3] Peripheral nerve stimulators (PNS) can be used to ensure adequate reversal, with the train-of four (TOF) ratio being the most widely used measure (see article in this edition of *Update*). The ratio that is judged adequate has increased with progressive evidence and some authors believe it may be as high as 0.9.[4] This can either be assessed subjectively (using visual or tactile assessment by the clinician), or objectively using an accelerometer. A review of over seven thousand elective adult patients found 51 significant respiratory events in the recovery ward. When 41 of these were matched with controls it was found that the incidence of TOF ratios of less than 0.7 was 73% in the patients with a respiratory

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event, whereas in the matched control group there was none with a TOF less than 0.9.[5]

A recent study of 185 patients showed that of ninety patients assessed using visual assessment of PNS to be adequately reversed, 10 required some airway support and 19 had arterial desaturation to below 90%. Twelve of these patients had an objective TOF ratio less than 0.7 on arrival in the recovery ward. In contrast where an accelerometer was used neither of these complications occurred and the lowest TOF value was 0.84.[6]

Recommendation: Paralysis and reversal

Use of a peripheral nerve stimulator reduces the incidence of postoperative respiratory and airway complications. *(Grade B)*

Position for extubation

Traditional anaesthetic doctrine is for patients to be extubated in the left lateral, head-down position, to reduce the risk of aspiration. Mehta studied six techniques of extubation in a population of 90 general surgical patients to assess prevention of aspiration of 20ml contrast medium, instilled into the hypopharynx.[7] He found that 10 degree head-down tilt in left lateral position, with gentle suction via a catheter placed through the endotracheal tube, prevented any trace of contrast passing below the cords. Importantly the same study demonstrated that in 10/30 patients there was evidence of contamination of the lungs despite attempts being made to empty the mouth and pharynx by suction.

However, it has been suggested in an editorial and supported by a survey of UK consultant anaesthetists that this practice is becoming less prevalent.[8] The change in practice may be related to the increased prevalence of obesity and chronic smoking related lung disease with more patients extubated in the sitting position. Another explanation is that the increase in use of the Laryngeal Mask Airway (LMA), that is usually removed with the patient supine, has made removal of airway devices in the supine position seem to be more acceptable practice. There is no trial evidence to confirm that supine extubation is more or less safe than other techniques. Following emergency surgery, extubation in the left lateral position is still the most favoured position.

Recommendation: Position for extubation

Extubation in the left lateral, head-down position is the position least likely to be associated with aspiration and therefore is the position that should be used in unstarved patients undergoing emergency surgery. *(Grade B)*

For elective patients, particularly those who are obese or have pre-existing respiratory compromise, the sitting position may be considered. *(Grade D)*

Pre-oxygenation prior to extubation

There is some evidence to suggest that a mixture of oxygen and nitrogen may have benefit in avoiding absorption atelectasis. However pre-oxygenation with 100% oxygen prior to extubation is recommended to improve the margin of safety, given the potential for unpredictable airway problems.[9]

Recommendation: Pre-oxygenation prior to extubation

Prior to extubation patients should be administered 100% oxygen. *(Grade D)*

Conscious level

The risk of laryngospam is thought to be higher if the airway is stimulated during Guedel's excitatory plane of anaesthesia. Therefore extubation should either be performed with the patient in a deep plane of anaesthesia or fully awake. A survey of anaesthetists in the United States listed reactive airways disease and reduction in coughing and straining as reasons to favour deep extubation.[10] Despite work demonstrating the ability of volatile anaesthetics to obtund airway reactivity, there is no clinical trial evidence to support this practice. The potential risks of deep extubation include airway obstruction and aspiration of gastric contents.

A randomised controlled trial in paediatric ENT and strabismus surgery found no difference in the incidence of laryngospasm, coughing, sore throat, croup and arrhythmias in those extubated deep or awake.[11] It appears that the technique used should primarily be dictated by the preference of the anaesthetist. A further small study in 1 to 4-year-olds found a higher incidence of coughing and desaturation below 90% with deep (defined as a volatile concentration of more than 2 MAC) compared to awake extubation from isoflurane anaesthesia.[12] This has not been studied in adults. Another suggested approach is that of a 'no touch' technique, where, after suctioning blood and saliva from the pharynx following tonsillectomy, the patient was turned on their side and no further stimulation was permitted until the patient woke spontaneously.[13] This case series of 20 showed a zero incidence of laryngospasm.

Recommendation: Conscious level

Following paediatric surgery, the incidence of post-extubation cough and laryngospasm are similar using deep or awake extubation. *(Grade C)*

In adults, to reduce the incidence of post-extubation cough, deep extubation may be considered. *(Grade D)*

Phase of respiration

Laryngospasm is believed to be less likely during inspiration, since the firing threshold of neurones supplying the adductors of the vocal cords is increased during inspiration.[14] Therefore some recommend extubation at the end of inspiration, with an accompanying positive pressure breath delivered as the cuff is deflated. This technique also

elicits a cough which assists with clearing of secretions from the airway. A further finding of this study was that a higher arterial partial pressure of CO_2 correlated with less cord reactivity. There are no clinical studies investigating this phenomenon in relation to extubation.

Recommendation: Phase of respiration

Extubation should be performed at the end of inspiration. *(Grade D)*

Laryngospasm

This is a relatively common complication in the post-extubation period. The reflex is mediated by the vagus nerves, with the afferent loop conducted via the superior laryngeal nerve to the cricothyroid muscle, causing prolonged adduction of the vocal cords.[15] Patients in an excitatory plane of anaesthesia are particularly at risk, although this phase is often more transient with the rapid onset and offset of today's inhalational and intravenous anaesthetic agents. Glottic stimulation is the most common precipitant, but it can be mediated by other stimuli such as movement and surgical stimulation.

Intravenous (IV) lidocaine 2mg.kg^{-1}, given at induction, dampens laryngeal and pharyngeal reflexes.[16] This is only effective if the injection is given within about 60 to 90 seconds of extubation.[9] This effect is thought to be mediated centrally and there may be a role in treatment of laryngospasm.

Visvanathan et al have designed an algorithm to guide treatment of patients who develop laryngospasm (Figure 1). The authors suggest that 31 out of 189 incidences of laryngospasm reported to the Australian Incident Monitoring Study (AIMS) would have been detected and managed more quickly using this guideline.[17]

As well as intravenous anaesthetic agents and suxamethonium (as described in Figure 1), doxapram 1.5mg.kg^{-1} has been used successfully in the management of laryngospasm.[18] A manual technique, Larson's manoeuvre, has been described in conjunction with jaw thrust. Firm pressure is applied in the space between the ascending ramus of the mandible and the mastoid process - the 'laryngospasm notch'[19] (Figure 2). The mechanism of this technique is unclear.

Recommendation: Laryngospasm

The administration of lidocaine immediately prior to extubation reduced the incidence of post-extubation laryngospasm (however in the authors' experience this not common clinical practice). *(Grade B)*

Adjuncts to the airway – the laryngeal mask

Replacing the endotracheal tube (ETT) with an intermediate airway (such as an LMA) prior to emergence from anaesthesia is safe and effectively reduces coughing, bucking, post anaesthesia sore throat and the cardiovascular response.[20,21,22] This skill is technically unchallenging and superior to use of an oropharyngeal airway.[23,24]

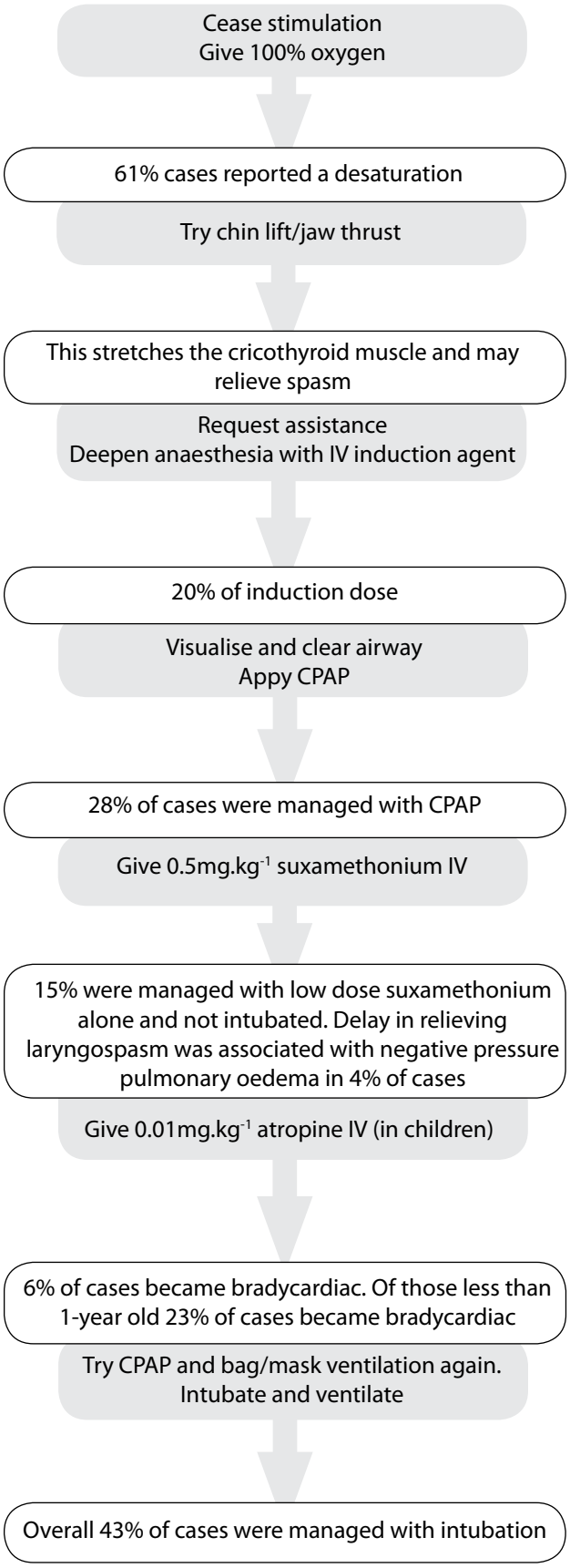

Figure 1. *Algorithm as proposed by Visvanathan et al for management of laryngospasm*[17]

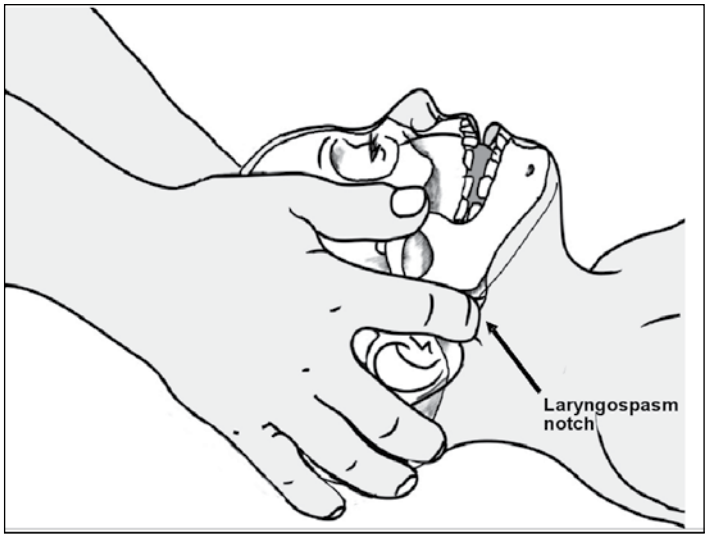

Figure 2. *Larson's manoeuvre involves firm bilateral, medial and cephalad pressure with either the index or middle finger in the 'laryngospasm notch'*

Recommendation: Adjuncts to the airway – the laryngeal mask

Following elective surgery replacing an endotracheal tube with an LMA will reduce the incidence of post-extubation airway adverse sequelae and obtund the cardiovascular response. *(Grade B)*

Pharmacological intervention: cough suppression and haemodynamic stabilisation

Cough is a common response during emergence from anaesthesia and may be considered a normal airway protective mechanism. In some situations this response may be detrimental, for example in neurosurgery or eye surgery. There is also a significant haemodynamic response to extubation which is of relevance for patients who may not tolerate extremes of cardiovascular response (eg. ischaemic heart disease, heart failure).[25]

β-agonists

Beta adrenergic agonists (e.g. albuterol) do not reduce the incidence of coughing at extubation.[26]

Lidocaine

The effects of intravenous, topical (larygotracheal topicalisation or instilled down the ETT) and intra-cuff lidocaine on cough and haemodynamic responsiveness have been studied.

Early studies showed that lidocaine topical spray (five minutes before and during extubation) and lidocaine 1mg.kg^{-1} IV (two minutes prior to extubation) reduce coughing and the haemodynamic response to extubation.[27,28] However more recent studies have shown that coughing and haemodynamic responsiveness are reduced when lidocaine is instilled topically down the ETT five minutes prior to extubation, but not when it was given intravenously.[29] Lidocaine applied topically prior to intubation has also been shown to be more effective when compared with the same dose intravenously.[30] The extubation benefits of topical lidocaine, administered prior to intubation, are seen in procedures of less than two hours duration.[31] In addition the serum concentration of lidocaine required to suppress the cough reflex has been recorded as >3mcg.ml^{-1} whilst cough suppression has been achieved at recorded levels <1.63mcg.ml^{-1} when the lidocaine is applied topically.[32,33]

Lidocaine instilled into the ETT cuff reduces the incidence of cough but has no effects on haemodynamic responsiveness.[34] These effects are also seen with alkalinised intra-cuff lidocaine; the ETT cuff was inflated with 2ml 2% lidocaine in 1.4% or 8.4% sodium bicarbonate, which may improve the diffusion of lidocaine across the cuff membrane. The incidence of post-extubation sore throat and cough were reduced.[35]

Opioids

Opioids have been shown to be effective in reducing the airway and circulatory reflexes at extubation. Low dose remifentanil reduced coughing and haemodynamic responsiveness to extubation in a trial of 60 elective adult ENT patients, with an incidence of coughing of 40% compared to 80% when a low dose infusion (0.014mcg.kg^{-1}.min^{-1}) was administered throughout the extubation period.[36] Alfentanil, 15mcg.kg^{-1} prior to extubation, has also been shown to be effective in a study of 34 elective adult oral surgical patients, with some attenuation of the haemodynamic response.[37] In both studies there was no significant delay in emergence. In a recent small randomised control trial, an anaesthetic using propofol-remifentanil was compared with one using sevoflurane-remifentanil. The total intravenous anaesthetic was associated with a statistically significant lower incidence of cough compared with the volatile-based anaesthetic at extubation, with a cough incidence of only 6%.[38]

Calcium antagonists

Verapamil 0.1mg.kg^{-1} alone and in combination with 1mg.kg^{-1} intravenous lidocaine was studied in 100 healthy patients undergoing elective minor surgery. As a sole agent, verapamil was more effective than placebo and intravenous lidocaine in blunting the haemodynamic response to extubation. The combination of verapamil and lidocaine had the greatest effects.[39] Verapamil 0.1mg.kg^{-1} has been shown to be more effective than diltiazem 0.2mg.kg^{-1}.[40]

β-blockers

Esmolol or labetolol were equally effective in controlling the systolic blood pressure at emergence following intra-cranial surgery and in the recovery room.[41] The effects of beta-blockade on the haemodynamic response to extubation appears to be greater than with short acting opiates.[42]

Recommendation: Cough suppression and cardiovascular response to extubation

Topical lidocaine can be used to reduce cough and the cardiovascular response to extubation where the benefits outweigh the risk of impaired airway protective reflexes. When administered at intubation, the effects last for two hours. Intravenous and intra-cuff alkalinised lidocaine are alternatives but may be less effective. *(Grade B)*

The difficult airway

The algorithms for difficult airway management recommended by the Difficult Airway Society (UK) do not mention extubation. The updated ASA (US) guidelines published in 2003 provide some guidance.[43] They advise that the anaesthetist consider the relative merits of awake versus deep extubation, as well as an evaluation for factors that impact adversely on ventilation and therefore mitigate against immediate extubation. They also recommend formation of a 'plan B' in the event of failed extubation, due to airway obstruction or respiratory failure, suggesting use of an airway exchange catheter (AEC, Figure 3). This is a long semi-rigid hollow tube that is used to facilitate the removal of an endotracheal tube whilst still maintaining access to the airway. Following extubation the AEC can be used as a conduit for the provision of oxygen via jet ventilation or oxygen insufflation. In the case of a failed extubation, an ETT can be 'rail-roaded' over the AEC, which acts as a bougie. Use of an AEC is straightforward and the procedure for use is described in Table 2. There are three main types available - the Sheridan TTX, Tracheal Tube Exchanger (Hudson Respiratory Care inc.), the Cook Exchange Catheter (Cook Medical) and the Endotracheal Ventilation Catheter (Cardiomed supplies inc.)

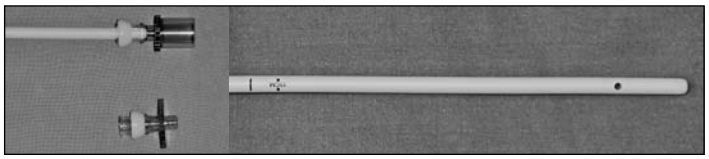

Figure 3. *A Cook Airway Exchange Catheter (Cook Medical) with the option of using either a 15mm adaptor or a Luer lock adaptor for use with jet ventilation*

Table 2. *Procedure for use of an airway exchange catheter*

- Patient sedated
- Administer 200mcg glycopyrolate to reduce oral secretions
- Administer 100% oxygen
- Suction ETT and pharynx
- Note length of ETT to nostril
- Deflate cuff
- Insert lubricated AEC to predetermined length - aim for 3cm above carina. In adults use a 14F AEC – this has an OD (outside diameter) of 4.7mm, which allows an ETT of ID (internal diameter) 5.5mm to be passed over it.
- Extubate patient
- Check position using capnography
- If applicable, oxygen can then be applied via the AEC
- AEC can be left in situ for several hours.

Benumof has written in support of the use of the AEC as part of a stepwise approach to extubation where the airway is difficult and failure of extubation is considered a possibility.[44] Airway exchange catheters tend to be used on intensive care patients and in this population they

Summary of recommendations (with grade)

1	Use of a peripheral nerve stimulator reduces the incidence of postoperative respiratory and airway complications.	**B**
2a	Extubation in the left lateral head down position is the position least likely to be associated with aspiration and therefore is the position that should be used in un-starved patients undergoing emergency surgery.	**B**
2b	For elective patients, particularly those who are obese or have pre-existing respiratory compromise the upright position may be considered.	**D**
3	Prior to extubation patients should be given 100% oxygen.	**D**
4a	Following paediatric surgery, to reduce the incidence of post extubation cough and laryngospasm, a technique of either extubation deep or awake can be considered.	**C**
4b	In adults, to reduce the incidence of post extubation cough, deep extubation can be considered.	**D**
5	Extubation should be performed at the end of the inspiration.	**D**
6	The administration of lidocaine immediately prior to to extubation will reduce the incidence of laryngospasm post-extubation.	**C**
7	Following elective surgery replacing an endotracheal tube with an LMA will reduce the incidence of post extubation airway adverse sequelae and cardiovascular response.	**B**
8a	Topical lidocaine can be used to reduce cough and the cardiovascular response to extubation where the risk of impaired airway protective reflexes is not outweighed by the benefits. IV and alakalinised intra-cuff lidocaine is an alternative but may be less effective.	**B**
8b	Where cough reduction is important consider small doses of short acting opiates and total intravenous anaesthesia.	**B**
8c	Where a cardiovascular response to extubation would be potentially detrimental a bolus dose of intravenous verapamil, esmolol or labetalol prior to extubation should be considered.	**B**
9	When the airway is considered difficult there should be consideration for a staged extubation using an Airway Exchange Catheter.	**B**

have been found to be well tolerated. Five out of 202 complained of a cough in one Canadian study - this was attributed to deep placement of the catheter.[45] In the same study AECs were shown to be effective with 20 out of 22 re-intubations being successful. In a second study there were 47 out of 51 successful re-intubations, with failures attributed to inadvertent displacement of the catheter (n=3) and significant laryngeal oedema.[46] Some potential risks of these devices include deep placement, trauma, high inflation pressures with jet ventilation and subsequent pneumothorax.

Recommendation: The difficult airway
When the airway is considered difficult consider a staged extubation using an airway exchange catheter. *(Grade B)*

SUMMARY

Despite a relative paucity of good quality evidence from large randomised trials, there are some areas where research data can be used to guide practice, improve safety and prevent undesirable complications related to extubation.

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Update in
Anaesthesia

Anaesthesia Outside the Operating Theatre

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Summary

Modern hospital practice has seen the role of the anaesthesiogist expand beyond the operating theatre complex. While the operating theatres have experienced staff, adequate equipment and monitors, providing anaesthesia outside this complex is challenging and requires expertise and skill.

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DEFINITION OF A REMOTE LOCATION

Remote locations, where anaesthesiologists may be required to administer anaesthesia or sedation outside the operating theatres, include:

- Radiology suites e.g. cardiac angiography, interventional radiology, CTscan, MRI
- Endoscopy suites
- The dental clinic
- The burns unit
- Psychiatric unit for electroconvulsive therapy
- Renal unit for lithotripsy
- The gynaecology unit for in vitro fertilisation.

WHO SHOULD PROVIDE SEDATION FOR THE PROCEDURES PERFORMED IN REMOTE LOCATIONS?

A trained anaesthesiologist should provide anaesthesia in remote locations within the hospital. However non anaesthesiologists are allowed to provide 'conscious sedation'. It is mandatory that all providers should be Adult Cardiac Life Support (ACLS) certified.

AIMS OF THE ANAESTHETIST

Safety of the patient is the overiding goal of anaesthesia in remote locations and the standard of care should not differ from that offered in the operating theatre. Rapid recovery from anaestheisa or sedation is beneficial.

In some circumstances, sedation may be chosen rather than general anaesthesia. The particular goals to consider when sedating patients are to:

- Guard the patient's safety and welfare
- Minimise physical discomfort and pain
- Control anxiety, minimise psychological trauma and maximize the potential for amnesia
- Control movement to allow safe completion of the procedure
- Return the patient to a state in which safe discharge from medical supervision is possible.

Some procedures may have special requirements dependent on the location (e.g. in the MRI suite) or the procedure being undertaken (e.g. methods to reduce intracranial pressure in the interventional neuroradiology suite).

PATIENT POPULATION

Many procedures undertaken in remote locations can be accomplished under light sedation, local anaesthesia, or with no sedation. However, there are groups of patients who may require deep sedation or general anaesthesia on a routine basis. These include:

- Children
- Uncooperative or anxious patients
- Claustrophobic patients (especially in MRI suites)
- Elderly or confused patients
- Patients undergoing painful procedures
- Patients requiring burns dressings.

CHALLENGES OF ANAESTHESIA IN REMOTE LOCATIONS

These can be classified as challenges related to:

- Equipment
- Staff
- The procedure
- The patient.

Challenges - equipment

Anaesthesia machine

Ideally the anaesthesia machine should be equivalent in function to that employed in theatres. However the anaesthesia machine available for remote locations is often a very basic model with minimal monitors that may not be in regular use in the operating theatres. It is important that these machines are on the same service schedule as the anaesthetic machines in the main operating theatre.

The design of the anaesthetic machine may not be familiar, for example the position of the oxygen flow meter may be on the left hand side (UK standard),

rather than the right hand side (USA standard). It is important to do routine safety checks, such as ensuring that the oxygen failure alarm is working or that there is a hypoxic link if nitrous oxide is being used. Make sure that you can see your anaesthetic machine during the case - radiology procedures are invariably undertaken in darkened rooms and the anaesthesiologist must be vigilant to detect unexpected events such as cessation of oxygen delivery. There may be a light on the anaesthetic machine, otherwise a torch is essential. The light from a laryngoscope is insufficient. Where facilities are available an emergency trolley with a defibrillator should be immediately available.

Oxygen supply
Modern operating theatres are usually equipped with a central supply of oxygen, air and nitrous oxide. Each remote site should have a reliable source of oxygen adequate for the duration of the procedure. In many remote locations, the anaesthesia machine may only have cylinders and therefore it is essential that extra cylinders are ready while the procedure is undertaken. These cylinders should be checked prior to the start of anaesthesia to ensure that they are full. A back-up of at least one full E type oxygen cylinder is advisable before starting any procedure in a remote location.

Cylinder keys
The key to open the cylinder should always be available with the machine. It is essential to check that the cylinder key is readily available prior to starting the induction of anaesthesia.

Electricity
There must be sufficient electrical outlets for the anaesthesia and monitoring equipment.

Illumination
A means of illumination other than the laryngoscope is needed.

Sodalime canister
When using a circle system it is advisable to put fresh soda lime in the canister before undertaking a procedure.

Anaesthesia circuit
Certain procedures require the anaesthesia machine to be at a distance from the patient, therefore circuits and monitors with long extension tubings are necessary. If using a long Bains circuit, a leak test is essential. A self-inflating bag should also be available to provide positive pressure ventilation in case of oxygen failure.

Drugs and supplies
Since these locations are visited infrequently by the anaesthesia team, there is often no regular check up of the anaesthesia inventory. Check that you have all the drugs that you may require during anaesthesia (including emergency and resuscitation drugs), and that these drugs have not exceeded their expiry date.

Working suction
Central suction may not always be available in remote locations, and therefore it is essential to ensure that a working suction machine is always available along with an electrical extension boards. A foot operated suction machine is handy as a back up and may be mobilised from the operating theatres.

Scavenging
If these anaesthetic vapours are used the there should be a reliable system for scavenging waste gases.

Space constraints
Radiology suites often contain very bulky equipment and it is often difficult to accommodate the anaesthesia machine - make sure that there is enough space in the working environment.

Operating tables
An operating theatre table with the expected range of positions, may not be available in these locations, so the various position adjustments including the height of the table may be difficult to achieve.

Monitoring equipment
Mandatory monitors should be as for any location where anaesthesia is conducted: a pulse oximeter, non-invasive BP cuffs, ECG and end-tidal CO_2 are a minimum requirement. Where muscle relaxants are used, a peripheral nerve stimulator is recommended.

Check that BP cuffs of the appropriate size are available. If possible, mobilise end-tidal CO_2 monitoring from the operating theatres. Monitoring may be a particular challenge in the MRI suite and specially shielded monitoring equipment is required that is MRI compatible and does not interfere with the MRI signal.

Special circumstances - Magnetic resonance imaging (MRI)
All equipment that is taken into the MRI suite should be MRI compatible, or should be fixed at a safe distance from the magnet. Of particular importance – NEVER take an oxygen cylinder into the MRI suite – deaths have resulted as the cylinder is sucked into the magnet coil. NEVER take any ferrous metal into the MRI suite – anaesthesiologists should remember that this includes laryngoscopes, scissors and stethoscopes and mobile phones. In an emergency, take the patient out of the MRI room, do not take the emergency equipment to the patient.

Equipment checklist for sedation or anaesthesia in the MRI suite

a. Anaesthesia drugs.
b. Resuscitation drugs.
c. Defibrillator.
d. A difficult airway trolley containing oropharyngeal and nasal airways, laryngeal mask airways, ETT of different sizes, bougies and stilettes should be available.
e. Simple positioning equipment for instance head rings, shoulder rolls, etc.
f. Infusion pumps with the extension tubing.
g. Warming devices - the temperature in the radiology suites is often cool as their equipment requires low temperature for its maintenance. For prolonged procedures, patients may become hypothermic and warming devices will have to be brought from the operating theatres.
h. Lead aprons, thyroid collars and dosimeters need to be worn in the radiology suites to reduce and monitor the exposure to radiation.

Challenges - staff

Staff that work in these areas are trained only in their speciality and so may not be familiar with the requirements for safe anaesthesia and may not be able to provide assistance to the anaesthesiologist. It is the sole responsibility of the anaesthesiologist conducting the cases to check the machine, anaesthetic drugs, emergency drugs and the defibrillators and to identify an assitant to help them.

In countries where it is usual to have a professional assistant providing support for the anaesthetist in theatres, these standards should be upheld in remote settings. Where this is not common practice it is sensible to have assistance in the form of a trainee anaesthetist. Where the anaesthetist works alone, ensure that rapid communication to colleagues in the main theatre suite is possible.

Communication

Planning is essential. Anticipate problems before starting the case; communication with theatre from a distance may be difficult and help may be slow to arrive.

Challenges - the procedure

Poor illumination

Many procedures such as interventioanal radiology or endoscopy that require video screening are carried out in darkened rooms. Ideally the anesthesia machine should have a fluorescent screen to visualise the flow meters and to check accurate gas flows. Remember that the safety of the patient is of paramount importance, and the lights should not be so low that you cannot monitor your patient.

Unplanned procedures

Beware the situation where the anesthesiologist is called after the intervention has started and the patient is found to be uncooperative. Without a prior plan or airway assessment the situation is hazardous – it is better to abort the procedure and come back another day when things can be planned properly. With the growth of acute cardiological intervention for acute coronary syndromes, emergency calls to the catheter laboratory for anaesthesic assistance are increasingly common.

Setting for the procedure

Burns dressings are commonly done at the bedside and these sites are usually poorly equipped to deal with any kind of emergency.

Patient position

Patients undergoing endoscopy and CT guided biopsies may be positioned in the lateral or prone position. Ensure that pillows are available for safe prone positioning (i.e. under the chest and pelvis to allow for free diaphragmatic excursion). Prone position becomes difficult if the patient requires resuscitation – reposition the patient rapidly if this is the case.

Duration of the procedure

The duration of these procedures is difficult to predict and they may finish very abruptly (e.g. cerebral angiography with coiling of cerebral aneurysms). Avoid long-acting muscle relaxants and maintain close communication with the specialist performing the procedure.

Post-procedure care

Patients who have had a procedure under general anaesthesia require expert recovery - this may be either in the procedure room or the patient may be transferred to the recovery room of operating theatres. Patients undergoing aneurysm coiling may need to be ventilated in the postoperative period. The availability of an ICU bed has to be confirmed prior to the procedure.

Consent forms

Many procedures in remote locations are performed as day care procedures. The patient needs to be registered with the hospital in the usual way, an admission clerking should be performed and consent taken. Day case procedures should not entail a change in the usual standard of care for the patient.

Challenges - the patient

Assessment

Patients are often admitted as a day case and include all age groups. A careful anaesthetic assessment is essential, even if this is done a few minutes prior to the procedure. In particular, the patient requires careful assessment for the reason that they require the intervention, as well as any associated co-morbidities. Fasting status of the patient should be noted and a quick airway assessment should be done. Presence of dentures should be noted. Be particularly careful with airway assessment as an unanticipated difficult airway is very challenging for the anaesthesiologist in remote locations if skilled help is unavailable.

Instructions

Patients who are planned for procedures under anesthesia should be given clear instructions regarding:

- Fasting
- Consent forms
- Medications for comorbidities
- A careful metal check needs to be performed by the radiographer prior to MRI scans – for instance, no hairclips, jewellery, safety pins, mobile phones, credit cards or coins.

CHOICE OF ANESTHETIC TECHNIQUE

- Monitoring only
- Sedation
- Regional anaesthesia
- Total intravenous anaesthesia
- General anaesthesia.

Monitoring only

The procedure specialist monitors the patient with the help of their staff and do not require an anaesthesiologist.

Sedation

Conscious sedation

This describes a depressed state of consciousness where the patient is able to respond to commands, maintains his/her airway and the airway reflexes are well preserved.

Deep sedation
The consciousness of the patient is depressed to an extent that the protective airway reflexes are obtunded and airway maintenance may become an issue.

The degree of safety in conscious sedation is much higher than deep sedation. The patient can easily drift from a state of conscious sedation to deep sedation, depending on his age, sensitivity to drugs, health status etc. Titration and adjustment of the doses of the sedative agents requires skill and experience.

Total intravenous anaesthesia (TIVA)
It is usual to choose drugs to provide a combination of hypnosis and analgesia. Drugs are used intravenously, and some adjunct is often required to maintain a patent airway. The airway can be maintained by chin lift/jaw thrust, or an oropharyngeal airway or laryngeal mask airway may be used if the patient is deeply anaesthetised. Procedures suitable for TIVA include lithotripsy, oocyte retrieval, in vitro fertilisation and foetal reduction in ultrasound rooms.

General anaesthesia
General anaesthesia with controlled ventilation is the choice of anaesthesia in many situations, particularly interventions such as for patients undergoing coiling of cerebral aneurysms. The goals of anaesthetic management are adequate depth of anaesthesia, methods to decrease intracranial tension, along with maintenance of normothermia (avoidance of hyperthermia).

In the MRI centre, an MRI compatible anaesthesia machine is essential if the machine is in the MRI room. Anaesthesia is induced outside the MRI room and the patient is transferred to the MRI compatible machine in the room. It is possible to maintain anaesthesia if the machine is outside the MRI room with the help of long anaesthesia circuits, but this is far from ideal and the patient is at greater risk of circuit disconnections. Monitors must always be kept outsde the MRI room.

Regional anaesthesia
Combined spinal-epidural anaesthesia has been used successfully in remote locations, for example for EVAR - Endovascular aneurysym repair. The conscious patient can communicate and this is a major safety consideration. Monitoring should be to the same standard as for general anaesthesia.

Monitoring
The essential monitor for patient safety is the presence of a trained vigilant anaesthesiologist at all times, monitoring various parameters such as level of consciousness, oxygenation, ventilation, and haemodynamics.

Minimum monitoring includes pulse oximetry, ECG, NIBP and end-tidal CO_2. In a non-intubated patient, end-tidal CO_2 monitoring can be achieved by taping the sampling line to the patient's upper lip. The expired CO_2 is sensed along with the graphic display of respiration.

In our centre, we do not have MRI compatible monitors and the anaesthesiologist sits inside the MRI suite along with the patient and monitors the radial/dorsalis pedis pulse. A cotton wick is placed on the patient's chest. The chest movements are assessed by the movement of the cotton wick when the patient is inside the "tunnel" and is sedated. Vigilence is essential. Ideally, MRI compatible monitors should be available - an MRI compatible pulse oximeter lead can be trailed out of the room and monitored in the control room.

DOCUMENTATION OF ANAESTHESIA
A time-based anaesthesia flow sheet should be available to record the following:

- Drugs administered – time and dose
- SaO_2
- Heart rate
- Respiratory rate
- NIBP – can omit if minimal sedation, e.g. during MRI/CT
- Level of sedation

Observations should be performed at 15 minute intervals for conscious sedation, and 5 minute intervals for deep sedation and general anaesthesia.

CHOICE OF DRUGS
This depends on the proedure being performed, and whether this is painful or painless. (e.g. MRI scan compared to endoscopy compared to a change of burns dressings). Precise guidance for different procedures is outside the scope of this article, however examples of commonly used agents include:

Midazolam
In paediatric patients, intranasal midazolam has also been tried successfully.

Fentanyl
0.25-0.5mcg.kg^{-1} is usually sufficient.

Propofol
A careful and slow intravenous injection of propofol is an ideal choice.

Ketamine
Used in children. Use in adults has decreased with the availability of propofol.

Ketofol
A combination of ketamine and propofol has also been used and it provides good hemodynamic stability.

Remifentanil
An ideal drug but not available in India and many other parts of the world.

Prilox cream has been used successfully in cases for lithotripsy.

There is substantial variability in the response to each agent between individuals, and so carefully administration of drugs, titrated to effect is essential.

Equipment check list for anaesthesia or sedation in a remote location away from the operating theatre[3]

Remember the acronym **SOAPME**.

S (suction) – Appropriate size suction catheters and functioning suction apparatus.

O (oxygen) – Reliable oxygen sources with a functioning flow meter. At least one spare E-type oxygen cylinder.

A (airway) – Size appropriate airway equipment:
- Face mask
- Nasopharyngeal and oropharyngeal airways
- Laryngoscope blades
- ETT
- Stylets
- Bag-valve-mask or equivalent device.

P (pharmacy) – Basic drugs needed for life support during emergency:
- Epinephrine (adrenaline)
- Atropine
- Glucose
- Naloxone (reversal agent for opioid drugs)
- Flumazenil (reversal agent for benzodiazepines).

M (monitors):
- Pulse oximeter
- NIBP
- End-tidal CO_2 (capnography)
- Temperature
- ECG

E (equipment):
- Defibrillator with paddles
- Gas scavenging
- Safe electrical outlets (earthed)
- Adequate lighting (torch with battery backup)
- Means of reliable communication to main theatre site.

Further detail on sedation for children can be found in the Further reading section.

SPECIAL CONSIDERATIONS

- Anaphylaxis to iodinated dyes is possible. All the drugs for management of anaphylaxis should always be immediately available.
- Techniques to measure temperature and avoid hypothermia are essential.
- Radiation exposure - anaesthesia personnel should be aware of the radiation hazards and take precautions to avoid radiation exposure.

POST-PROCEDURE CARE

Transport of the patients to a standard recovery room accompanied by the monitors along with the accompanying anaesthesiologist is the safest practice for post-procedural care. Most patients require oxygen during transport. Patients who require elective postoperative ventilation must be transferred with continuous monitoring.

DISCHARGE CRITERIA

The discharge criteria of these patients are the same as for any patient after surgery.

CONCLUSION

The secret of success in anaesthesia for remote locations is the skilled anaesthesiologist with the appropriate equipment and drugs, along with adequate back up facilities.

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Update in
Anaesthesia

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Monitoring of Neuromuscular Block

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Summary

Postoperative residual curarization occurs even after administration of intermediate-acting non- depolarizing neuromuscular blocking drugs, for example, atracurium or vecuronium.

Satisfactory recovery from neuromuscular block has not occured until the train-of-four ratio is >0.9.

Quantitative methods of measuring evoked responses, for the example, acceleromyography or mechanomyography, are necessary to ensure adequate recovery from block.

There is increasing evidence that residual neuromuscular block is common, and also that it may adversely affect patient outcome. A study by Debaene and colleagues[1] found that 45% of patients had residual curarization (train-of- four [TOF] ratio<0.9) in the postoperative recovery room after a single intubating dose of the intermediate-acting drugs atracurium, vecuronium or rocuronium. Another study found residual curarization (TOF ratio<0.7) in 42% of patients in the postoperative recovery room after vecuronium.[2] Neuromuscular block was not antagonized in either study and the use of neuromuscular monitoring was not recorded, as anaesthetists were encouraged to carry out their practice routinely during these investigations. Although there is no evidence that residual neuromuscular block leads to increased mortality, significant pulmonary morbidity has been demonstrated after using longer-acting agents such as pancuronium.[3] As well as interfering with pulmonary mechanics, residual neuromuscular block impairs the ventilatory response to hypoxia.[4] At low doses, these drugs significantly impair pharyngeal function and lead to an increased risk of tracheal aspiration and airway obstruction.[5]

When neuromuscular monitoring is used, visual or tactile evaluation of the degree of neuromuscular block is unreliable. Even experienced anaesthetists are unable to detect fade when the TOF ratio is >0.4.[6] It is now thought that significant residual curarization is still present if the TOF ratio is <0.9[7] (not 0.7 as previously suggested[8]). It is clear that as well as monitoring neuromuscular block clinically, we should be using quantitative techniques to assess the degree of recovery.

MONITORING NEUROMUSCULAR FUNCTION

On recovery, the anaesthetist can assess muscle power by a variety of clinical tests, such as the ability to sustain head lift for 5 seconds,[8] or the ability to hold a tongue depressor between the teeth. These are a crude assessment of neuromuscular function, and can be influenced by many factors, for example, residual sedation or inability to follow instructions. In 1958, Christie and Churchill-Davidson described the use of a nerve stimulator to monitor neuromuscular block. However, it was not until the TOF pattern of stimulation was described in 1970, that such equipment came into routine clinical use.[9]

STIMULATING THE MOTOR NERVE

The degree of neuromuscular block can be assessed by applying a supramaximal stimulus to a peripheral nerve, and then measuring the associated muscular response. (The motor unit consists of a motor neurone and a muscle, which are separated by the neuromuscular junction. Typically, one nerve fibre will innervate between 5 and 2000 muscle fibres). The nerve chosen to be stimulated must fulfil a number of criteria. First, it must have a motor element; second, it must be close to the skin; and third, contraction in the muscle or muscle group which the nerve supplies must be visible or accessible to evoked response monitoring.

In order to stimulate a nerve, an electrical current will need to be applied. The current is usually applied transcutaneously, using ECG electrodes. The chosen nerve will contain many motor nerve fibres. All of these fibres will need to be stimulated in order to produce a maximal muscle contraction. Generating an action potential in all of the nerve fibres in a motor nerve will require a current of sufficient magnitude and duration. Most nerve stimulators will apply a current for 0.1–0.3ms, which is more than adequate. The current which generates a response through all nerve fibres and hence a maximal muscle contraction is termed a maximal stimulus. Traditionally, a current of 25% above the maximal stimulus is applied when stimulating a peripheral nerve: this is termed a supramaximal stimulus.

IDEAL NERVE STIMULATOR

The ideal nerve stimulator would possess certain basic properties: it should be battery operated and able to deliver a *constant current*, up to a maximum of 80mA. This is preferable to a nerve stimulator that can only deliver a constant voltage.

Current magnitude is the factor that determines whether a nerve depolarizes or not. At a constant voltage, current will vary depending on the resistance of the skin. The two are related by Ohm's Law which is given by the equation V = IR, (V = voltage, I = current and R = resistance). Skin resistance will range from 0 Ω

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to 5kΩ, and is affected by such factors as skin temperature, adequacy of electrode application, and disease state, for example, diabetes mellitus or chronic renal failure. Adequacy of electrical contact should be displayed on the monitor screen.

The pulse stimulus should last no longer than 0.3ms and be of a monophasic, square wave type. This will ensure that a constant current is maintained throughout the stimulus. The polarity of the electrode leads should be indicated; it is recommended that the negative electrode be placed directly over the most superficial part of the nerve. The positive electrode can then be placed in a position along the course of the nerve, usually proximally to avoid direct muscle stimulation. The nerve stimulator should be capable of delivering a variety of patterns of stimulation including: single twitch (at 1Hz); TOF twitch stimulation (usually 2Hz with at least a 10s interval between trains); tetanic stimulation at 50Hz for up to 5s; and double-burst stimulation (DBS). Good electrical contact with the skin can be established using ECG electrodes of the silver/silver chloride variety. The skin should always be cleansed adequately before applying the electrodes. The ideal stimulator would also enable monitoring of the evoked responses. The pattern of the evoked response generated by nerve stimulation will depend on the type of drug used to produce neuromuscular block, and the pattern of stimulation.

PATTERN OF NERVE STIMULATION

Single twitch stimulation

A single square wave supramaximal stimulus is applied to a peripheral nerve for a period of about 0.2ms, at regular intervals, and the evoked response is observed. The twitch response will only be depressed when a neuromuscular blocking agent occupies 75% of the post-synaptic nicotinic receptors. Twitch depression will need to be more than 90% in order to provide good conditions for abdominal surgery.

The most useful time to apply the single twitch pattern of nerve stimulation is at the onset of neuromuscular block. Using a single twitch at 1Hz (1 twitch every second), it is possible to establish the level at which a supramaximal stimulus is obtained. The onset of neuromuscular block can then be observed, using a single twitch at 0.1Hz (1 twitch every 10s). The onset and recovery from depolarizing and non-depolarizing block monitored using single twitches have a similar pattern, differing only in timescale — Figures 1A and B.

The major limitation to this technique is the need to measure a control twitch before administering the neuromuscular blocking agent. Single twitches are also used in the post-tetanic count, but in this instance a control twitch height is not required.

Train-of-four stimulation

The TOF pattern of twitch stimulation was developed in 1970 by Ali and colleagues,[9] in an attempt to provide a clinical tool to assess neuromuscular block in the anaesthetized patient. The principle was to produce a pattern of stimulation that did not require the comparison of evoked responses to a control response obtained before administration of a neuromuscular blocking drug. The pattern involved stimulating the ulnar nerve with a TOF supramaximal twitch stimuli, with a frequency of 2Hz, that is, four stimuli each separated by 0.5s. The TOF was then repeated every 10s (train frequency of 0.1Hz). As well as enabling the observer to compare T1 (first twitch of the TOF) to T0 (control), it also enables comparison of T4 (fourth twitch of the TOF) to T1. This is known as the *TOF ratio*.

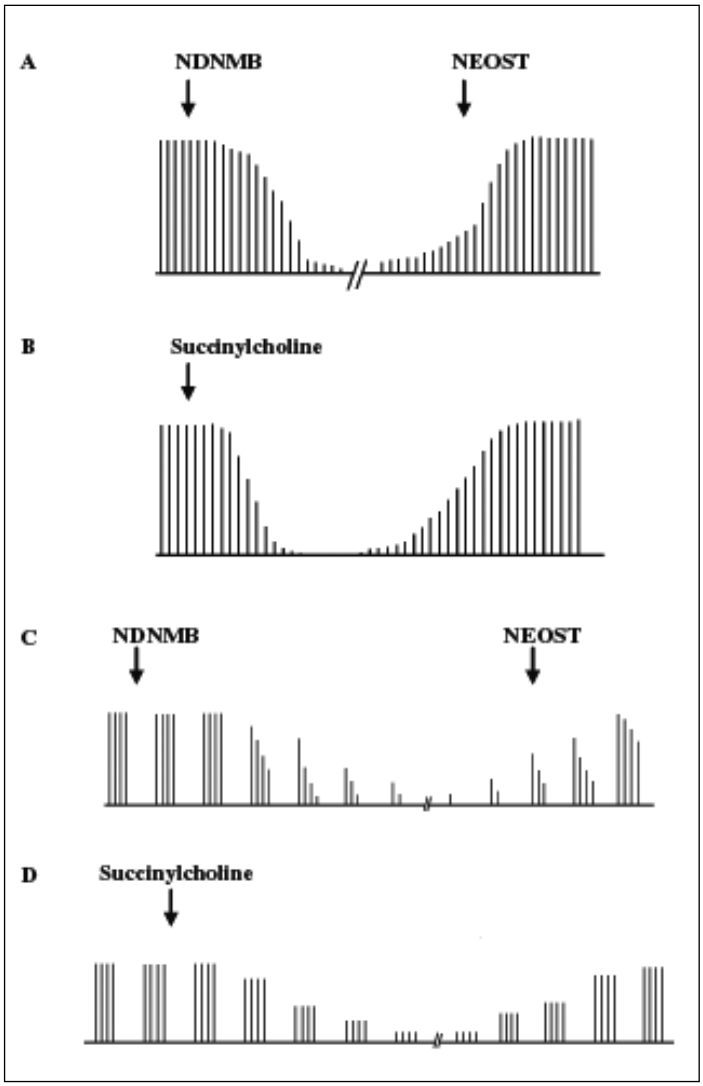

Figure 1. *(A) Pattern of evoked muscle responses to twitch stimulation after administration of a non-depolarizing neuromuscular blocking drug (NDNMB), followed by antagonism with neostigmine (NEOST). NEOST hastened the rate of recovery, if the twitch has already started to increase. (B) Pattern of evoked muscle responses to twitch stimulation after administration of succinylcholine. (C) TOF monitoring of onset of neuromuscular block produced by a NDNMB, followed by antagonism with NEOST, given when three twitches of the TOF are detectable. (D) TOF monitoring of onset of, and recovery from, neuromuscular block produced by succinylcholine.*

When a non-depolarizing agent is given, a typical pattern is observed. There is a reduction in the amplitude of the evoked responses, with T4 affected first, then T3, followed by T2, and finally T1 (Figure 1C). This decrement in twitch height is known as *fade*. As the non-depolarizing block becomes more intense, T4 disappears followed by T3, T2, and finally T_1. The reverse is true during recovery from non-depolarizing block: T1 reappears first followed by T2, T3, and finally T4 (Figure 1C).

During onset of non-depolarizing block, T4 disappears at about 75% depression of T1, T3 at 80–85% depression of T1, and T2 at 90% depression. During partial non-depolarizing block, the number of twitches *(TOF count)* correlates with the degree of neuromuscular block. Twitch suppression of 90% would equate to a TOF count of 1 or less. Reversal of residual neuromuscular block can safely be achieved when the TOF count is 3 or greater.[7]

The T4/T1 ratio is important as it is thought to be closely related to T1/T0. One of the most useful clinical applications of the TOF ratio is in monitoring recovery from neuromuscular block. Traditionally, it had been accepted that a TOF ratio of 0.7 or greater was an indication of adequate reversal.[9] However, this has been challenged recently and it is now thought that a TOF ratio of 0.9 should be achieved before tracheal extubation.

The TOF pattern is less useful in monitoring depolarizing neuromuscular block. During onset of depolarizing block, each of the four twitches is decreased equally in size, that is, there is no fade (Figure 1D). This is also observed during recovery. However, if larger doses of depolarizing agent are given, for example in techniques that require repeated bolus doses or infusions of succinylcholine, then a *Phase 2 block* may develop. This is a block produced by a depolarizing drug which develops some of the characteristics of a non-depolarizing block. With TOF monitoring, fade is observed.

Tetanic stimulation

Tetanic stimulation uses a high frequency (50–200Hz) with a supramaximal stimulus for a set time: normally 5s. In healthy skeletal muscle during normal movement, the response is maintained as a tetanic contraction. However, on administration of a non-depolarizing neuromuscular blocking drug, the muscle, depending on the degree of block, will show signs of fade, that is, the stimulated muscle will be unable to sustain a muscular contraction. At higher frequencies (100–200Hz) muscular fatigue may develop, but at a stimulation frequency of 50Hz this should not occur, and the degree of fade will correspond more closely to the degree of neuromuscular block. This pattern of stimulation is very sensitive and can elicit minor degrees of neuromuscular block, which is potentially useful in the postoperative recovery room. However, its use is limited by the fact that tetanic stimulation is extremely painful.

Tetanic stimulation has complex effects on the neuromuscular junction especially in the presence of a neuromuscular blocking drug. Fade is thought to be an effect of a non-depolarizing agent on the presynaptic nerve membrane. Acetylcholine released during a tetanic stimulus into the synaptic cleft has a positive feedback effect through its actions on presynaptic receptors. These actions ensure that the amount of acetylcholine released from the nerve terminal is far greater than that which is required to generate an adequate end-plate potential and sustain a tetanic contraction. In the presence of a non-depolarizing neuromuscular blocking agent, this margin of safety is greatly reduced. The competitive block at the presynaptic receptors decreases the amount of acetylcholine mobilized and released, contributing to the fade seen during tetanic stimulation.

During partial depolarizing block, fade is not observed in response to tetanic stimulation. The amplitude of the evoked response will be lower but the tetanic contraction will be maintained.

Post-tetanic count

During profound non-depolarizing neuromuscular block, there may be no response to TOF or single twitch stimulation. In such circumstances, a post-tetanic count (PTC) may be useful. If a 5 second tetanic stimulus at 50Hz is administered, after no twitch response has been elicited, followed 3 seconds later by further single twitches at 1 Hz, there may be a response to single twitch stimulation. Although this pattern will not be seen during very profound block, a response will be seen in the early stages of recovery, before the TOF reappears. This is known as *post-tetanic facilitation*. On completion of a tetanic stimulus, acetylcholine synthesis and mobilization continue for a short period. As a result there is an increased, immediately available store of acetylcholine which causes an enhanced response to subsequent single twitch stimulation. The number of post-tetanic twitches is an indication of when the first twitch of the TOF will reappear. For instance, the first twitch of the TOF generally returns with a PTC of 9 when using atracurium or vecuronium.

The main use of PTC is when profound neuromuscular block is required, for example, during retinal surgery, when movement or coughing could have devastating effects. It should be remembered that a tetanic stimulus, by mobilizing acetylcholine, might affect the neuromuscular junction of a stimulated nerve for a significant time. If two PTCs are administered in quick succession, the degree of neuromuscular block will be underestimated. It is recommended that tetanic stimulation should not be repeated for a period of 6 minutes.[10]

Double-burst stimulation

DBS was developed to enable the anaesthetist to detect even small degrees of neuromuscular block clinically. Significant residual neuromuscular block can be assessed using the TOF response. However, small degrees of residual block may be easier to appreciate with DBS.

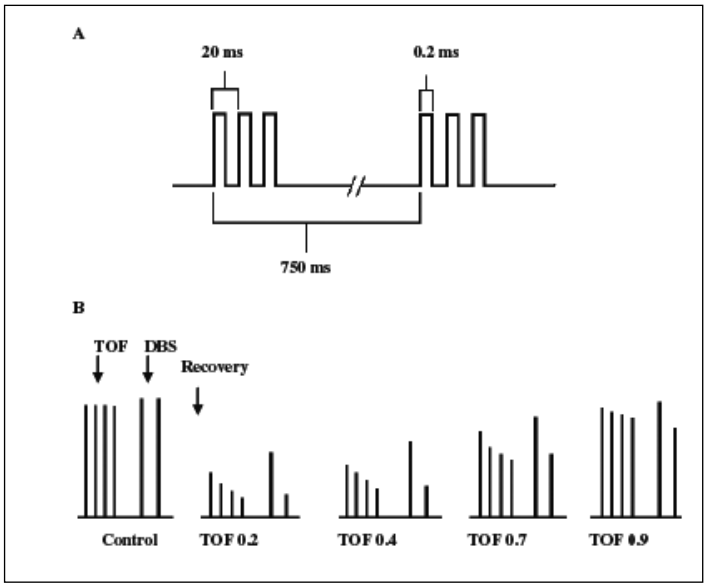

Figure 2. *(A) Double-burst Stimulation. Three impulses in each burst lasting 0.2ms, and separated by 20ms. The two bursts are separated by 750ms. (B) Comparison of evoked muscle responses with DBS and TOF stimulation, after administration of a NDNMB. Fade with DBS is easier to appreciate clinically than fade with TOF stimulation.*[11]

In DBS, two short bursts of tetanus at 50Hz at a supramaximal current are applied to a nerve. Typically, each burst will have three impulses lasting 0.2ms. Each impulse is delivered every 20ms and the two bursts are separated by 750ms (Figure 2A). In unparalysed muscle, two separate muscle contractions of equal intensity will occur. In muscle partially paralysed with a non-depolarizing agent, the response to the second burst is reduced. This is the phenomenon of fade. The ratio of the magnitude of the second stimulus to the first is known as the DBS ratio. The DBS ratio has very similar properties to the TOF ratio (Figure 2B). However, tactile evaluation of the DBS ratio has been shown to be more accurate than tactile evaluation of the TOF ratio.[11]

MEASURING EVOKED MUSCLE RESPONSES

Assessing muscle responses by visual or tactile means is difficult. There are a number of mechanical (mechanomyography [MMG] and acceleromyography) and electrical (electromyography [EMG]) methods for detecting and measuring these evoked responses more accurately.

Mechanomyography

MMG is the measurement of evoked muscle tension. The most commonly studied muscle is adductor pollicis in the thumb. When the ulnar nerve is stimulated at the wrist, the adductor pollicis contracts and causes the thumb to move. If the thumb is stabilized and placed under a fixed amount of tension (preload), then evoked responses can be measured as a change in tension develops.

This is achieved using a strain gauge transducer and recorder. Note that the thumb will not move in this situation; the muscular contraction is said to be isometric. The evoked change in tension is detected by the strain gauge and transduced into an electrical signal, which can then be displayed. In order to ensure accurate readings, the arm and hand must be fixed and movement of the thumb must be along the length of the transducer. This technique can be used for assessment of any pattern of nerve stimulation and is the gold standard. It has the disadvantage of being cumbersome and impractical for use in the operating theatre. There some commercially available mechanomyographs, for example, Myograph 2000 (Biometer Int A/S).

Electromyography

EMG is the recording of a compound action potential that occurs during muscular contraction, whether voluntary or evoked. Again, the adductor pollicis and ulnar nerve are the most commonly used, although other sites in the hand have been advocated, for example, the hypothenar eminence or first dorsal interosseous muscles. Evoked action potentials are a measurement of electrical changes that occur in muscle during stimulation; it is assumed that these are equivalent to the muscular contraction that occurs after excitation–contraction coupling.

The stimulating electrodes are placed over the ulnar nerve. The recording electrodes must be placed carefully: one over the muscle belly; a second, over the tendinous insertion of the muscle; and a third, in a neutral site distant to the muscle. On stimulation, a number of low voltage motor action potentials will be generated. These can be summated into a compound action potential which, because of the very low voltages measured, must be amplified. Recording of EMG potentials has several advantages over MMG. The equipment needed is not as bulky and is easier to assemble. The arm and hand do not need to be fixed as rigidly. The EMG does, however, have a number of disadvantages. It is particularly prone to interference, especially from diathermy. Hand temperature and movement will adversely affect the readings to a greater degree than with MMG. Another potential source of inaccuracy is direct muscle stimulation. Some of these devices are particularly prone to drift. Despite the availability of the Datex Relaxograph, the limitations of EMG mean that it is unlikely to gain widespread clinical use.

Acceleromyography

Acceleromyography was developed as a more convenient method of monitoring evoked responses in the operating theatre. The principle is similar to MMG; however, instead of measuring force of contraction directly, acceleration of the contracting muscle is measured. Force can then be calculated using Newton's second law of motion: force = mass x acceleration. Acceleration is measured by a piezoelectric ceramic wafer that is strapped to the thumb. When the adductor pollicis is stimulated, the thumb will move and the attached transducer will produce a voltage, which is proportional to its acceleration. The voltage can then be converted into an electrical signal and displayed as a twitch response. For accurate measurement, the accelerating digit must be free to move.

It has been established that acceleromyography is comparable to MMG.[12] Acceleromyography is particularly suited to TOF measurement and most of the commercially available machines will enable TOF ratio monitoring, for example, TOF Watch (Organon). Although neither tetanus nor DBS can be monitored by this method, PTC can be.

WHICH NERVE TO STIMULATE AND WHEN?

It must be remembered that onset and offset of block is faster in central muscles with a good blood supply, for example, diaphragm and larynx. Conversely peripheral muscles, with a relatively poor blood supply, will have a slower onset of block and a longer recovery time, for example, adductor pollicis. The muscles of the upper airway and pharynx behave as central muscles at onset; however, they are sensitive to neuromuscular blocking drugs and recovery is slow, mirroring the peripheral muscles.

Table 1. *Conditions where neuromuscular monitoring is essential*[10]

After prolonged infusions of neuromuscular blocking drugs or when long-acting drugs are used
When surgery or anaesthesia is prolonged
When inadequate reversal may have devastating effects, for example, severe respiratory disease, morbid obesity
In conditions where administration of a reversal agent may cause harm, for example, tachyarrhythmias, cardiac failure
Liver or renal dysfunction, when pharmacokinetics of muscular relaxants may be altered

Induction of anaesthesia

During induction of anaesthesia and tracheal intubation, the muscles of the larynx and jaw must be paralysed as well as the diaphragm. The orbicularis oculi is probably the ideal muscle to monitor at this time as it is more similar to a central muscle: onset of block will be similar to the laryngeal muscles and diaphragm.[13] Single twitch or TOF stimulation is the most valuable stimulation pattern at induction. Single twitch stimulation will allow the maximal stimulation level to be obtained. Disappearance of the TOF will correspond to optimal intubating conditions.

Maintenance of anaesthesia

As the diaphragm is relatively resistant to neuromuscular block, a more sensitive peripheral muscle such as the adductor pollicis may not adequately reflect the degree of block required at this stage of anaesthesia. A central muscle which is resistant to neuromuscular block, for example, orbicularis oculi, will reflect the diaphragm more closely and should be monitored at this time. PTC and TOF monitoring are most useful during profound neuromuscular block.

Reversal and recovery

Before administering a neuromuscular antagonist, the TOF count should be at least 3.[7] At this time, monitoring a peripheral muscle such as adductor pollicis is the best option. The respiratory muscles are likely to have recovered to a greater degree, and monitoring a peripheral muscle provides a larger margin of safety. Neuromuscular monitoring should be used routinely when a neuromuscular blocking drug is given; however, there are certain conditions when monitoring neuromuscular block is essential and these are given in Table 1.

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Anaesthesia

BRIEF COMMUNICATION

Paediatric day care surgery at the Korle-Bu Teaching Hospital, Accra, Ghana

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Key words: Daycare surgery, paediatric surgery, inhalational anaesthesia, parental satisfaction

SUMMARY

This paper documents an example of successful daycare surgery in a developing country. We report the prospective experience of paediatric daycare surgery from a paediatric surgery unit of a teaching hospital in an urban centre of a developing country and assess the degree of parental satisfaction of the procedure. The literature regarding daycare surgery for children has mainly come from developed countries where daycare is well established, especially in many sub-specialties such as otorhinolaryngology. Examples from developing countries are few although the potential for provision of service to larger groups of children is understated in developing countries in particular. A questionnaire was developed and administered to the parents of patients undergoing daycare surgery under general anaesthesia over the six-month period in our unit.

INTRODUCTION

Since the 1980s daycare surgery has become an accepted practice for many procedures in paediatric surgery. The literature has examples from developed countries where daycare surgery is well established, initially in subspecialties such as otorhinolaryngology (ENT). There are few documented examples from developing countries. The potential for the provision of service to larger groups of children by this method is understated especially in developing countries where funds are at a premium and resources are scarce.

This paper reports on six months experience of a paediatric surgery unit of a teaching hospital in an urban centre in a developing country. The paediatric surgery unit of the Korle-Bu Teaching Hospital has been using day care surgery for many procedures since the 1970s. This is a prospective review of cases and outcomes as part of an audit process. This study is ongoing but the results discussed here are for the initial six-month period of the study.

MATERIALS AND METHODS

All patients undergoing daycare surgery under general anaesthesia over the six-month period were included in the study. Informed consent was obtained from parents who agreed to have their children participate in the study. A questionnaire was developed and administered to the parents of patients by residents or house officers on the paediatric surgery team.

On the day of surgery, all children were allowed one bottle of Sprite or 250mls of Kalyppo (a clear flavoured sugar drink) at 6 am and then reported to the ward by 7am for surgery.

All surgery was carried out using general anaesthesia without intubation. Intra-operative analgesia administered was recorded and repeat random blood sugars were also taken on the ward prior to discharge home. On discharge home, all patients were given two doses of paracetamol suppositories with the option to administer more as required.

At the initial review four days postoperatively, parents were asked specific questions relating to postoperative pain, occurrence of vomiting, the activity of the child postoperatively, their satisfaction with the procedure and their responses noted. The wound was then inspected and the parents' overall impression of the whole surgical process was recorded

The results were collated and analysed using the SPSS statistical package (version 13.0) using descriptive analysis of sex, age, weight, surgical pathology using diagnosis, duration of anaesthesia and postoperative complications as noted by parents at the initial review.

RESULTS

Seventy-one patients were enrolled in the study during this period. Fifteen (21.1%) were female and 56 (78.9%) were male. Their ages ranged from 3 weeks to 13 years, with weight ranging from 2.4kg to 50kg (mean 18.4kg). The commonest diagnosis was right inguinal hernia (18), followed by a left inguinal hernia (11), undescended testes (7), right hydrocele (6), bilateral undescended testes and umbilical hernia (5 each).

The duration of anaesthesia was from 10 to 130 minutes, with inhalational anaesthesia without

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intubation used in all cases. For analgesia, 64 patients (90.1%) had additional local analgesia consisting of 0.25% plain bipivacaine infiltrated in the wound. Forty-one patients (57.8%) had paracetamol suppositories and one patient (1.4%) was given pethidine. Patients were discharged from hospital within four hours of surgery; the criterion for full recovery was tolerance of a clear fluid drink.

The parents of 60 patients (84.5%) reported that their child had not vomited in the postoperative period with 11 (15.5%) parents confirming that some vomiting had occurred. In all cases this occurred once and did not require any intervention. In 56 patients (78.9%), no further analgesia was required at home. Fifty-six parents (78.9%) stated that the activity of their child postoperatively was normal, with little indication that any surgery had occurred. Fifteen parents (21.1%) reported that the child's activity had decreased in the postoperative period for up to two days. In 66 patients (93%), the wound was clean and dry at initial inspection. The wound was moist in 3 patients (4.2%). There was no record of the wound findings in 2 patients.

Sixty-nine parents (97.1%) indicated absolute satisfaction with the entire surgical process, with only 2 parents expressing some reservations due to their own anxieties. There were no unplanned admissions to hospital in this series.

DISCUSSION

In line with the findings of Desjardins et al that premedication offers no added advantage in giving children undergoing daycare surgery,[1] the patients in this series were not given any premedication. The majority of the patients (60 out of 71, 84.5%) did not experience any vomiting in the postoperative period suggesting that the mode of anaesthesia given in our unit is suitable for daycare surgery. This series confirms the findings of other studies that have suggested that nausea and vomiting are less of a problem postoperatively than pain.[2]

Parents are capable of assessing pain in young children as well as independent assessors.[3] In this study, 79% of parents felt that their children did not required any further analgesia after discharge, implying that intraoperative analgesia with local infiltration of 0.25% plain bupivacaine in the wound, together with preoperative insertion of paracetamol suppositories ($25 mg.kg^{-1}$) offered satisfactory postoperative analgesia. This figure is comparable to those of a previous study, where 75% of parents expressed satisfaction with postoperative analgesia.[4] Use of infiltrated bupivacaine alone has been shown in a previous study to provide adequate postoperative analgesia.[5] This is in contrast to other studies that have recommended use of intraoperative fentanyl or pentazocine,[6] and postoperative tramadol.[7]

Fifty-six (78.9%) of the patients experienced little limitation in their activity and had returned to normal within twenty-four hours of surgery. This indicates the suitability of these patients to daycare surgery. Since the majority of patients (93%) showed good wound healing with no signs of wound infection, it is likely that parents understood and followed the instructions given to them about wound care. This finding is confirmed in other studies.[2,4,8,9]

CONCLUSION

The study confirms that daycare surgery is eminently practicable for the purposes of most daycare paediatric surgery and that parental satisfaction is very high at the Korle-Bu Teaching Hospital, an urban centre in a developing country. There is scope in this setting to widen the variety of specialties involved and procedures performed as day cases. This will enable a large number of children to have surgery in the face of the current shortages of nurses and hospital beds.

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Update in Anaesthesia

CASE REPORT

Magnesium treatment of epinephrine-induced tachyarrhythmia during halothane anaesthesia

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SUMMARY
Halothane is known to be associated with ventricular arrhythmias during anaesthesia and also to lower the threshold for ventricular arrhythmias induced by epinephrine (adrenaline). Intravenous magnesium sulphate has been shown to be an effective treatment for a wide range of cardiac arrhythmias, including ventricular arrhythmias. We present a case report of a patient who developed a broad complex tachycardia after sub-mucosal injection of epinehrine-containing local anaesthetic solution during halothane anaesthesia, who was successfully treated with intravenous magnesium sulphate.

CASE REPORT
A 24-year-old, 50kg ASA grade 1 male presented for repair of cleft palate at Mulago Hospital, Kampala, Uganda. He had undergone a previous uneventful cleft lip repair and had no past medical history of note, in particular, no history of chest pain or palpitations. He worked as a farmer, had excellent exercise tolerance and there was no history of recent illness.

Anaesthesia was induced with thiopentone 500mg and suxamethonium 100mg and the trachea was intubated. Anaesthesia was maintained with 2% halothane in oxygen via a Boyle's machine with a circle system, using manual ventilation with an Ambu® bag. The patient was monitored with a pulse oximeter, manual sphygmomanometer and a precordial stethoscope. The palate was infiltrated with 10ml 0.5% lidocaine (lignocaine) with epinephrine 1:80,000 for haemostasis prior to the start of surgery (50mg lidocaine and 125mcg epinephrine). Approximately five minutes after the initial incision, the patient developed an irregular heartbeat suggestive of multiple ectopic beats, with his systolic blood pressure maintained at 140mmHg. No alternative volatile agent was available so the inspired concentration was reduced to 0.5%. 50mg intramuscular pethidine was administered and the ventilation rate increased to reduce the carbon dioxide level (although there was no end-tidal carbon dioxide monitor available). The ectopic beats continued and then about 5 minutes later the patient suddenly developed a sustained tachycardia at a rate of 180 beats per minute, associated with a weak but palpable pulse and a fall in systolic blood pressure to 60mmHg. The halothane was reduced further to 0.25% and 100mg intravenous ketamine was administered to maintain anaesthesia. An electrocardiogram (ECG) was brought from another theatre that demonstrated a regular broad complex tachyarrhythmia suggestive of ventricular tachycardia. Lidocaine 100mg IV was administered with no effect. There was no defibrillator and amiodarone was not available. Magnesium sulphate was brought from the labour ward and 25mg.kg^{-1} (1.25g) was administered by slow intravenous injection. By the time the injection was completed, the tachyarrhythmia had been terminated, approximately 10 minutes after it had started. The blood pressure was restored to normal and the operation was completed successfully without any further problem. The patient was monitored with ECG, blood pressure and pulse oximetry in the recovery room and observed for two hours with no recurrence of the arrhythmia. The patient made an uneventful postoperative recovery and was discharged home three days later.

DISCUSSION
Halothane remains the volatile agent of choice many developing countries and is unfortunately often administered without the benefits of ECG monitoring.[1] Halothane has well-documented effects on the heart, including myocardial depression, bradycardia, A-V conduction disturbances (via an effect on the SA and AV nodes), promotion of re-entrant tachycardia in association with myocardial ischaemia and reduction in the threshold for epinephrine-induced ventricular arrhythmias. The latter may be associated with high levels of endogenous epinephrine (light anaesthesia, high end tidal carbon dioxide levels), or epinephrine when injected subcutaneously or by sub-mucosal infiltration for surgical haemostasis.[2] The effects of halothane on the heart may be mediated by interactions with ion channels in the cardiac cells, particularly inhibition calcium channels responsible for contraction of the cardiac myocytes and maintaining the refractory period of the cardiac action potential, by promoting adrenergic receptor stimulation, or via inhibition of potassium channels to cause prolongation of the QT

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interval and malignant tachyarrhythmia.[3] Traditional methods to avoid halothane-induced myocardial side effects are to avoid deep halothane anaesthesia, avoid light anaesthesia by using a balanced anaesthesia technique with adequate analgesia, ensure adequate ventilation, and limit the dose of injected epinephrine to no more than 2mcg.kg^{-1}.

In the case described, the anaesthetic technique could have promoted the development of ventricular tachycardia through inadequate analgesia, ineffective ventilation due to lack of muscle relaxation in a young fit patient, and infiltration of the surgical site with a high concentration of adrenaline. This may have been avoided by a balanced anaesthesia technique using an analgesic agent prior to the start of the surgery, ideally a non-depolarising muscle relaxant, and a more dilute solution of epinephrine for wound infiltration (1:200,000 solution containing 5mcg.ml^{-1} epinephrine). There was no alternative volatile agent to halothane to maintain anaesthesia, so the concentration of halothane was reduced and pethidine and ketamine administered for analgesia and to maintain anaesthesia respectively.

Ventricular tachycardia is a potentially life threatening tachyarrhythmia that may deteriorate to ventricular fibrillation. The recommended treatment of an adult with stable ventricular tachycardia is chemical cardioversion with a loading dose of amiodaraone 300mg IV over 20-60 minutes, then 900mg amiodarone IV over 24 hours.[4] Lidocaine 100mg has been shown to be effective, but in only 30-40% of cases.[4] Synchronised electrical cardioversion is recommended for unstable VT, using an initial synchronised shock of 200J, increasing to 360J and loading with amiodarone if necessary. Unfortunately neither a defibrillator nor amiodarone were available during this case, and lidocaine was ineffective.

Magnesium is an essential cation in the body, and has a wide range of physiological functions, such as involvement in neuronal excitability, muscle contraction, control of bronchial and vasomotor tone, neurotransmitter release and cardiac excitability.[5] It is often said to act as a physiological calcium antagonist. It is indicated in the treatment of eclampsia, severe asthma and in particular, for the treatment of polymorphic ventricular tachycardia associated with prolonged QT syndrome. Magnesium acts as an effective membrane stabiliser, and has also been reported to be useful in the treatment of atrial and ventricular arrhythmias after cardiac and thoracic surgery, to reduce the ventricular rate in atrial fibrillation and Wolf-Parkinson-White and for digoxin induced arrhythmias. The patient was hypotensive so a small dose of magnesium was used in this case to avoid further fall in blood pressure (25mg.kg^{-1}), but it was effective in terminating the ventricular tachycardia immediately.

To our knowledge, this is the first case report to demonstrate that intravenous magnesium can be used terminate epinephrine-induced ventricular tachycardia during halothane anaesthesia in humans. Animal studies have suggested that magnesium can be used to reduce the duration of epinephrine-induced tachyarrhythmia during halothane anaesthesia,[6] but the exact mechanism is unclear. Magnesium is an inexpensive drug that is in common use in clinical practice, including in developing countries.

We recommend that patients receiving halothane anaesthesia should be closely monitored for arrhythmias, that deep halothane anaesthesia be avoided and that the dose of injected epinephrine to induce vasoconstriction at the surgical site should be kept within safe limits. Furthermore, we recommend that magnesium sulphate should be available in theatre when halothane is used and that intravenous magnesium sulphate should be considered early in the treatment of epinephrine-induced tachyarrhythmia during halothane anaesthesia.

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Update in
Anaesthesia

CASE REPORT

Post-dural puncture headache after unrecognised dural puncture

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Key words: post-dural puncture headache, epidural, labour analgesia

SUMMARY

We report a case of post-dural puncture headache (PDPH) following epidural labour analgesia without an obvious dural puncture. A twenty-eight year primigravida, with a past history of migraine, developed a headache characteristic of PDPH eighteen hours postpartum, even though thorough testing of epidural catheter placement at the time of insertion had been uneventful. She was managed conservatively and her symptoms subsided after one week. A diagnosis of PDPH should be considered in patients who have received epidural analgesia, even in the absence of obvious dural puncture, so that the full range of treatments for this incapacitating condition can be offered.

INTRODUCTION

Post-dural puncture headache is an important iatrogenic complication of epidural insertion in obstetric patients and results from accidental puncture of the dura mater. The signs and symptoms of PDPH result from loss of cerebrospinal fluid, traction on the cranial contents, and reflex cerebral vasodilatation.[1] Following dural puncture with a 16 gauge Tuohy needle, up to 70% of subjects report symptoms related to low CSF pressure.[2] However 12% of patients receiving a labour epidural suffer a headache that is not characteristic of PDPH.[3]

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CASE REPORT

A twenty-eight year primigravida (height 158cm, weight 55kg) reported to the labour room of our hospital with labour pain at 38 weeks gestation. Her past history revealed treatment for simple migraine (Trade name, Dart: acetaminophen 300mg, propyphenazone 150mg, caffeine 50mg as needed) for 12 years, which was stopped prior to conception. She had received paracetamol for migraine during pregnancy. The patient requested an epidural for labour analgesia, which was performed in the sitting position. Using an 18G Tuohy needle (BD Perisafe™), epidural insertion at the L2-L3 interspace was unsuccessful. The epidural space was successfully identified in L3-L4 interspace using the technique of loss of resistance to saline. A 20G closed-end, multi-orifice epidural catheter was inserted and secured at 8cm length from the skin puncture. An epidural test dose (3ml 2% lidocaine with 5mcg.ml^{-1} epinephrine) was administered to rule out intravascular or intrathecal placement, following which 10ml 0.125% bupivacaine with 2mcg.ml^{-1} fentanyl was administered as 5ml increments. Analgesia was then maintained with an epidural infusion of 0.125% bupivacaine with 2mcg.ml^{-1} fentanyl at a rate of 6ml.hour^{-1}. The patient delivered a healthy 3.2kg male baby vaginally after 5 hours. Following delivery, the epidural analgesic infusion was stopped and the catheter removed.

Eighteen hours postpartum, the patient complained of neck pain and a pulsatile occipital headache that increased on sitting and standing and was partially relieved by lying supine. Examination was unremarkable except for neck stiffness and tenderness at the skin puncture site, with no evidence of local infection. In view of the low suspicion of dural puncture at the time of epidural insertion, the headache was initially felt to be a migraine. However this diagnosis was revised since the patient described such characteristic symptoms of a PDPH. The patient was reassured, oral liquid intake was encouraged and regular paracetamol and a non-steroidal anti-inflammatory drug were prescribed. The patient preferred to lie down in the bed because of the headache. After 48 hours, the patient's symptoms were only partially relieved and she was offered an epidural blood patch, which she refused. Conservative management was continued and she was discharged home on seventh day after complete relief of her symptoms.

DISCUSSION

Although dural puncture was not clinically evident at the time of epidural insertion, the features of this pateint's headache were typical of PDPH, particularly the increase in severity of the headache on standing. The differential diagnosis includes tension and migraine headache, pre-eclampsia, caffeine withdrawal headache

and cerebral pathologies. Patients with a history of migraine are more prone to develop both postpartum headache and PDPH.[3]

The incidence of postpartum headache following epidural labour analgesia without clinically evident dural puncture is 12%.[3] Indeed up to 39% of parturients who have not received neuraxial block report symptoms of a headache following delivery.[4] Aspiration of CSF is diagnostic of intrathecal catheter placement, however failure to aspirate does not rule it out. The incidence of accidental dural puncture with a Tuohy needle, unrecognized by CSF visualization, but subsequently diagnosed by onset of PDPH, is 1.8%.[5] As many as 26% of accidental dural punctures are unrecognized at the time of the procedure and first present as PDPH in the early puerperium.[2] A lignocaine test dose is very reliable in identification of unintentional subarachnoid injection, but two to six minutes is needed to recognize signs of subarachnoid injection. One explanation for this is the widespread use of dilute bupivacaine in place of lidocaine as the epidural test dose, with a view to avoiding the dense motor block associated with lidocaine.

An alternative explanation for PDPH following unrecognized dural puncture is that the epidural catheter tip may puncture the dura while being threaded into the epidural space. If, as in this case, an epidural catheter with a closed tip and three lateral eyes is used, it is conceivable that the test dose could stay within the epidural space with the closed catheter tip plugging the hole in the dural. When the catheter is removed (or it migrates), the dural hole becomes 'unplugged' and results in PDPH.

PDPH may also be caused by the tip of the needle scratching through the dura, which provides another possible aetiology in this patient, particularly since epidural insertion required attempts at two levels.[6]

CONCLUSION

This report demonstates that dural puncture cannot be totally excluded at the time of epidural insertion and the diagnosis may be made retrospectively at the time of onset of PDPH. Diagnosis of PDPH is important so that the effective treatment for this condition can be offered to the patient. We recommend explaining to the patient about the possibility of PDPH even in the absence of obvious dural puncture.

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Update in
Anaesthesia

CASE REPORT

The fractured capnography sampling line - a great pretender

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SUMMARY

We report a fault in the gas sampling line of a monitor at our hospital and the readings which occurred as a result.

CASE REPORT

A 54-year-old man underwent emergency laparotomy under general anaesthesia. The patient received a rapid sequence induction including administration of suxamethonium in the anaesthetic room and, following intubation, ventilation for approximately two minutes on isoflurane 2% while a second peripheral cannula was inserted. The patient was then transferred to theatre and connected to the circle breathing system of the anaesthetic machine in theatre. Peripheral nerve stimulation confirmed recovery from suxamethonium and a non-depolarising muscle relaxant (rocuronium 30mg) was given. Shortly afterwards, the monitor appeared as shown in Figure 1, with the following abnormalities seen: a low end-tidal percentage of inhalational anaesthetic within the circle system, a low end-tidal carbon dioxide partial pressure and an irregular capnograph trace. No immediate explanation was found for these unexpected readings and senior help was summoned. Close inspection of the gas sampling tubing revealed a fracture of the tubing at the 'patient end' (Figure 2). This was replaced and all measurements returned to more anticipated values. The operation proceeded without further incident.

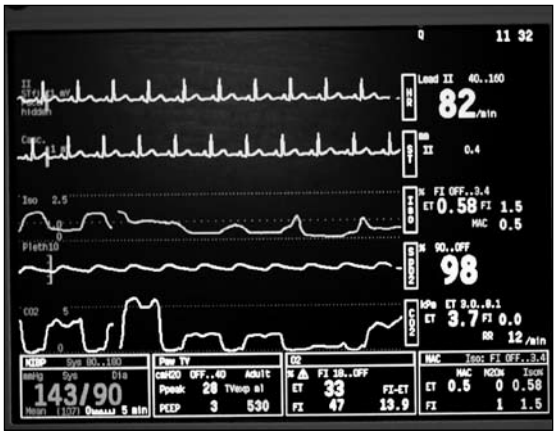

Figure 1. *Monitor appearance during intermittent positive pressure ventilation*

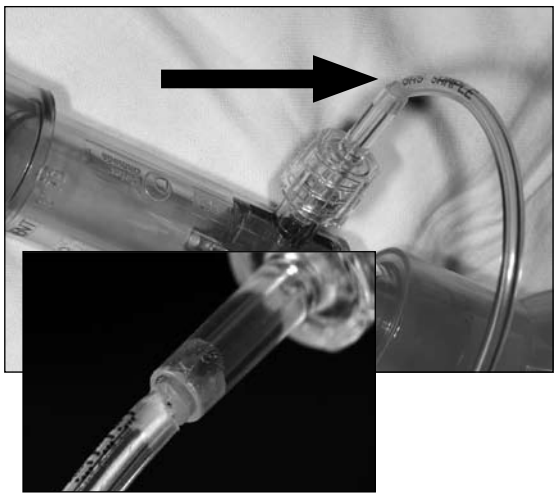

Figure 2. *Gas sampling line incorrectly attached. The arrow marks the site of the fracture (shown inset in close-up)*

DISCUSSION

We report this case to make anaesthetists more aware of this potential equipment problem which we feel is important for a number of reasons. First, the fault has occurred several times at our hospital and, although easily rectified, in each case this fault has been missed during standardised pre-anaesthetic checks, and despite clear instructions from the manufacturer. Second, the fault affects all aspects of gas monitoring (capnography, agent and oxygen monitoring) both in terms of the numerical value and waveform displayed. In addition, the fault may occur intermittently and with sudden onset during anaesthesia if the sampling line is disturbed. Third, the resulting appearance mimics serious conditions, such as sudden reduction in cardiac output, which may lead to inappropriate management with potential harm to the patient.

The gas sampling line is designed with a ninety degree 'elbow' connector at the patient end to avoid stress at the connector. However, the sampling line may be reversed and the elbow connector may be erroneously attached to the gas sampling inlet of the monitor leaving the straight Luer connector attached to the sampling port of the breathing system. Our experience is that this arrangement predisposes to kinking of the sampling line which affects gas monitoring. With repeated use in

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this manner, a fracture may develop at the Luer connector end which can allow air to be entrained into the gas sampling stream. The size of the hole varies according to the position of the sampling line. Small changes in the aperture of the fracture easily occur if the sampling line or breathing system are moved, leading to sudden changes in monitored end-tidal CO_2 and agent levels. A sudden fall in end-tidal CO_2 or agent might lead to a diagnosis of an abrupt fall in cardiac output (for example such as that found in pulmonary or air embolus) or an inadequate level of inspired agent respectively. In addition, an irregular shaped capnograph trace during positive pressure ventilation may suggest incomplete neuromuscular block, leading to further doses of non-depolarising muscle relaxant (see Figure 1).

Gas sampling leaks have been reported in the literature due to presumed manufacturing faults[2], loose connections[3,4] and a small hole.[5] To our knowledge, this is the first example of leak caused by plastic fatigue, due to incorrect placement of the elbow piece, and the first description of a variable leak - simulating a change in the patient's condition. Zupan et al reported a loose connection in a gas sampling line resulting in an unusual capnography waveform (constituting a long duration, low plateau followed by a brief peak) but their findings differ to ours in the waveform seen and do not resemble a curarisation notch.[4] Our case is also the first to demonstrate a change in the gas analysis during anaesthesia, suggestive of change in the patient's clinical state.

The key to detecting this fault lies in awareness of the potential problem and checking of the breathing system and associated apparatus. More specifically, if the sum of the fractional end-tidal values of gases (i.e. $F_{É}O_2 + F_{É}N_20 + F_{É}CO_2 + F_{É}AA$) is significantly less than 1.0 after even a short period of ventilation at high flows, or is variable, a leak in the system and entrainment of nitrogen from the air should be suspected. We note that anaesthetists who habitually exclude nitrogen from their anaesthetic circuits by using nitrous oxide and oxygen rather than air and oxygen may be alerted to the problem more quickly since an increase in nitrogen partial pressure will be more obvious.

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Update in
Anaesthesia

CORRESPONDENCE

Henna and pulse oximetry

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Dear Sir,

I would like to share my experience from working in the Republic of Yemen. Several factors are reported as interfering with the pulse oximetry reading. In Yemen, females use Lawsonia Inermis (henna) dye on their hands and feet as ornamental decoration. This dye cannot be removed but fades with time. An example is shown in Figure 1.

Presence of this dye can cause interference with the pulse oximetry reading (Figure 2), which gives a good waveform, an accurate pulse rate, but an arterial oxygen saturation reading of 0. This interferes greatly with our monitoring of female patients and we report our experience for the benefit of other anaesthetists practicing in his setting.

Figure 1

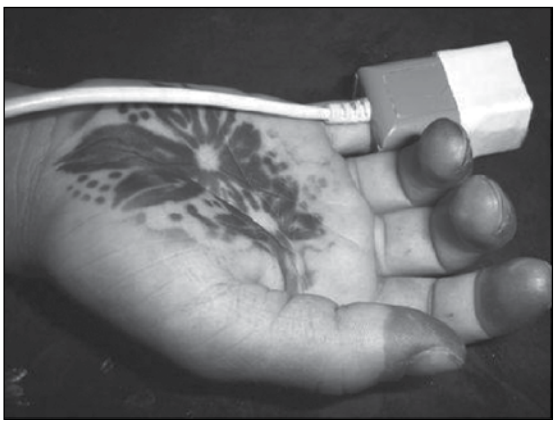
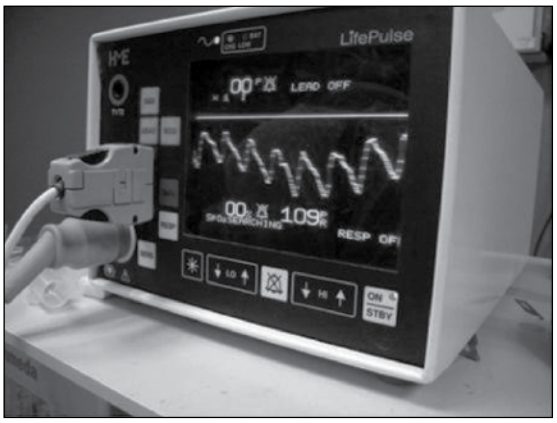


Figure 2. *(A) Pulse oximeter applied to a patient with henna*



(B) Pulse oximetry display

CORRESPONDENCE

Damaged Dräger vaporizer interlock pin: potential for a fatal anaesthetic incident

Christie N Mato, Maxwell Tobin, University of Port Harcourt Teaching Hospital, Nigeria

Dear Editor,

We wish to report the potential for a fatal intraoperative incident related to a damaged Dräger vaporizer interlocking pin.

In 2006, the University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria, became one of the beneficiaries of the Federal Government upgrade of eight tertiary health facilities in Nigeria. Through VAMED Engineering, the hospital received five Dräger Fabius 2000 series anaesthetic machines. The Dräger Fabius 2000 is an anaesthetic machine with safety features such as the Diameter - index Safety System (DISS), low oxygen pressure alarm and the vaporizer interlock safety system.

The anaesthetic machines supplied to our hospital have the halothane and isoflurane vaporizers in series with an interlocking bar in between (Figure 1). This interlocking bar prevents the two vaporizers being used at the same time. There are two holes with 'nibs' on the control dial of each vaporizer. The nib in the hole prevents the locking bar from sliding into the hole unless the vaporizer is first turned off. Thus, to change from halothane to isoflurane, the halothane vaporizer must be turned off before the locking bar can slide into the hole and lock it to allow the isoflurane vaporizer control to be turned on for use. If the halothane vaporizer is still in use and the sliding bar is released so isoflurane can be used, the nib in the hole will prevent the sliding bar from engaging the hole in the halothane vaporizer (because the latter has not been turned off).

Figure 1. *Note the interlocking bar between the vaporizers, that are in series*

If the nib is missing, damaged or broken, then there is no nib in the hole (Figure 2) and there is nothing to prevent the sliding bar from engaging the hole in the halothane vaporizer. Thus, halothane is at 5% (not turned off), the sliding bar is engaged and the isoflurane vaporiser is also on (Figure 3), with the consequence that the patient receives a mixture of halothane and isoflurane. Unrecognized, this is capable of causing a fatal incident intra-operatively.

We discovered this during a machine check in our theatre, and propose the following mechanism for the damage to the vaporizer. The positioning of the Dräger anaesthetic machine in this particular theatre is unique in our hospital, in that it is positioned on

Figure 2. *Halothane vaporizer with nib missing*

Figure 3. *The isoflurane nib is visible and the halothane vaporizer is locked at the 5% position with isoflurane being delivered at 1%*

the left of the operating table (Figure 4), that is on the left of a right-handed anaesthetist. In trying to turn off the vaporizer, a right-handed anaesthetist (who is used to the machine being on his right) may have used his left hand to inadvertently turn the dial anticlockwise instead of clockwise. Excessive force may have broken the plastic nib.

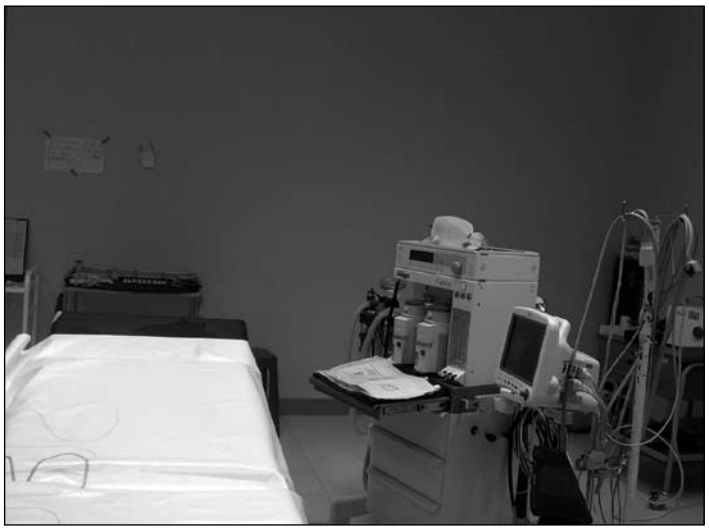


Figure 4. *Anaesthetic machine on the left of the operating table, requiring a right-handed anaesthetist to use the his left hand to turn the vaporizer dial*

If a thorough machine check has not been conducted, a right-handed anaesthetist may use his left hand to 'turn off' the faulty vaporizer but in an anticlockwise direction, but unknowingly, the vaporizer will be at 5%, and the sliding bar will engage at the 5% position because there is no nib. Isoflurane will be turned on, but the patient will also be receiving halothane at 5%.

Two similar incidents of damaged nibs have been reported,[1,2] both concerning the Dräger anaesthetic machine, one with isoflurane and servoflurane,[1] the other with isoflurane and desflurane.[2] This is the first report involving a halothane vaporizer, the high potency of this agent making the potential for harm from this fault of greater significance.

The damaged nib has been reported to manufacturers through their representative VAMED Engineering. We report this to alert other beneficiaries of the Dräger anaesthetic machine, and remind anaesthetists of the importance of mandatorily carrying out a machine check prior to administering each anaesthetic. Ideally right-handed anaesthetists should have their machines positioned on their right, and avoid using excessive force to turn the dial.

References

1. Webb c, Ringrose D, Stone A. Faulty interlock on Drager vaporisers. *Anaesthesia* 2005; **60**: 628 – 9.
2. Jagannathan VK, Nortcliffe SA. Potentially fatal vaporizer incident. *Eur J Anaesth* 2008; **25**: 165-6.

Cerebral challenge

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Case 1

A 70-year-old man is scheduled to have bilateral inguinal hernia repair under general anaesthetic. He had a myocardial infarction 5 years ago but has no cardiac symptoms and walks his dog 5 miles every day without trouble.

- What does this ECG show?
- What precautions would you take when giving this man an anaesthetic?

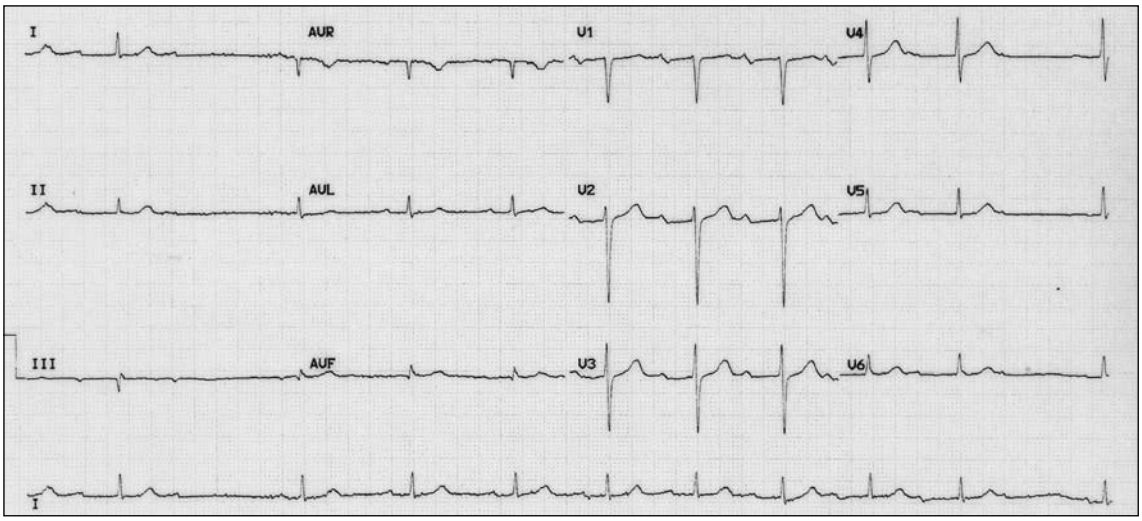

Figure 1. *Preoperative ECG*

Case 2

You are asked to see a 72-year-old man on the surgical ward. He underwent an elective right hemicolectomy for a bowel tumour seven days previously. His initial postoperative recovery was good, but the surgeons have become increasingly concerned about him over the last 12 hours. He is confused, his respiratory rate is 28 per minute, temperature 37.8°C, oxygen saturations are 91% on air, his pulse is 110 per minute (regular) and his blood pressure is 95/46. He is oliguric, passing 5-10ml urine per hour for the last 4 hours, and has been given fluid boluses. The surgeons are concerned that he is developing pulmonary oedema.

On examination his chest is clear but there is decreased air entry at both bases. You request an urgent chest X-ray (CXR).

- What does the CXR show?
- What is the differential diagnosis?
- Describe how you would manage this patient.

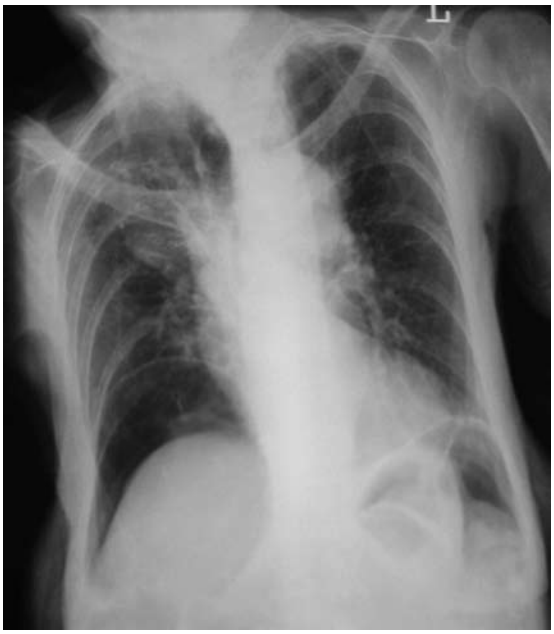

Figure 2. *Erect chest X-ray*

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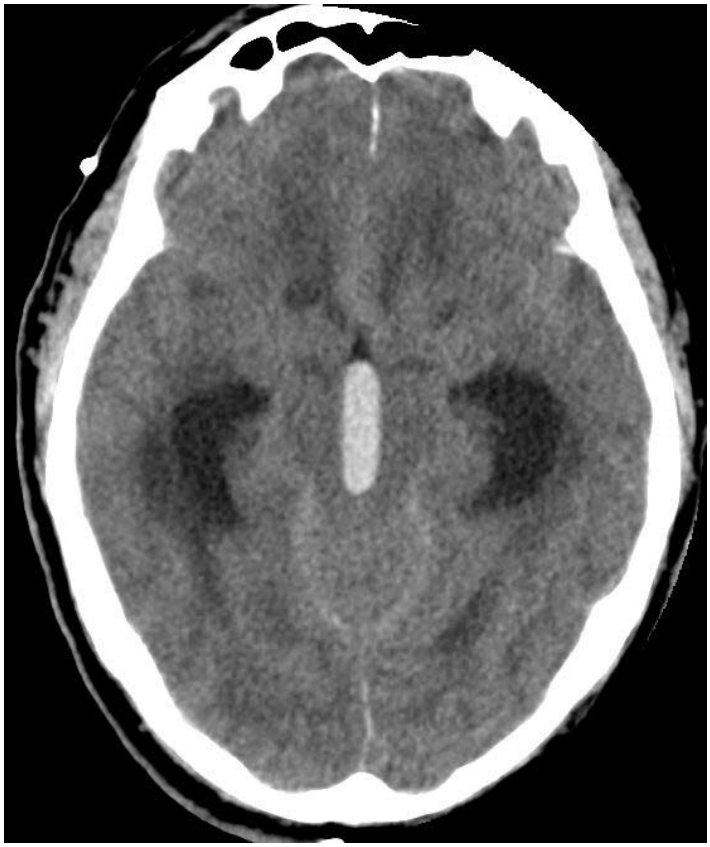

Figure 3. *CT head without contrast*

Case 3

A 50-year-old woman is brought to the Emergency Department by her husband after becoming unsteady on her feet and increasingly drowsy. He says that she had a sudden onset of severe headache 12 hours ago, which has persisted. She has been getting increasingly confused and becoming more difficult to rouse. On examination her eyes will only open to pain, she is groaning but still localises to pain on both sides. Her pupils are equal and reactive. The ED team have requested a CT head scan.

- What does the CT scan show?
- How would you manage this patient?

DISCUSSION

Case 1

This man has Wenkebach phenomenon (Mobitz type I, second degree heart block). This means that the P-R interval lengthens with each beat until a QRS complex is dropped (circled on the rhythm strip in Figure 4). The ECG also shows Q waves in lead III and AVF, suggesting that the patient may have had an inferior myocardial infarction in the past. Rhythm disturbances are more common with inferior myocardial infarctions because the right coronary artery generally supplies the atrioventricular node as well as the inferior part of the heart.

There is a small possibility that Mobitz type I block could progress to complete heart block under anaesthetic. However, this man has no cardiac symptoms, in particular no history of syncope or presyncope, and has a good exercise tolerance.

As a precaution, where available, an external pacing defibrillator should be in theatre and temporary pacing pads could be attached to his chest (back and front) prior to induction.

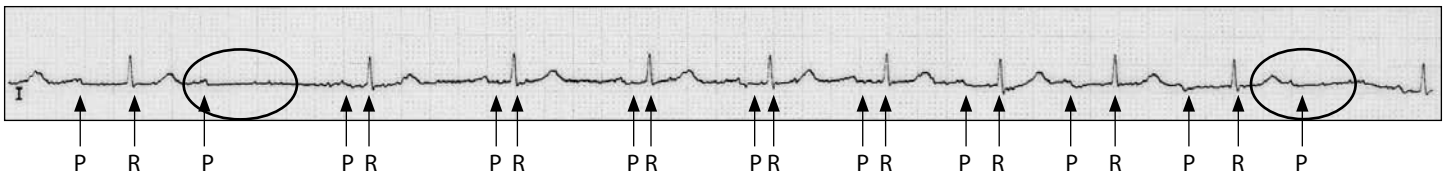

Figure 4. *The PR interval gradually increase until a QRS complex is lost*

Case 2

This man underwent a major surgical procedure seven days ago and, having initially made the expected recovery, there has clearly been deterioration in his clinical state in the last twelve hours. Many hospitals have started using early warning scores (EWS) to increase the rapidity and reliability of detection of patients with a significant change in their clinical status. Using the score system shown in Figure 5, this man's EWS is 8. He should be resuscitated immediately, with attention to his airway, breathing and ventilation, while a cause for his deterioration is sought. The CXR shows bilateral air under the diaphragm (Figure 6). The area immediately under the diaphragm is usually opaque (white) since the upper part of the abdomen contains solid structures such as the liver and the spleen. It is normally only possible to discern the upper surface of the diaphragm on a CXR, since it is seen in contrast to the air-filled lung tissue above it. In this CXR

Early Warning System Observations Score (EWS) Parameters

Score	3	2	1	0	1	2	3
HR per minute		< 40	41-50	51-100	101-110	111-129	>130 (>180*)
BP Systolic	<70 (<60*)	71-80	81 - 100	101 - 199		> 200	
Resp per minute		< 8*		9 - 14	15 - 20	21 - 29	> 30
Central nervous system				Alert	Drowsy/ rousable to voice or newly confused	To pain	Unresponsive*
Temperature		<35		35.1-37.5	>37.5		
Urine output	Nil	< 20ml/hr for 2hrs or has not voided within 4hrs of admission	20-50ml/hr for 2hrs or has not voided within 4hrs of admission	>50ml/hr for 2hrs			

Figure 5. *An example of an Early Warning Score, where a score of 3 or more should trigger the on-call doctors to attend to the patient immediately*

there is a clear gap between the diaphragm and the structures below, indicating the presence of air. The most likely cause is a perforated abdominal organ, in this man suggesting that the bowel anastomosis has leaked.

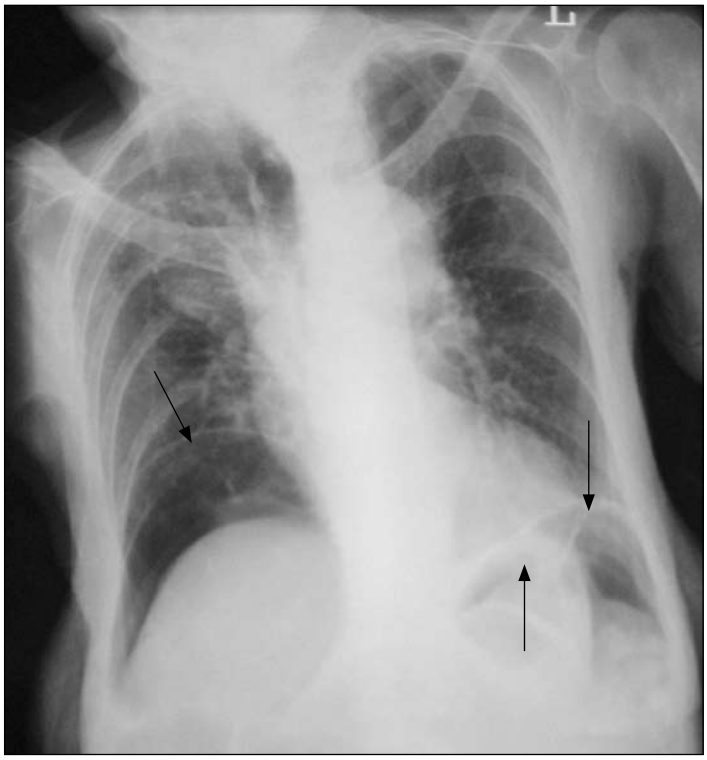

Figure 6. *Chest X-ray showing gas under the diaphragm. The white arrows indicate the raised left and right hemidiaphragms. The gastric bubble is indicated by the black arrow*

Other causes of gas under the diaphragm on a CXR include:

- recent laparotomy, however this would have been expected to have dispersed by seven pays postoperatively, or
- recent laparoscopic surgery. During laparoscopic surgery gas (normally CO_2) is used to inflate the abdominal cavity to allow visualisation of organs and structures.

It is sometimes difficult to differentiate air under the diaphragm from the normal stomach bubble. The following can help distinguish between the two:

- Look at the length of the air bubble. If it is longer than half the length of the hemidiaphragm it is more likely to be free air since air in the stomach is restricted by the anatomy of the stomach.
- Look at both hemidiaphragms. If air is present bilaterally it is likely to be free air in the abdomen.
- Look at the thickness of the diaphragm. If free air is present then the white line visible on the CXR will consist of the diaphragm only. If the air is in the stomach it will consist of the diaphragm, stomach wall and lining and therefore be much thicker. In general if the white line is less than 5mm thick there is likely to be free air in the abdominal cavity.

This patient should be managed with an 'ABC' approach. High flow oxygen should be delivered (15l.min^{-1}). This patient was transferred to the operating theatre and an emergency laparotomy revealed anastomotic breakdown with associated faecal peritonitis. Postoperatively, the patient was transferred to the Intensive Care Unit and remained intubated and ventilated for 3 days. He developed severe sepsis and multiorgan failure. He survived, being discharged from the ICU two weeks later.

Case 3

The blood in the third ventricle has caused hydrocephalus, blocking the normal CSF drainage pathway, causing dilated lateral ventricles and a raised intracranial pressure (See Figures 7 and 8). This has led to her progressive symptoms and decreasing conscious level. It is unclear how much of her neurological deterioration is due to the bleed, or the secondary hydrocephalus. Therefore this patient needs urgent CSF drainage via an extra-ventricular drain (EVD), which generally requires transfer to a neurosurgical centre.

Under general anaesthesia, she will have a burr hole made in her skull, through which a tube will be passed into the lateral ventricle to drain CSF into a drainage bag.

The rate of drainage is modulated by the height of the collection bag above the patient's foramen magnum at the base of the skull. (See Anaesthesia for Neurosurgery in Update 23, December 2007). Her Glasgow Coma Score is 9 (E2, V2, M5) and she will require frequent

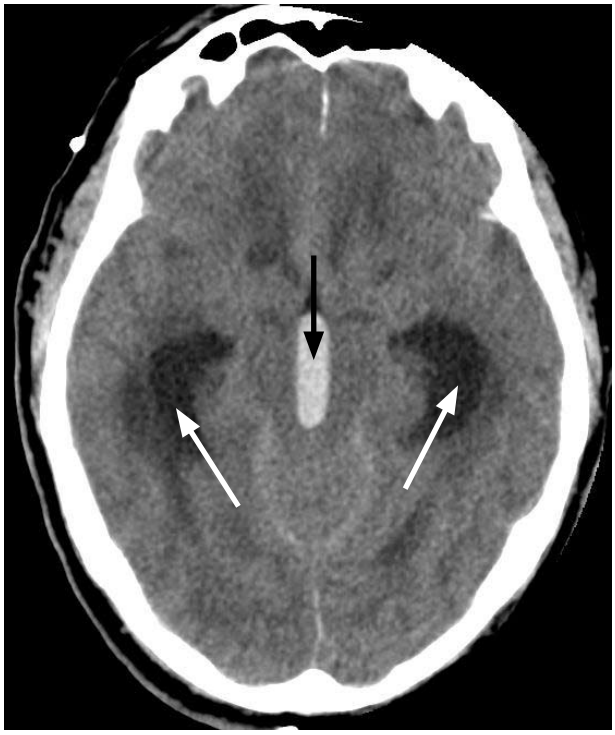

Figure 7. *This CT scan shows obstructive hydrocephalus secondary to a third ventricular haemorrhage. The white area in the centre is fresh blood within the third ventricle (black arrow) and the dark areas on either side are dilated temporal horns of the lateral ventricles (white arrows). It is unusual to see the temporal horns this clearly at this level of the brain and temporal horns greater than 2mm are diagnostic of hydrocephalus.*

neurological observations in case she deteriorates and needs intubation to protect her airway. If transport to another centre is required, where

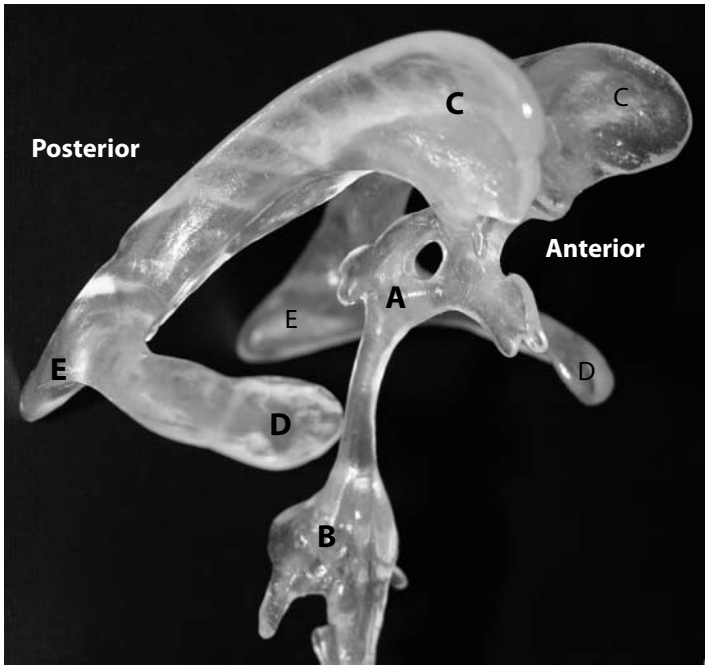

Figure 8. *The anatomy of the ventricular system of the brain showing: A – the third ventricle; B – the fourth ventricle; C – the right and left lateral ventricles with, D – their temporal and, E – occipital horns*

the facilities exist it would be sensible to sedate, intubate and ventilate her for the journey. After EVD insertion, where available, she should have a CT angiogram to look for berry aneurysms in her cerebral circulation. It may be possible to reduce the patient's risk of having a further bleed by either coiling (inserting tiny coils of wire under radiological guidance) or clipping any aneurysms at operation.

From the Journals

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A rational approach to perioperative fluid management

Chappell D, Jacob M, Hofmann-Kiefer K, Conzen P, Rehm M. *Anesthesiology* 2008; **109**: 723–40

This thought-provoking article consolidates the accumulated knowledge about perioperative fluid loss and replacement. The authors recap the limitations of monitoring in goal-directed resuscitation, refuting the concept that aggressive fluid management improves outcome. Their review of the literature shows that perioperative weight gain (from fluid accumulation) correlates with mortality.

The classic 'third space' described in textbooks does not exist and the phenomenon of unexplained perioperative fluid shift can be described in terms of fluid shift from the intravascular to the interstitial space.

The authors review colloid and crystalloid distribution in the body, noting that attempting to replace blood loss with crystalloid results in loading of the entire extracellular fluid compartment. Postoperative positive fluid balance is related to overestimation of loss and replacement with excessive crystalloid.

The endothelial glycocalyx (the term describing the glycoproteins sectreted by and lining the endothelial cells within the body's blood vessels) is deemed to be critical to maintenance of the normal vascular barrier in the classic Starling equation. Metabolic stress from surgery, sepsis, inflammation or hypervolaemia can cause dysfunction of this barrier and cause so-called 'type 2' fluid shift of protein-rich fluid into the tissues. The authors propose that using colloid in this context is more rational than crystalloid.

In summary, the authors propose that perioperative fluid management should consist of replacing urine output and insensible loss with crystalloid and using colloid to replace circulatory loss, possibly using a goal-directed approach, with goals being individualized to the patient and surgery. Supply should be matched to demand (i.e. fluid loss) and not a routine replacement of perceived high insensible and third space loss.

Further reading

Freshwater-Turner D, Green R, McCormick B. Body fluid compartment, sodium and potassium. *Update in Anaesthesia* 2008; **24,2**: 43-51

Benefit and risk of intrathecal morphine without local anaesthetic in patients undergoing major surgery: meta-analysis of randomized trials

Meylan N, Elia N, Lysakowski C, Trame`r M. *British Journal of Anaesthesia* 2009; **102**: 156–67

This meta-analysis aimed to quantify the perioperative benefits and risks of intrathecal morphine. Study inclusion criteria were strictly restricted to randomized controlled trials using single intrathecal morphine injection against placebo in major surgery under general anaesthesia. Twenty-seven trials comprising 645 active treatments versus 560 placebo cases were included.

Intrathecal morphine decreased pain intensity at rest and on movement, decreased hospital stay and showed a trend towards fewer pulmonary complications. The authors equate the analgesic effect to the gold-standard of epidural analgesia with local anaesthetic, both of which produce a 1cm decrease on a 10cm Visual Analogue Scale at 24 hours. Intravenous morphine sparing was most marked in abdominal as opposed to cardiothoracic surgery.

Respiratory depression was exclusively a feature of intrathecal morphine cases as opposed to controls, with a number needed to harm of 15 (at worst) to 84 (at best).

There was no evidence of dose-response relationship in either analgesic benefit or adverse effects. A variety of doses have been used historically, from 300 to 4000mcg. All studies in the last decade have used doses less than 1000mcg.

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Transfusion in trauma: why and how we should change our current practice?

Theusinger O, Donat R, Ganter M. *Current Opinion in Anaesthesiology* 2009; **22**: 305-12

This review article summarises recent developments in the management of haemorrhage due to trauma. It specifically focuses on the recognition that early coagulopathy arises due to activation of inflammatory cascade from tissue injury and hypoperfusion, rather than the traditionally proposed dilutional coagulopathy, hypothermia and metabolic acidosis, which are more important in late coagulopathy. Early acute coagulopathy involves activation of protein C which has profound anticoagulant effects on clotting factors V and VIII.

The authors emphasize the importance of serum lactate and base deficit as surrogate measures of adequacy of resuscitation. Therapeutic strategies include resuscitating to achieve a target systolic blood pressure of no greater than 100mmHg until bleeding is controlled (in the absence of brain injury), restrictive red blood cell transfusion titrated against physiological triggers and a possible role for early use of fibrinogen, prothrombin complex concentrates and recombinant factor VII. The authors also discuss the benefit of introduction of a transfusion algorithm for massive haemorrhage in their hospital.

This algorithm used a combination of clinical evaluation, laboratory and bedside coagulation tests, and they were able to demonstrate significant overall reductions in use of blood products and associated costs.

The analgesic efficacy of transversus abdominis plane block after caesarean delivery: a randomised controlled trial

McDonnell J, Curley G, Carney J, Benton A, Costello J, Maharaj C, Laffey J. *Anaesthesia and Analgesia* 2008; **106**: 186-91

This article describes the use of the transversus abdominal plane (TAP) block to provide postoperative analgesia after Caesarean section. The principle and technique of the TAP block have been well described in previous articles.

Fifty-two patients undergoing elective caesarean section were randomized to a standard analgesic regime alone or the regime supplemented with bilateral TAP blocks using ropivacaine. The group with supplementary TAP blocks had a 70% lower PCA (patient controlled analagesia) morphine requirement, no sedation and less postoperative nausea and vomiting within the first 48 hours after operation.

While no adverse effects were reported, the authors remind us of the ever-present risks of local anaesthetic toxicity and emphasize that the study was not powered to assess safety. Additionally all blocks were performed by a single investigator (to reduce inter-operator variability) which may limit generalization of the findings.

The authors believe that the TAP block may have a place as part of a multimodal analgesic regime for analgesia after caesarian section.

Further reading

Webster K. The transverse abdominal plane (TAP) block: abdominal plane regional anaesthesia. *Update in Anaesthesia* 2008; **24,1**: 24-9

Adjuvant analgesics in neuropathic pain

Kong VK, Irwin MG. *European Journal of Anaesthesiology* 2009; **26**: 96-100

This review article presents a summary of the role of adjuvants (drugs with a primary non-pain action but which may be analgesic in certain situations) in neuropathic pain. The authors use number needed to treat (NNT) and number needed to harm (NNH) to compare relative efficacies and adverse effects.

Older agents, specifically carbamazepine, phenytoin and tricyclic antidepressants (TCAs), seem to be effective (NNT = 1.9-2.1) but with a high side-effect profile (NNH = 3.7). Carbamazepine is particularly effective in trigeminal neuralgia and phenytoin in diabetic neuropathy.

Newer agents such as gabapentin, pregabalin and some antidepressants have more data available and a favorable efficacy profile (NNT = 4) with an acceptable side-effect profile (NNH = 6). Topical agents (capsaicin and lidocaine) were less efficacious but with fewer side-effects.

Perhaps most illuminating is the paucity of evidence from which NNH and NNT are drawn - meta-analyses largely used data from studies of different quality, in different populations and using different outcome measures.

Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists

TM Cook, D Counsell, JAW Wildsmith on behalf of The Royal College of Anaesthetists Third National Audit Project. *British Journal of Anaesthesia* 2009; **102**: 179-90

This prospective observational audit looked at all major complications occurring in one year as a result of central neuraxial block and expressed this as a proportion of a (projected) denominator of all such blocks performed over a year in UK National Health Service hospitals.

Overall serious complications following CNB were rare: 2-4 per 100,000 cases. Complication rates for epidurals were twice those of spinals and caudals. The authors caution against over-interpretation of sub-group analysis as overall numbers were low. Nevertheless, older patients were more at risk of spinal cord ischaemia and vertebral canal haematoma whereas younger patients suffered more nerve injury. Prognosis of the former complications was poor whereas most of the latter recovered.

Further reading

The complete article is available free through the BJA website (available at: http://bja.oxfordjournals.org/cgi/reprint/aen360)

Effects of extended-release metoprolol succinate in patients undergoing non-cardiac surgery (POISE trial): a randomised controlled trial

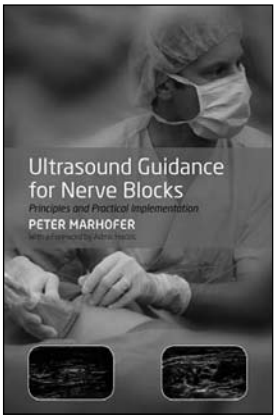
POISE Study Group; Devereaux PJ, Yang H, Yusuf S et al. *Lancet* 2008; **371**: 1839–47

This large randomized controlled trial addressed the question of whether pre-operative beta-blockade in high risk patients undergoing non-cardiac surgery improved mortality and reduced the incidence of adverse cardiovascular events.

While the study did demonstrate benefit in terms of cardiovascular mortality and morbidity, there was an excess of strokes and deaths from other causes in the treatment group.

It is unclear whether the explanation for this result lies with the drug used (i.e. is this a class effect of all beta-blockers or a finding specific to the trial drug, metoprolol?), the dosage regime or the extent (or 'tightness') of beta-blockade. While perioperative beta-blockade appears protective, it is not yet without concern.

Book Reviews



Ultrasound Guidance for Nerve Blocks, Principles and Practical implementation

Peter Marhofer, *Oxford University Press* £24.95

ISBN: 978-0-19-954756-2

This compact paperback handbook is written by Peter Marhofer with contributions from Professors Kapral, Kettner and Willschke. All of these are respected regional anaesthetists from Vienna, arguably one of the pioneers and leading centres of ultrasound guided regional anaesthesia in Europe, with much published research.

Chapter 1 covers the principles of ultrasonography, including basic physics and the generation of ultrasound images, but should perhaps expand on image artefacts. The next three short chapters describe the advantages of ultrasound for regional anaesthesia, limitations of the techniques and technical and organizational considerations. Chapter 5 offers a good summary of the different appearances of nerves at various anatomical positions although rather glosses over the problems of "anisotropy", which can seriously affect the imaging of nerves.

Usefully, this chapter also covers the ultrasound appearance of other structures, e.g. muscle, tendons, bones, blood vessels. Chapter 6 discusses needle guidance techniques, i.e. in plane versus out of plane. Whilst the Vienna group clearly have a preference for out of plane approach, they fail to provide a balanced argument or mention needle guidance devices.

There is little to criticize in the main chapters on neck, upper extremity, lower extremity and trunk blocks; each block is well described covering the anatomy (including recognized variants), ultrasound description and practical block technique. Several photos illustrate set up, orientation, ergonomics, hand and probe position, and there are plenty of labelled ultrasound images often showing the needle approach. Each block is also summarized in a table which details suggestions of ultrasound settings and patient positioning, anatomy and nerve appearance, needle choice and local anaesthetic volume. They also give an indication of block difficulty both for the technique and for the visualization of nerves. It is useful that, with each chapter or description of a block, there are one or two pertinent references for further reading.

Principally, this is a good book, which suffers (as all ultrasound books will do) by providing still images of what is a dynamic practical procedure. It usefully fills a gap between the large expensive textbooks of Bigeliesen, Gray and Chan and the numerous websites. It is the first, probably of many, pocketbooks of ultrasound guided regional anaesthesia on the market and it will be interesting to see how future competition matches up.

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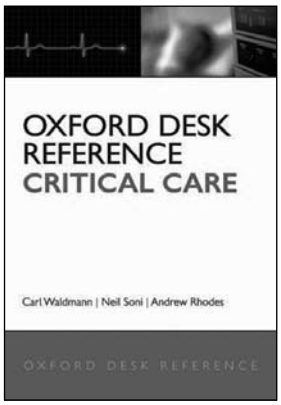
Oxford Desk Reference: Critical Care

Carl Waldmann, Neil Soni and Andrew Rhodes, *Oxford University Press* £55 (Hardback)
ISBN: 978-0-19-922958-1



The Oxford Desk Reference: Critical Care is a new critical care textbook in which individual topics are self-contained and concise enough to be digested quickly. The text seems intentionally short for a comprehensive textbook of critical care and each topic is covered in its entirety in a two to four page spread. Aimed at specialist healthcare staff in Intensive Care and High Dependency Units, much of its content is also relevant to Emergency Medicine and the management of acutely unwell patients in lower dependency areas. In essence, it is an expanded Oxford Handbook of Critical Care, down to the chapter headings and topics covered within each chapter. It covers therapy techniques followed by monitoring, drugs, disorders of organ systems and miscellaneous problems commonly presenting to the ICU including shock, infection/ inflammation and trauma/burns. It concludes with a section covering ICU organisation and management. The content is ordered logically and coverage of relevant topics is comprehensive. There is an extensive list of contributors and individual chapters draw on the expertise of specific authors.

As a practical reference textbook, the Oxford Desk Reference has many positive points. The fact that each topic within a chapter is a self contained, bite-sized chunk of information is invaluable when a specific question ('How do I manage x condition?', 'How does my device work?') needs to be answered rapidly. Its is not necessary to read an entire chapter to understand a given topic and each topic can stand alone, meaning that its content is readily accessible. The emphasis is on presenting the content in a clinically applicable way, but the book also deals explains the principles underlying the practical advice and is certainly not just a recipe book for management of problems. For readers who wish to expand their knowledge of a particular area, each chapter suggests further reading, generally journal articles, but also relevant guidelines. The layout is intuitive with subheadings and bullet points to guide you through the text. Slight criticisms are that the font is small and there are relatively few figures, making the text can appear dense.

Overall, the Oxford Desk Reference: Critical Care is a useful addition to the selection of critical care textbooks available. During a working day (or night) on ICU, I have found the content practical, easy to access and pitched at an appropriate level. It strikes a balance between providing enough information to manage a given presentation whilst being small and concise enough to make finding relevant information quick and easy. The editors anticipate that the book will be available for reference in high dependency areas, and its format and content make it a valuable resource in the management of the critically ill patient.

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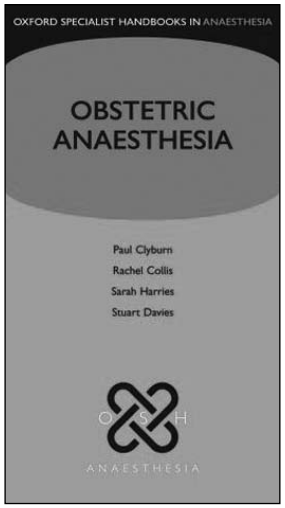

Oxford Specialist Handbooks in Anaesthesia: Obstetric Anaesthesia

P Clyburn, R Collis, S Harris & S Davies, *Oxford University Press* £24.95

ISBN: 978-0-19-920832-6

This handbook was published in August 2008 and is one of the latest additions to the extensive Oxford Specialist Handbooks catalogue. The book is primarily aimed towards trainee anaesthetists but is also intended to be of value to other members of the labour ward team including midwives, obstetric trainees and consultant anaesthetists.

The editors have achieved a style and layout that allows easy navigation through the text, with twenty-two chapters including an A to Z of conditions common to obstetric anaesthesia.

Each chapter is broken down into manageable sub-sections with clear headings and bullet points. Within each section there are highlighted boxes relating to anaesthetic implications or management of specific conditions, with references provided as a further reading list at the end of each chapter. There are clear diagrams and tables throughout the book that complement the text.

The compensatory mechanisms in heart failure and a failed intubation algorithm are both well presented, and there is an excellent table on the timing of epidural insertion/removal in relation to heparin administration that is both clear and unambiguous.

There are also several useful photographs that help convey practical techniques including hand positions for epidural insertion and optimal positioning of the obese patient prior to intubation.

Several topics are covered especially well, including a very useful summary of the findings of the latest CEMACH report. There are also comprehensive chapters on regional anaesthesia for labour and for caesarean section, and a clear, logical strategy for fluid management in patients with severe pre-eclampsia. It is pleasing to see there is emphasis on the recognition and management of the sick obstetric patient with chapters devoted to major obstetric haemorrhage, hypertensive and embolic diseases and the management of the collapsed or compromised parturient.

Although the book is organised and well structured, the colour scheme is rather unremarkable. The highlighted areas in the book are a rather dull beige colour, which whilst inoffensive might have better caught the reader's attention if the presentation had been more striking. While most clinical guidance is current, the recommendation regarding prophylaxis against infective endocarditis in the chapter on management of cardiac disease is already out of date.

Overall this excellent handbook is a recommended read for all anaesthetists involved in the care of pregnant women and would be a valuable purchase for any anaesthetic department. It is a very useful reference that covers a wide breadth and depth of topics and will be of value both to trainees new to obstetric anaesthesia and those studying for exams, as well as to all experienced members of the labour ward team.

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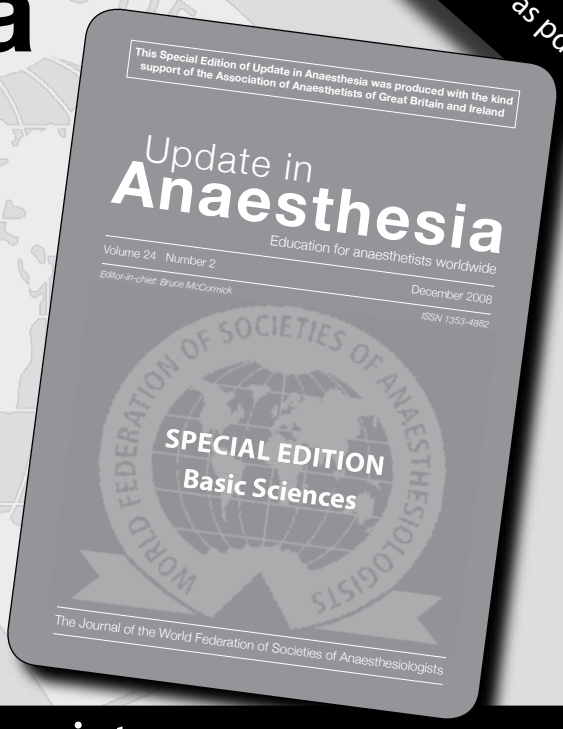

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Update in Anaesthesia

Guide for Contributors

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Update is sent to over 3000 English-speaking anaesthetists, and read by many others including surgeons, nurses and medical students. *Update* is also translated into different languages including Spanish, Russian, French and Mandarin. After being produced in the paper format, *Update* is published on the internet (www.worldanaesthesia.org) and read by 90 people a day from more than 130 countries. *Update* is also distributed in the form of a CD-ROM, produced by the Association of Anaesthetists of Great Britain and Ireland.

Articles for consideration by the Editorial Board should be submitted as Word documents (Rich Text Format is preferred) to the Editor-in-chief, Bruce McCormick, by email at Bruce.McCormick@rdeft.nhs.uk or post on CD-ROM or paper copy to Dr Bruce McCormick, Department of Anaesthesia, Royal Devon and Exeter Hospital, Barrack Road, Exeter, EX2 5DW, UK.

CLINICAL OVERVIEW ARTICLES

General considerations

- Papers must not have been published in whole or any part in another journal.
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- On acceptance for publication copyright becomes vested in the journal.
- Original textual matter quoted from other authors must have formal citation and be appropriately referenced.
- Some readers' first language may not be English. Please keep your text straightforward and avoid long sentences and complex terminology. Explain words and abbreviations that may not be universally standardised. Aim to include the full range of therapies available worldwide, but provide most detailed descriptions of those therapies available in resource-poor settings (see 'Management of sepsis with limited resources' in *Update 23* – www.worldanaesthesia org/component/option,com_docmantask,cat_view gid,67 Itemid,49/). Discuss older drugs as well as newer ones; halothane, thiopentone, ketamine and ether are widely used around the world.
- The article should be long enough to cover the topic in reasonable detail. Many readers will not have access to texts or journals to supplement their reading. Include text boxes and teaching points to make the layout interesting. Avoid long numbered lists with complex subdivisions. Check that your text is correct, particularly drug doses, as many readers will not be able to verify them.

Authors' details

Please supply the full forename and surname of all authors, stating their title (Anaesthetic Clinical Officer, Dr, Professor etc) and the name and address of their institution. One author should be identified for correspondence, with an email address provided.

Drug doses

Please use the international units, e.g. $mg.kg^{-1}$ rather than mg/kg. Use SI notation for g, mg, mcg etc. Please use internationally accepted non-proprietary drug names, e.g. furosemide, epinephrine and avoid trade names.

Headings

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Illustrations / figures

These may be sent to us as drawings (black on white), which we will scan into the text, or as picture files in jpg (JPEG) format. Black and white photos are also suitable. If you do not have facilities to produce drawings, contact the editor for help. If you copy illustrations from another publication please obtain copyright permission from the publishers or author. If patients appear in a photo please ensure that they have consented to this. Text accompanying illustrations should be supplied on a separate piece of paper.

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Tables

These should be prepared using the Microsoft Word table facility whenever possible.

Graphs

Graphs should be supplied using the Microsoft graph-compiling feature within Microsoft Word, or as a figure on paper.

References

A minority of Update readers have access to journals and therefore references should in general be limited to those that would be considered as 'further reading'. Please format your references as shown. Number the references in the order they appear, using the reference number as a superscript at the relevant point in the text.

References should include: names and initials of all authors (unless more than 6, when only the first 6 are given followed by 'et al.'), title of the paper; Medline abbreviation of the journal title (in italic); year of publication; volume number; first and last page numbers.

Papers accepted but not yet published should be included in the references, with the abbreviated journal name, followed by '(in press)'.

Those in preparation (including any submitted for publication), personal communications and unpublished observations should be referred to as such in the text.

1. Reynolds F, O'Sullivan G. Lumbar puncture and headache. 'Atraumatic needle' is a better term than 'blunt needle'. *Br Med J* 1998; **316**: 1018.

2. Costigan SN, Sprigge JS. Dural puncture: the patients' perspective. A patient survey of cases at a DGH maternity unit 1983–1993. *Acta Anaesthesiol Scand* 1996; **40**: 710–14.

3. Spriggs DA, Burn DJ, French J, Cartlidge NE, Bates D. Is bedrest useful after diagnostic lumbar puncture? *Postgrad Med J* 1992; **68**: 581–3.

References to books should give book title, place of publication, publisher and year; those of multiple authorship should also include chapter title, first and last page numbers, and names and initials of editors. For example:

1. Roberts F. Chapter 22: Ear, nose and throat surgery. In: Allman KG, Wilson IH, eds. Oxford handbook of Anaesthesia (1st edition) Oxford: Oxford University Press, 2001: 506-39.

UPDATE SHORT REPORTS

The scope for publication of articles describing original research and audit conducted in, and specifically relevant to, poorly-resourced settings is limited. Successful publication in major journals is rare and the distribution and accessibility of the national and regional journals that currently publish these articles is often poor. As the official journal of the World Federation of Societies of Anaesthesiologists, *Update in Anaesthesia* is the appropriate forum for publication of these manuscripts and offers a wide distribution.

The guidance above for clinical overview articles applies, with the following additional considerations.

Legal considerations

- Papers based on clinical investigation on humans should include the consent of patients and a statement of approval from an appropriate Ethics Committee. In those institutions where Institutional Review Board consent is required for the performance of audits, this should be obtained and referred to in the text.
- Avoid use of identifiable names, initials and hospital numbers of patients.
- Human subjects of case reports, research or audits should not be identifiable. Manuscripts should not disclose patients' names, initials, hospital numbers (or other data that might identify the patient(s)).
- Guides for use of tables, figures and illustrations are as described above for Clinical Overview articles.

Brief Communications

- Original investigative articles or audits of patient outcome or clinical techniques.
- Up to 1500 words (approximately 2 pages of *Update in Anaesthesia).*
- Subdivided into:
  - Summary (maximum five sentences) and key words
  - Introduction
  - Patients and methods
  - Results
  - Discussion
  - Acknowledgements
  - References – maximum 15
  - Tables and/or figures - limited to two per article.

Case Reports

- Suitable for presenting descriptive studies (a series of cases), personal experience or individual case reports of particular interest.
- Up to 800 words. Three tables or figures are allowed in addition to text.
- A summary may be included (up to five sentences). Division into sections is optional.
- Up to seven references may be given.

Correspondence

- Welcomed on any subject, including editorials or articles that have appeared in *Update in Anaesthesia*.
- Letters may also be a suitable vehicle for presenting items of experience or observation that are too brief for Brief Communications.
- Papers describing procedures, techniques or equipment adapted by readers to their own conditions of work are welcomed.

Proofs

- Proofs are sent to the author designated to receive them. Corrections should be kept to a minimum and the proofs returned within 7 days of receipt.

The editorial team will be delighted to help with the preparation of articles. The best way of doing this is via email - Bruce.McCormick@rdeft.nhs.uk

Dr Bruce McCormick
Editor-in-chief
Update in Anaesthesia, July 2008

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Update in
Anaesthesia
Education for anaesthetists worldwide

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