

# Update in **Anaesthesia**

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The Journal of the World Federation of Societies of Anaesthesiologists

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## Editorial

### Evidence to support the use of surgical checklists

Major morbidity following surgery occurs in 3–25% of patients being treated in a hospital setting.<sup>1</sup> In edition 24,1 of *Update in Anaesthesia* we published the World Health Organization's Surgical Safety Checklist with an accompanying editorial.<sup>1,2</sup> This checklist was constructed and distributed as part of the WHO's Safe Surgery Saves Lives campaign in 2008. The checklist serves as a generic template that can be modified for use in each theatre setting, making it adaptable for use in all healthcare sites in the poorest to the most affluent countries. At the time of its introduction there was increasing evidence that preoperative checklists are effective in reducing adverse events and in enhancing team work in a theatre environment. The WHO checklist was introduced without specific evidence that it would affect outcomes, but because it seemed a sensible and intuitive development in the drive to reduce morbidity and mortality for the surgical population. The 'Time-out' part of the checklist, that takes place between the surgeon, anaesthetist and scrub nurse immediately prior to the commencement of surgery, has been widely adopted in the UK and the US. There is little data to demonstrate whether the checklist has been widely adopted in developing countries.

When first introduced in the UK the checklist was viewed with scepticism by some. However, there is now increasingly robust evidence to show that checklists in general, and specifically the WHO's Surgical Safety Checklist, can dramatically effect morbidity and mortality in surgical patients. The strength of this evidence should highlight to all of us that simple safety systems like the WHO check-list are a priority or even an imperative.

A study published in 2009 in the *New England Journal of Medicine* (and supported by the WHO), showed that introduction of the WHO checklist in eight hospitals around the world was associated with a reduction in major complications from 11.0% to 7.0% - an absolute risk reduction 4% and a relative risk reduction of 36%.<sup>3</sup> Despite these dramatic results, several areas of weakness in the study design have allowed doubts to be raised about the study's validity. There was no attempt to allow for confounding variables, meaning that other non-measured factors could have accounted for the difference seen before and after introduction of the checklist. Measurement of outcome data, with feedback to surgical teams, was introduced to these centres as part of this study and it is recognised that knowing that your performance

is under scrutiny can itself affect performance and therefore outcomes. To some it seems implausible that a strategy as simple as the WHO checklist could have had such a dramatic effect on mortality and morbidity when the specific checks do not particularly correlate with the recognised causes of surgical adverse events. In addition the hospitals where compliance with the checklist was best did not necessarily show the greatest reduction in adverse events.

A second major study, conducted in eleven hospitals in the Netherlands, was published in November 2010 and this study has gone a considerable way towards answering the criticisms of the former paper.<sup>4</sup> A comprehensive, multidisciplinary checklist was introduced to six of the hospitals, midway through a six-month period of data collection to assess the rates of adverse events, morbidity and mortality in these hospitals. Data from over 7000 patients showed that the number of complications per 100 patients decreased from 27.3 to 16.7. In-hospital mortality decreased from 1.5% to 0.8%, giving a relative risk reduction of 47%. The remaining five hospitals served as matched controls and outcome did not change over the study period.

Although this study used a more detailed collection of checklists that covered pre- and postoperative pathways of care, rather than focusing exclusively on the preoperative areas, several of the flaws with the earlier study were addressed. The Dutch study showed that compliance with the checklists correlated with fewer complications - the more checklist items that were missed the greater the chance of a complication occurring. The use of control hospitals excluded the influence of confounding factors and, by choosing hospitals with established systems for measurement and feedback on surgical complications, the effects of introduction of such a system were removed.

It is interesting to note that the incidence of all types of complication was reduced, even those that one would intuitively feel were attributable primarily to the surgical technique, such as haemorrhage and anastomotic breakdown. This suggests that there is some generic feature of checklists that enhances teamwork, communication and handover between and within teams that is to the benefit of the patient. Even though the checklist used differed from that promoted by the WHO, this study suggests that the results may be applicable to use of other checklists. These findings are also in line with those of another recent study that showed that introduction of a medical team training

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program for theatre staff in eighteen medical facilities was associated with an 18% reduction in mortality.<sup>4</sup>

It has now been two years since the launch of the WHO's Safe Surgery Saves Lives Campaign. Implementation of the surgical checklist has been effectively established in many countries and has become a standard of care. In many theatres the day begins with briefing and finishes with a de-briefing. The most recent evidence shows that, whether we are able to accurately measure it or not, these systems are likely to contribute to reductions in complications and to improve patient safety. I would strongly urge all theatre teams to incorporate team briefing, 'time-out' and team debriefing into their daily practice.

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## Editor's Notes

Dear Readers,

Welcome to *Update 26,1*. I hope that the last edition, 'Guidelines for the management of Emergencies in Anaesthesia' has been useful in your daily practice. Your feedback is always welcome and helps the editorial team to continue development of this journal, aiming to provide relevant and appropriate educational material for you on a regular basis.

My plans for future editions of *Update in Anaesthesia* are as follows. Edition 27,1 will follow in 2011. The emphasis of this edition will shift towards articles focusing on more basic aspects of anaesthesia, of relevance to all anaesthesia practitioners whether practicing in low-resource or affluent settings. Topics will include venous cannulation, use of a face mask, choice of anaesthetic technique and management of bronchospasm occurring during anaesthesia. As suggested by reader's feedback on the emergencies edition, we plan to produce a one page summary algorithm for all future articles that describe management of critical events in anaesthesia.

Intensive Care Medicine (ICM) is an area that has developed enormously over the last 30 years. Critical care is more expensive than regular ward care and so this area of medicine has largely been driven forward in wealthier countries. Although many of the most visible changes in Intensive Care Units involve advances in specific therapies and technologies, the major advantages of intensive and high-dependency care are a better nurse to patient ratio, regular medical review

and thorough attention to detail in the management of each patient's basic medical needs. Major improvements in survival are achieved by administration of oxygen, early administration of antibiotics, timely surgical intervention and prevention of secondary infection by simple manoeuvres such as nursing patients in a head-up position. These basic strategies, that form the cornerstones of Intensive Care Medicine, are largely independent of resource availability and are applicable to any healthcare setting around the world. Most healthcare institutions have an area of the hospital or a section of a ward that is designated a high-dependency area. Edition 27,2 (December 2011) will be an expanded edition focusing on this area of medicine.

There were some notable topics missing from the emergencies edition of *Update*. An article describing management of massive blood loss was withheld whilst we waited for an updated guideline to be published by a subcommittee of the AAGBI council. This article and a summary of the most recent changes to the European Resuscitation Council's guidelines will be included in the ICM edition.

As always please email me (Bruce.McCormick@rdef.nhs.uk) or Carol Wilson (worldanaesthesia@mac.com) if you would like to be added to our mailing list or if you have any requests or suggestions for future articles. Alternatively write to me at the postal address below.

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## News from the WFSA

### The Obstetric Anaesthesia Committee

The past year for the Obstetric Committee has been one of forging links with sister organizations and attempting to build the bridges by which we may collaborate on future multidisciplinary projects.

Late in 2009, following an earlier introductory meeting in London, the Chairman, Dr Paul Howell, travelled to Cape Town as guest of FIGO (the International Federation of Gynecology and Obstetrics) to participate in their World Congress. There he joined round-table panel discussions devoted to the FIGO initiative on Maternal and Newborn Health supported by the Bill and Melinda Gates Foundation. He made clear to parties, who habitually forget to include anaesthetic involvement in the planning of maternity projects (e.g. obstetricians, midwives, health planners), how pivotal we are in improving obstetric surgical outcome in resource poor areas.

The WFSA has now become a Partner in the World Health Organization Partnership for Maternal, Newborn and Child Health (PMNCH), a multidisciplinary alliance of interested parties who are working to improve the health of mothers and children worldwide. This will hopefully improve our international profile and our ability to liaise with like-minded organizations on joint future projects – all too pressing since it's now clear that Millennium Development Goals 4 and 5 are far from being met.

Links with the Obstetric Anaesthetists' Association (OAA) and the Association of Anaesthetists of Great Britain and Ireland (AAGBI) continue to grow, and the WFSA has joined forces with them on several interesting ventures. Thanks to a generous grant from Baxter, and collaboration with the OAA and Elsevier, publishers of the *International Journal of Obstetric Anesthesia* (IJOA), a two CD set of useful obstetric anaesthetic resource material is being produced for distribution in resource-poor countries. This set, which comprises a variety of different tools including a webcast of the 2008 OAA Three Day Course with slides and abstract book, video of how spinals work, and back copies of *IJOA*, *Update in Anaesthesia* and *Tutorial of the Week*, is almost ready for circulation through usual WFSA routes.

In addition, in collaboration with the Publications Committee, the OAA and the AAGBI, an exciting new handbook of obstetric anaesthesia, specifically targeted at anaesthetic providers in resource-poor area, has just been completed, and is ready for shipping. Already in hardcopy, it is hoped to make it available in electronic format at some point in the future.

As and when these two new educational tools are received, please do feed back to us with your comments, including what is useful, what is not, and what else would you like included (for the next editions)!

Around the world, individual members of the Obstetric Anaesthesia Committee continue to make significant contributions to the practice of obstetric anaesthesia and analgesia in their own regions, and beyond. Everyone plays their part, but special mention should perhaps be made of Dr Medge Owen who heads Kybele, an organisation that takes

multidisciplinary teams into transitional level countries and shows how obstetric (anaesthetic) care can be improved through a combination of formal lectures and hands-on practical tuition. Recent publications show that this approach can make a lasting impact, with sustained changes in practice – an excellent example to us all!<sup>1,2</sup>

Finally, in the not too far distant future, our next World Congress in Argentina in 2012 approaches. There will, of course, be an obstetric anaesthetic component to the meeting – always popular sessions – so put the dates in your diary, and see you there!

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Chairman

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## Perioperative management of antiplatelet drugs

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### INTRODUCTION

Thirty-day mortality of postoperative surgical patients is around 0.7-1.5% in the developed world. In the UK, with approximately 4 million operations per year, this equates to 25,000 to 30,000 postoperative deaths per year, or 70-80 deaths per day. Cardiovascular causes of death are by far the most common at 59%, with respiratory causes accounting for 35% of deaths.<sup>1</sup>

### PATHOGENESIS OF ATHEROTHROMBOSIS

Cardiovascular and cerebrovascular events are closely linked to instability of atheromatous plaques within blood vessels and to the thrombogenicity (the ability to form thrombus) of blood. If an unstable plaque ruptures to expose a thrombogenic surface to the passing blood, a platelet clot forms over it leading to an acute thrombotic event. Approximately 66% of sudden cardiac events and 50% of postoperative myocardial infarctions are due to disruption and thrombosis of an unstable plaque.

### ANTIPLATELET DRUGS

Antiplatelet drugs are prescribed for cardiovascular

events (acute coronary syndromes or myocardial infarction) and cerebrovascular events (transient ischaemic attacks or stroke). These may be for:

- **Primary prevention** in patients with risk factors but no history of an event, or
- **Secondary prevention** for those who have had an event, e.g. a transient ischaemic attack.

In the arterial side of the circulation, clot formation is more dependent on platelet aggregation, in contrast to the venous side where clotting factors and fibrin deposition play a more important role. Aspirin and clopidogrel specifically inhibit platelet function and are the antiplatelet drugs most commonly encountered by anaesthetists in the perioperative period.

### Aspirin

Aspirin irreversibly inhibits the enzyme cyclooxygenase-1 (COX-1), leading to inhibition of thromboxane-A<sub>2</sub> production. This results in reduced platelet activation and vasodilation. It is an irreversible effect, with the function of each platelet inhibited for its lifespan. Platelets are replaced at the rate of about 10% per day

### Summary

Antiplatelet drugs, such as aspirin and clopidogrel, are widely used in primary and secondary care and are very commonly encountered in the perioperative setting. In this article we explore the specific uses of antiplatelet drugs, their mechanisms of action and possible consequences of their discontinuation. An algorithm is included to guide decisions on whether to stop drugs in the perioperative period.

### Juliet Barker

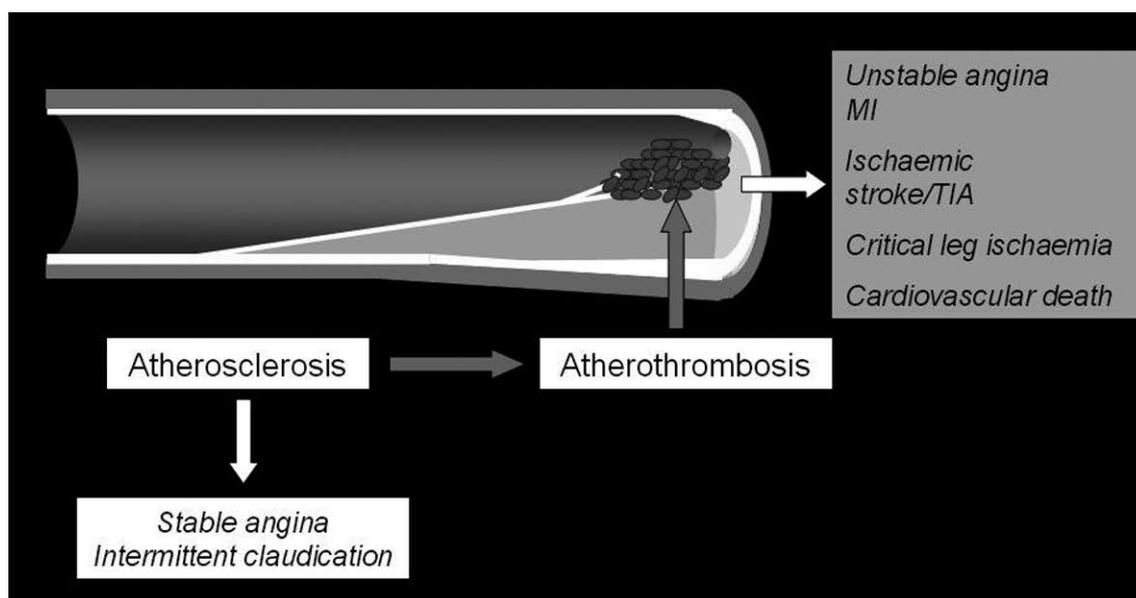
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**Figure 1.** A summary of atherothrombosis - a generalised and progressive process: MI - myocardial infarction; TIA - transient ischaemic attack

and so, after stopping aspirin, it takes about ten days to fully recover platelet function by replacing all affected platelets.

### Clopidogrel

Clopidogrel is a prodrug, metabolised by the cytochrome p450 enzyme system to an active metabolite with a half-life of about four hours. It is a non-competitive, irreversible antagonist of the platelet adenosine diphosphate (ADP) receptor (*P2Y12*), inhibiting ADP induced platelet aggregation for 7 days.

### Dipyridamole

Dipyridamole inhibits platelet aggregation and causes vasodilation by inhibiting the breakdown of cyclic adenosine monophosphate (cAMP) by phosphodiesterase within platelets. Elevated cAMP levels result in a reduced response to several stimuli, including platelet activating factor and ADP, thus inhibiting aggregation. Dipyridamole also inhibits the uptake of adenosine into platelets, erythrocytes and endothelial cells. The resultant raised surrounding adenosine concentration acts at the platelet A<sub>2</sub> receptor also leading to a rise in intracellular cAMP, this time by promoting the action of adenylate cyclase.

## INDICATIONS FOR ANTIPLATELET DRUGS

- **Aspirin** is used alone in 'low risk' primary prevention.
- **Clopidogrel** is used where aspirin is not tolerated or with aspirin in high risk cases, especially after coronary stent insertion.
- For secondary prevention of transient ischaemic attacks, **aspirin plus dipyridamole** (usually the modified release form) is recommended for two years, followed by aspirin alone.

Aspirin reduces the incidence of death, myocardial infarction (by 30%) and stroke (by 25%) in a wide range of patients at high risk of occlusive vascular disease.<sup>2</sup> Long-term administration of clopidogrel to patients with atherosclerotic vascular disease is more effective than aspirin in reducing the combined risk of ischaemic stroke, myocardial infarction, or vascular death,<sup>3</sup> although it only causes approximately 50% inhibition of maximum platelet aggregation in response to ADP. The combination of both drugs has a greater anti-platelet effect than either alone because they work by different mechanisms.

### Coronary stents

A subgroup of patients taking these drugs for secondary prevention of coronary events have undergone percutaneous coronary intervention (PCI), which consists of balloon dilatation and/or stenting of one or more coronary arteries. These patients are at particularly high risk of a further cardiac event if their antiplatelet therapy is stopped.

Coronary stents are placed across a narrowing in a coronary artery, stenting it open and preventing further occlusion. There are two main types of stent - bare metal (BMS) or drug eluting (DES).

*Bare metal stents* provide a thrombogenic surface when initially inserted, but as endothelium grows over them (over approximately 3 months) this risk is reduced. However, as the endothelium thickens the risk of re-occlusion gradually increases. Re-stenosis necessitates re-intervention in 15–20% of patients treated with a BMS within one year.

*Drug eluting stents* are impregnated with antimitotic chemotherapeutic drugs, such as rapamycin and paclitaxel, that inhibit endothelial growth. The stent remains uncovered and the requirement for re-intervention is reduced to about 5% per year. The thrombogenic metal of the stent is however in contact with blood for longer.

For both types of stent it is recommended that aspirin be continued for life. Dual therapy with aspirin and clopidogrel is 'mandatory' until re-endothelialisation, i.e. 6 weeks for a bare metal stent and 12 months for a drug eluting stent. For PCI without stenting both drugs should be given for 2 to 4 weeks.

## WHEN TO STOP ANTIPLATELET DRUGS

A major side-effect of these drugs is bleeding, which is relevant to both the surgeon and anaesthetist over the perioperative period. When considering whether to continue or stop antiplatelet therapy, first it is important to determine whether the agent is given for primary or secondary prevention, and second whether the patient is at high or low risk of occlusive disease. A balance must be considered between the risks of morbidity and mortality due to bleeding or clotting.

Traditionally there is an overriding concern about the risk of bleeding and so a tendency towards stopping antiplatelet drugs in the perioperative period. If antiplatelet drugs are continued, the average increase in blood loss when continuing aspirin alone is 2.5–20%. Blood loss increases by 30–50% with aspirin and clopidogrel used in combination.<sup>4</sup> The transfusion rate increases by about 30% and so it appears that increased bleeding is a justifiable concern. The risk of an ischaemic event is similar to the risk observed in patients with stable coronary artery disease, i.e. 2–6% for non-fatal myocardial infarction and 1–5% for cardiac mortality.<sup>4</sup>

However, withdrawal of antiplatelet drugs results in a rebound hypercoagulable state, which aggravates the hypercoagulability caused by surgery, greatly increasing the likelihood of a cardiovascular event. Withdrawing aspirin in a patient with coronary artery disease leads to a 2 to 4 fold increase in the rate of death or myocardial infarction. Stopping antiplatelet drugs in patients with coronary stents is the major independent predictor of stent occlusion. The non-fatal myocardial infarction rate increases to 35% and average mortality increases to 20–40%.<sup>4</sup>

Although it is true that increased bleeding is a risk in patients where antiplatelet therapies are continued, it is clear that some patients are exposed to a far greater risk by stopping these drugs. In addition the bleeding risk is partially negated by careful surgery, blood transfusion and platelet therapy if required. The balance of risks must be considered before deciding which drugs to continue for each patient, with a specific comorbidity, undergoing a specific surgical procedure.

## GUIDANCE ON STOPPING OR CONTINUING ANTIPLATELET DRUGS

Several groups have suggested guidelines to aid this decision making process. The decision rests on patient factors such as:

- Why are they taking the drug?

- Is it for primary or secondary prevention?
- Are they particularly high risk, i.e. do they have a coronary stent in situ?
- If so which type (drug eluting or bare metal) and how long have they been in situ?

Surgical factors such as the site of surgery and type of surgery should also be considered. In some types of surgery, bleeding in closed spaces (such as intracranial neurosurgery) can have devastating consequences and some types of plastic surgery with large raw areas can have high bleeding potential.

The American Heart Association/American College of Cardiology have recommended that patients have 12 months of dual antiplatelet therapy after ANY drug eluting stent insertion and the postponement

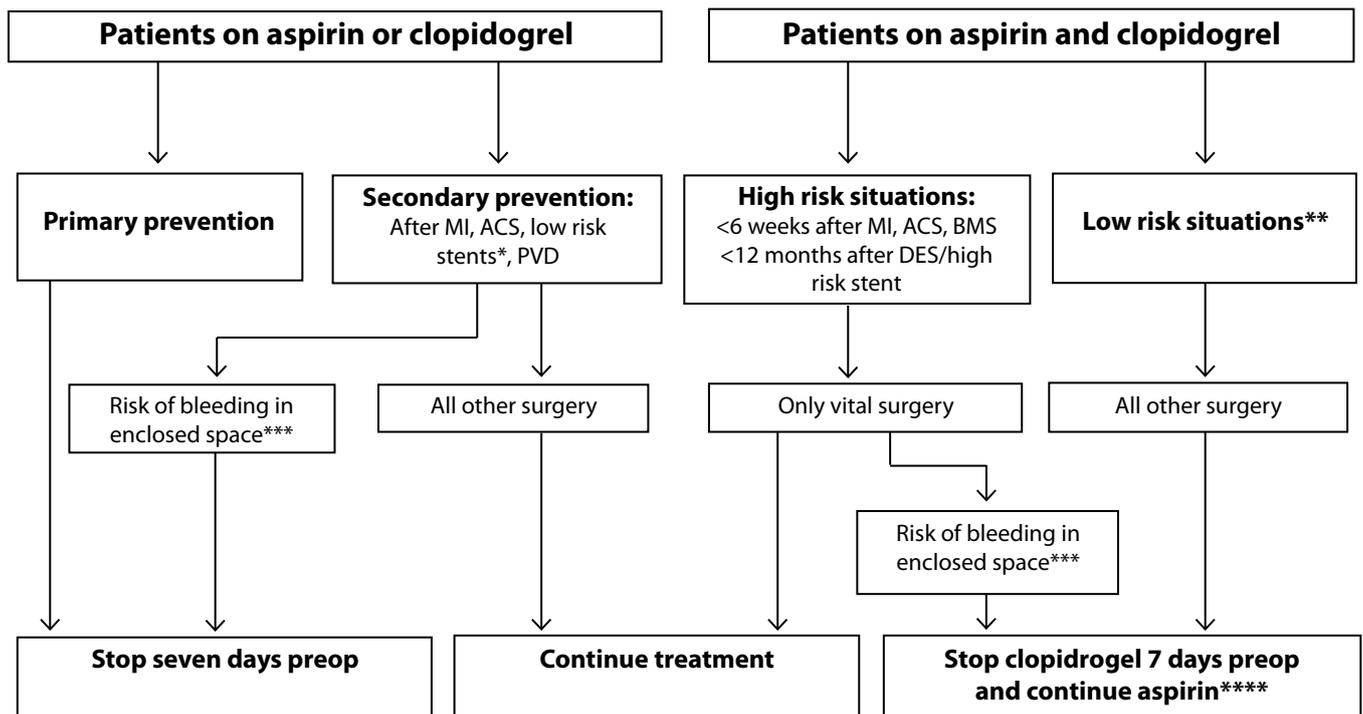
of ALL elective operations during this period. They suggest that aspirin should NEVER be stopped. It has also been suggested that 'Apart from low coronary risk situations, patients on antiplatelet drugs should continue their treatment throughout surgery. However operations traditionally associated with excessive blood loss should be postponed unless vital'<sup>4</sup>

Given this complexity of decision making, the following algorithm (Figure 1) has been proposed to help decide which patients should continue their antiplatelet therapies in the perioperative period and which patients should have them withheld.<sup>5</sup>

Patients should have their therapies restarted as soon as is safe postoperatively. Loading doses of the drugs should be given to reduce the thrombosis risk as soon as possible. In the event of not being able to give the drugs (for example because the patient is nil by

**Figure 1.** Algorithm for preoperative management of patients on antiplatelet therapy (reproduced from Reference 4 by kind permission of Oxford University Press).

### Algorithm for preoperative management of patients on antiplatelet therapy



#### Abbreviations

MI - myocardial infarction; ACS - acute coronary syndrome; PVD - peripheral vascular disease; PCI - percutaneous coronary intervention; BMS - bare metal stent; DES - drug eluting stent;

\* Low risk stents: those receiving aspirin only

\*\* Examples of low risk situations: 3 months after BMS, uncomplicated MI and PCI without stenting

\*\*\* Risk of bleeding in closed space: closed space spinal surgery, posterior eye chamber surgery

\*\*\*\* In high risk situations discuss with consultant anaesthetist/cardiologist and consider "bridging" therapy (e.g. simultaneous unfractionated heparin and GP IIb/IIIa antagonist infusions)

Withdrawing aspirin must be evaluated for each case individually; if aspirin or clopidogrel are stopped, early postoperative re-institution is important.

mouth) other anticoagulation methods should be considered. Bear in mind that many of the alternative drugs affect the venous side of the circulation more than the arterial and so are not providing comparable protection from arterial events.

In the event of bleeding, platelet transfusion is the only effective method of reversing the effect of these drugs. DDAVP (desamino D-arginine vasopressin)<sup>6</sup> and aprotinin (an anti-fibrinolytic agent)<sup>7</sup> may increase platelet function to some degree.

## CONCLUSIONS

In summary the management of patients taking antiplatelet drugs is complex and our current level of understanding is poor. There is a significant potential to do severe harm to patients if their drugs are stopped inappropriately, or indeed if they bleed following surgery whilst still taking them. The default position in many settings seems to be that the decision to stop or not is undertaken preoperatively by surgeons and their favoured decision is to stop clopidogrel almost always and aspirin very frequently.

It is likely that the full implications of stopping antiplatelet drugs are not fully appreciated and, understandably, a fear of bleeding predominates. We suggest that it would be more appropriate to fear the cardiovascular effects of stopping the drugs. Deferring surgery until the patient is 'safe' to stop clopidogrel, or accepting a risk of increased bleeding and adopting strategies to cope with this, if the patient cannot be deferred is more appropriate. Further research in this area will provide the evidence base for robust guidelines to advise management of each patient taking antiplatelet drugs.

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## Surgically placed rectus sheath catheters

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### INTRODUCTION

The aim of modern surgical and anaesthetic practice is to facilitate the rapid recovery of patients with better anaesthesia, surgical techniques and analgesia, resulting in fewer complications and earlier return to normal activities. There are multiple techniques available for postoperative analgesia following laparotomy. These include patient controlled analgesia (PCA), epidural analgesia and intermittent injection of local anaesthetic agents via a rectus sheath catheter. All these modalities have risks and benefits that must be considered when planning postoperative pain management.

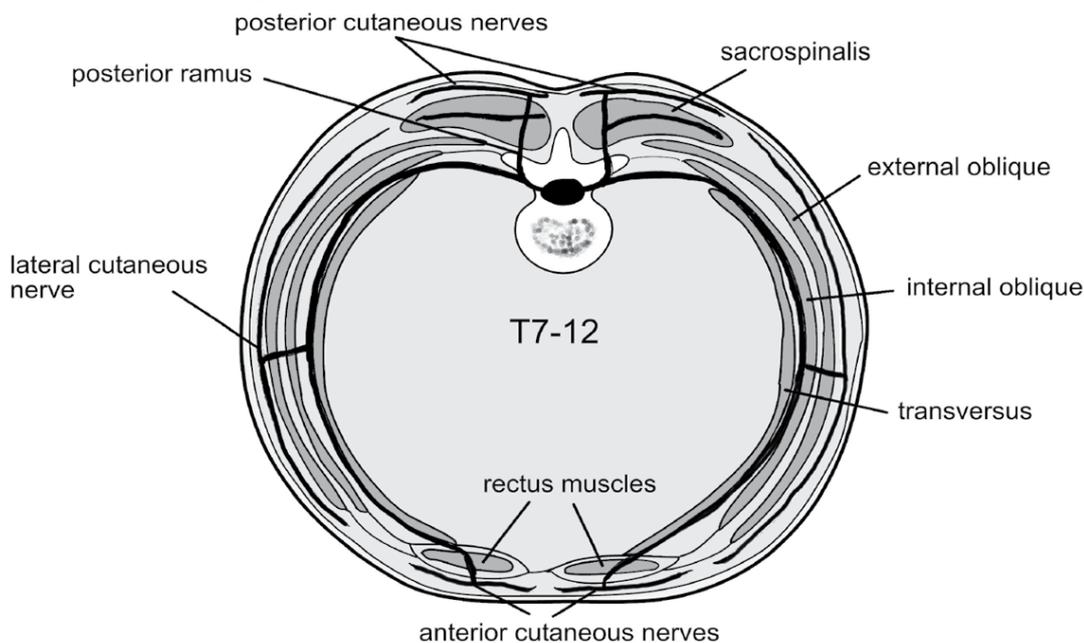
In our institution we use rectus sheath catheters placed by the operating surgeon with increasing frequency and have found this to be an efficient and safe technique. This article accompanies the following article, describing ultrasound guided insertion of rectus sheath catheters and provides an alternative technique that will be easier to adapt to use in settings where resources are limited.

### BACKGROUND

The use of rectus sheath catheters for the administration of local anaesthetic is not new. In the 1950s several studies reported on the use of local anaesthetic catheters to reduce postoperative pain after gynaecological and general surgical procedures.<sup>1-3</sup> This technique has been further investigated with several papers demonstrating the benefit of either continuous or bolus administration of local anaesthetic,<sup>4-9</sup> and others showing no difference.<sup>10-13</sup> The technique is based on the blockade of the anterior division of the T6-T11 thoraco-abdominal intercostal nerves. These nerves leave the spinal cord dividing into anterior and posterior divisions. The anterior divisions pass posterior to the costal cartilages and then between the transversus abdominis and internal oblique muscles, before passing medially to pierce and supply sensation to the rectus and overlying skin. Therefore a catheter placed anterior to the posterior sheath will block these nerves and achieve reduced pain fibre transmission from a midline laparotomy wound (Figure 1).

### Summary

Rectus sheath analgesia is a safe and reliable alternative to other techniques such as epidural catheters. Where the equipment or technical expertise is not available for ultrasound placed catheters, the surgeon can site bilateral catheters at the beginning or end of a laparotomy. The technique and safety aspects of rectus sheath catheters are described in this article.



**Figure 1.** Axial cross-section of the abdomen demonstrating the anatomy of the intercostal nerves (reproduced courtesy of Katrina Webster and Dave Wilkinson)

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Our practice is to use epidural catheters which have multiple perforations at the end of the tubing (Smiths-medical 16G epidural mini-pack). A catheter is placed on each side at the superior end of the laparotomy wound; these may be placed at the beginning of surgery, when the peritoneum is first opened or at the end of surgery just prior to closure. The surgeon places one hand inside the abdomen and with the other hand inserts the Tuohy needle through the skin and fascia. The surgeon feels when the needle tip is just superficial to the interface between the peritoneum and muscle layer (Figure 2), and should also palpate and therefore avoid the inferior epigastric artery.



**Figure 2.** Insertion of a Tuohy needle for a left sided rectus sheath catheter. The surgeon is standing on the patients left, with his left hand within the abdomen and his right hand holding the needle

The stylet is then removed from the needle and the epidural catheter fed through until a 5cm length is in the peritoneum-muscle interface (Figure 3). The surgeon holds onto the catheter tip of the catheter while the needle is removed. The catheter is secured at this point, to avoid accidental removal. We use adhesive epidural catheter dressings (Smiths-medical 'Lock-it plus' - Figure 5); other centres secure them with silk or other suitable suture material. Once secured, a bacterial filter is connected and the catheter is flushed as they can occlude if left during abdominal closure.



**Figure 3.** Threading the catheter through the needle to leave 5cm within the space (usually 12-15cm at the skin)



**Figure 4.** Insertion of a right rectus sheath catheter

The procedure is repeated on the contralateral side and 20mls of 0.25% plain levo-bupivacaine is injected into each side. This initial bolus will block the intercostal nerves and augment analgesia as the anaesthetic is ended and through the recovery period until the next bolus.



**Figure 5.** Rectus sheath catheters in place

On the ward nursing staff administer local anaesthetic every 6 hours in to each catheter, usually with around 20mls of 0.25% levo-bupivacaine (the recommended maximum dose is 2mg.kg<sup>-1</sup> every 6 hours). Bupivacaine (non-isomeric) can be also be used. Great care should be taken that the recommended maximum dose of local anaesthetic agent is not exceeded (Table 1).

**Table 1.** Maximal allowable doses of local anaesthetic agents

	Plain local anaesthetic (mg.kg <sup>-1</sup> )	With epinephrine (mg.kg <sup>-1</sup> )
Bupivacaine	2	2
Lidocaine	3	7
Ropivacaine	3	3

The catheters must be inspected everyday for signs of infection or occlusion. They are usually weaned by day 4 but may be left in for up to a week. Although this technique is opioid-sparing, for large laparotomy wounds a morphine PCA (patient-controlled analgesia) pump is commonly prescribed for the first 24 hours.

## CONCLUSION

We have found that this technique of surgically placed rectus sheath catheters is safe and provides good additional pain relief in most patients. It has the additional benefits of being quick and does not require use of ultrasound, which is not available in many hospitals. It is also not associated with the risks and side effects of epidural anaesthesia including hypotension, epidural abscess or spinal cord injury.

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## Ultrasound guided rectus sheath block - analgesia for abdominal surgery

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### Summary

Regional anaesthesia techniques are evolving rapidly, with ultrasound technology allowing improvements in reliability and efficacy. Over recent years there has been growing interest in abdominal plane blocks, with promising data emerging on the therapeutic benefits of these techniques. The rectus sheath block is a very useful regional technique which allows sensory blockade of the abdominal wall.

### HISTORY OF THE RECTUS SHEATH BLOCK

Abdominal field block was first described in 1899 by Schleich.<sup>1</sup> Various methods of abdominal field block have been used in anaesthetic practice over recent decades. A technique involving multiple injections of local anaesthetic in the abdominal wall was used in the 1980's.<sup>2</sup> This technique was simplified with a single injection non-ultrasound technique used through the 1990's, which was commonly used for paediatric umbilical surgery.<sup>3</sup> Since 2007 the technique has further developed to include ultrasound guidance<sup>4</sup> and placement of rectus sheath catheters.

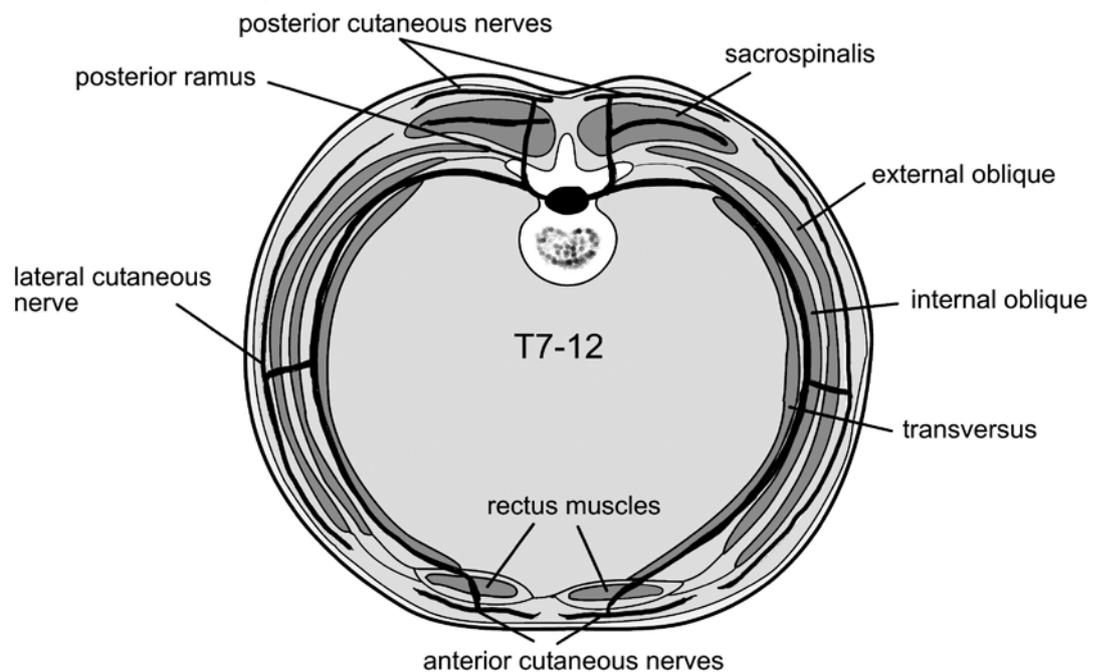
Ultrasound guidance for regional anaesthesia is associated with higher block success rates, shorter onset times, reduced total anaesthetic dose required and reduced complications.<sup>5,6</sup> There is also the advantage of direct observation of pattern of anaesthetic spread. Increasing use of ultrasound by the anaesthetic profession, and our evolving appreciation of the benefits of ultrasound in performance of regional

techniques has caused some techniques to gain new clinical utility. The rectus sheath block is an example of this evolution, where ultrasound allows accurate placement of catheters and therefore continuous ongoing postoperative analgesia becomes possible.

### ANATOMY

Innervation of the anterolateral abdominal wall arises from the anterior rami of spinal nerves T7 to L1. Branches from the anterior rami include the intercostal nerves (T7-T11), the subcostal nerve (T12) and the iliohypogastric / ilioinguinal nerves (L1).

Intercostal nerves T7 to T11 exit the intercostal spaces and run in the neurovascular plane between the internal oblique and the transversus abdominis muscles. The subcostal nerve (T12) and the ilioinguinal/ iliohypogastric nerves (L1) also travel in the plane between the transversus abdominis and internal oblique, innervating both these muscles. The T7-T12 nerves continue anteriorly from the transversus plane



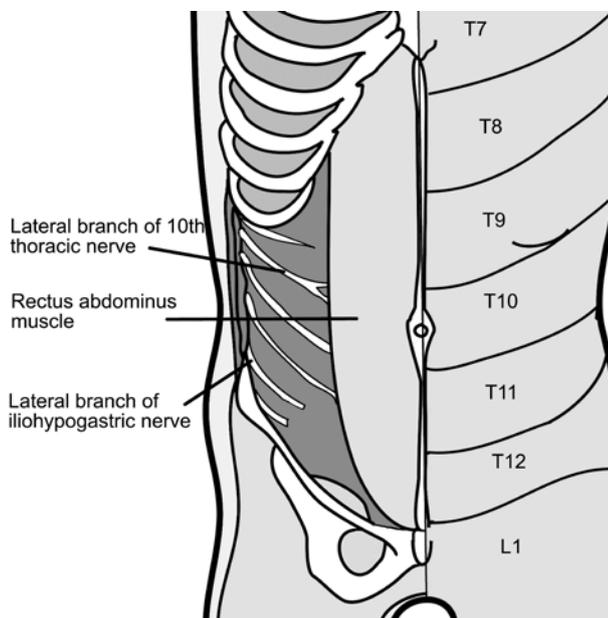
**Figure 1.** Transverse section of the abdominal wall showing the path of nerves T7-T12 as they travel from the spine to the anterior abdomen

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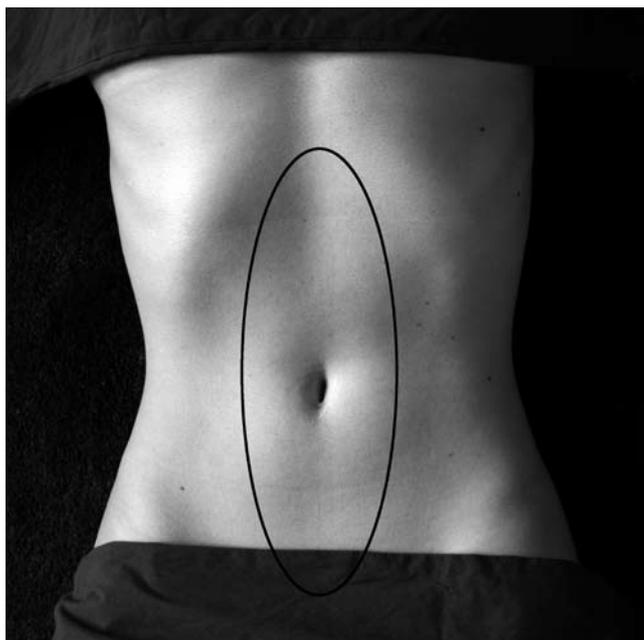
to pierce the rectus sheath and end as anterior cutaneous nerves. The T7-T11 nerves provide sensory innervation to the rectus muscle and overlying skin. T7 gives sensory innervation at the epigastrium, T10 at the umbilicus, and L1 at the groin.<sup>7,8</sup>



**Figure 2.** Cutaneous sensory nerve distribution and dermatomes on the abdominal wall

### CLINICAL APPLICATIONS

Local anaesthetic deposition within the posterior rectus sheath bilaterally provides dense and predictable analgesia over the middle anterior wall from the xiphoid process to the symphysis pubis, as shown in Figure 3. It is therefore used for surgery with midline (or paramedian) abdominal incision. Rectus sheath block does not provide analgesia for the lateral abdomen.



**Figure 3.** Area of sensory block provided by rectus sheath catheters (area within the black circle)

Rectus sheath block will provide somatic pain relief for abdominal wall structures superficial to the peritoneum. For surgery deep to the peritoneum (such as bowel resection) there is usually a component of deeper visceral pain, for which systemic analgesia is routinely given. If oral intake is permitted postoperatively a suitable analgesic regime is: regular paracetamol, regular non steroidal antiinflammatory, and oral opiate as required. If the patient remains nil by mouth postoperatively an opiate patient controlled intravenous analgesia device (PCA) can be used.

Patients with rectus sheath catheters typically demonstrate low pain scores and low opiate requirements,<sup>9,10</sup> although precise benefits have yet to be well defined scientifically. It is not uncommon for patients to use no opioid medication even on day 1 after major laparotomy.

Early mobility is a major advantage of the rectus sheath catheter technique. Excellent analgesia combined with no motor block of the limbs and no mandatory connection to infusion devices or IV poles, allows patients to mobilise early. It is common to see rectus sheath catheter patients walking within 48 hours of major laparotomy. This suggests major clinical benefits including potential for reduced deep vein thrombosis and pulmonary embolus, reduced atelectasis and respiratory infection, and minimal motor deconditioning.

### **How does analgesic effect of rectus sheath block compare to epidural anaesthesia for abdominal surgery?**

An effective epidural will provide complete analgesia after abdominal surgery, while rectus sheath block patients may experience some visceral pain. Visceral pain is usually minimal by 24 hours after surgery.

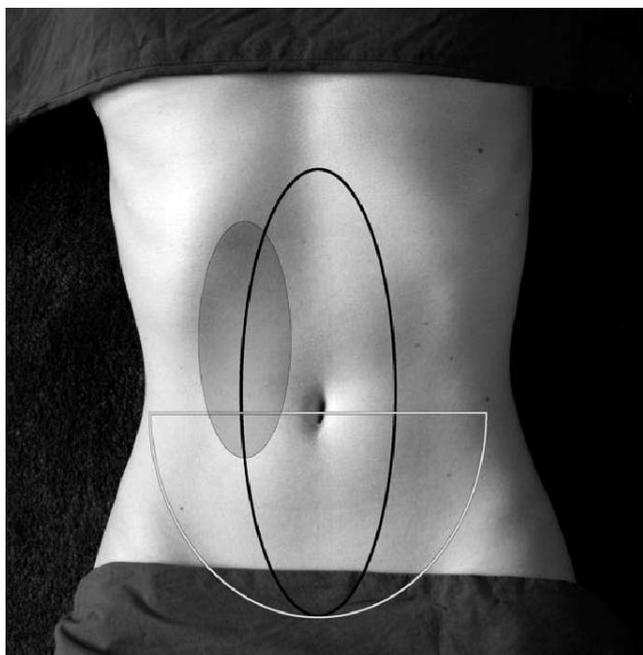
Rectus sheath catheters provide several advantages over epidural anaesthesia. These include avoidance of the significant risks associated with neuraxial techniques, especially in the setting of coagulopathy or recent use of drugs impacting upon coagulation (aspirin, clopidogrel, heparin etc). Rectus sheath catheter insertion presents minimal risk in septic patients. Sepsis is a common contraindication to epidural in emergency laparotomy patients. There is no safety disadvantage with rectus sheath catheter insertion during anaesthesia compared to awake, hence avoiding patient discomfort or distress which can occur during epidural insertion. Rectus sheath analgesia has no haemodynamic effects, and is ideal for patients with hypotension related to sepsis or hypovolaemia. Unlike epidurals, rectus sheath catheters do not need to be connected to pumps and poles thereby permitting early mobilisation.

### **What is the difference between rectus sheath block and transversus abdominis plane (TAP) block?**

Transversus abdominis plane (TAP) block is an alternative technique for abdominal wall analgesia. The TAP block is performed laterally on the abdomen by placing local anaesthetic in the plane between the internal oblique and transversus abdominis muscles.<sup>11</sup> The distribution of sensory blockade is different to that seen with rectus sheath block (Figure 4).

Rectus sheath block reliably provides sensory block for the whole midline of the abdomen. Compared to TAP block, the rectus sheath continuous catheter technique provides denser analgesia of a much

shorter duration. For this reason rectus sheath block is only useful after laparotomy if catheters are placed and regular ongoing dosing is given into the rectus plane. In contrast, single injection TAP block has been shown in numerous studies to have ongoing reduction in pain scores and opiate consumption for several days postoperatively and so is suitable for single shot blockade.<sup>12,13</sup>



**Figure 4.** Comparison of sensory block achieved by rectus sheath block (large black circle over abdominal midline), bilateral standard TAP block (grey semi-circle over lower abdomen), and unilateral oblique subcostal TAP block (which can vary but approximately covers the area shaded in grey in the upper abdominal quadrant)

**When do I use a rectus sheath block? When do I use a TAP block?**

For midline or paramedian incision extending above the umbilicus my technique of choice is rectus sheath catheters. Median incision requires bilateral catheters while paramedian incision (over a single rectus muscle) requires a unilateral rectus sheath catheter on the surgical side. For transverse or pfannensteil incisions below the umbilicus I use a standard TAP block. For transverse or Kocher incision above the umbilicus I use an oblique subcostal TAP block.<sup>14</sup> If a transverse incision is above the umbilicus and includes both rectus sheath and TAP territory, a combination of both techniques can be used. Care must be taken to ensure safe doses of anaesthetic are not exceeded, especially if using combined techniques.

**Rectus sheath catheters in intensive care patients**

Critical care patients present a particular challenge for provision analgesia after laparotomy. This patient group often require emergency surgery and may have sepsis, coagulopathy and haemodynamic instability. In many patients for urgent laparotomy an epidural is contraindicated. Siting an epidural postoperatively is usually not possible due to difficulty positioning and safety concerns placing epidurals in unconscious patients. Use of epidural analgesia after bowel surgery has caused some concern regarding decreases in splanchnic blood supply and hypoperfusion of bowel anastomoses.<sup>15</sup> Opiate infusions can exacerbate ileus and cause

sedation. Rectus sheath catheters are an excellent analgesic modality for post laparotomy intensive care patients as they can be placed with minimal risk of complications and the resultant analgesia (without side effects) allows timely wean of sedation and extubation.<sup>10</sup>

**PERFORMING THE BLOCK**

**Preparation**

Informed consent for the chosen regional technique must be obtained for all elective cases. For patients requiring emergency laparotomy, professional judgement should be used regarding risk and benefit of placing catheters. Patients may be awake, sedated or anaesthetised. The block is ideally performed after induction and intubation but before surgical incision. If the surgery may involve the rectus muscle (such as fashioning a stoma or for paramedian incision) or immediate surgical commencement is required, the block is performed after completion of surgery prior to emergence. In the case of rescue blocks (performed on awake patients postoperatively), local anaesthetic is used to cover needle insertion and minimal or no discomfort is reported during the procedure.

A functioning intravenous cannula must be in place prior to the procedure. Vital sign monitoring, according to local guidelines, must be used during the procedure and emergency equipment to respond to complications such as local anaesthetic toxicity must be readily available.

The usual methods to ensure asepsis are adopted including sterile gown, sterile gloves and sterile drapes. A mask and hair cover should be worn. A sterile ultrasound probe cover and sterile ultrasound gel are used.

The rectus muscle is imaged with the ultrasound probe in a longitudinal orientation above the level of the umbilicus with the patient supine. A broadband (5-12MHz) linear array probe is used, with an imaging depth of 4-6cm. A 50mm probe footprint is ideal for abdominal blocks, allowing better needle imaging than smaller probes.

**Inserting the needle and catheter**

An 18G Tuohy needle is introduced in plane to the ultrasound probe just below the costal margin at an angle of approximately 45 degrees to the skin (see Figure 5 & 6).

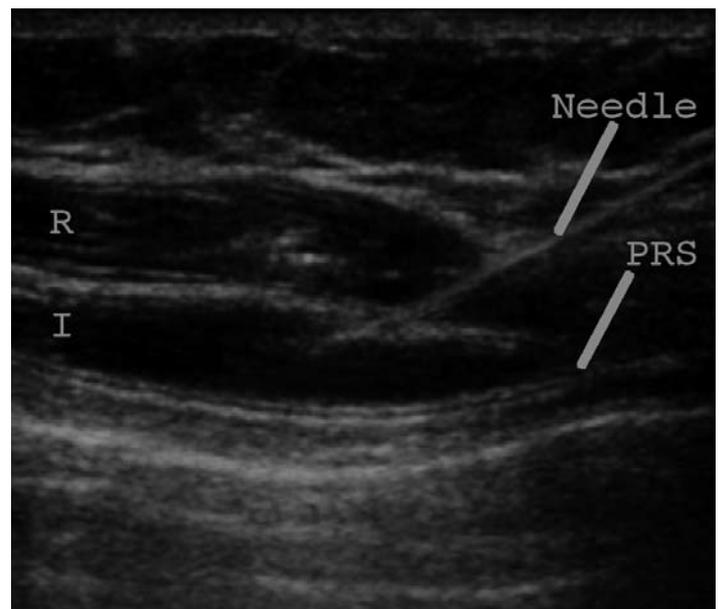
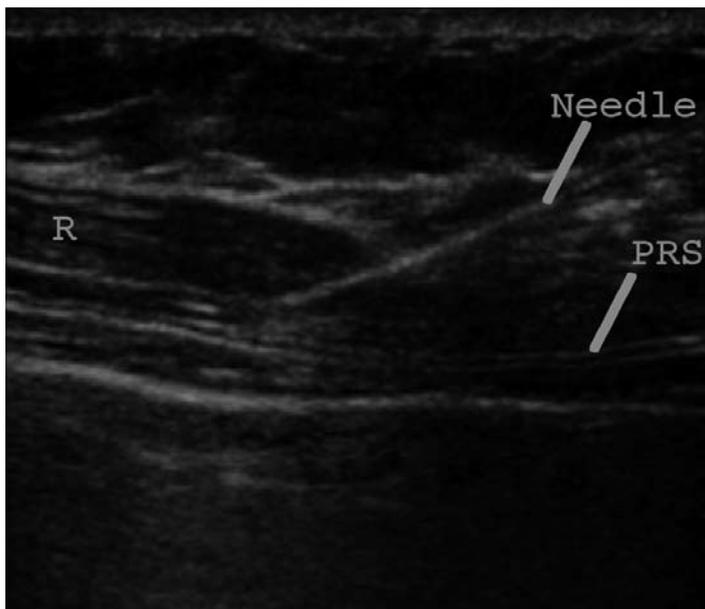


**Figure 5.** Position of probe and needle for rectus sheath catheter insertion



**Figure 6.** Representation of where probe (black rectangle) and needle (black circle) are positioned for insertion of rectus sheath catheters

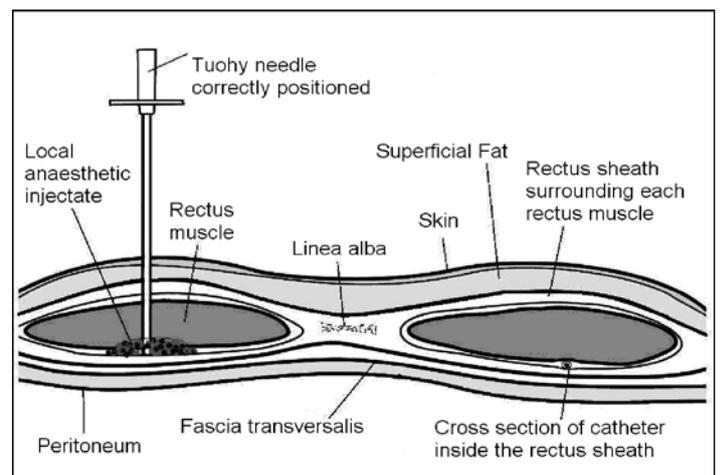
The ultrasound image allows identification of the rectus muscle and hyperechoic twin lines deep to it (posterior rectus sheath and fascia transversalis). Under direct vision the needle tip is advanced to the desired position, posterior to the rectus muscle and above the underlying rectus sheath (Figures 7 and 8). Insertion of local anaesthetic will hydrodissect the rectus muscle away from the posterior rectus sheath.



**Figure 7.** The first ultrasound image shows a needle with the needle tip positioned below the rectus muscle. The second ultrasound image is 1 second later as local anaesthetic is injected to lift the rectus muscle off the posterior rectus sheath. R= rectus muscle, I= injectate (local anaesthetic), PRS= posterior rectus sheath (twin 'tram'-lines).

A 20ml bolus dose of 0.25% bupivacaine or levobupivacaine (or 0.375% ropivacaine) is deposited, with ultrasound imaging demonstrating correct location. The catheter is then threaded through the Tuohy needle and secured to the skin. Approximately 8cm of catheter is inserted into the space. Depending on the angle of needle insertion and size of the patient, the catheter depth at the skin is usually 12-15cm. With an insertion point just below the costal margin this should position the tip of the catheter at approximately the umbilical level. It is useful to ensure the dressing stays as high and as lateral on the abdomen as possible to avoid interference with the surgical field (Figure 9).

The technique is repeated on the opposite side. Further doses of 15-20ml bupivacaine or levobupivacaine 0.25% (or ropivacaine 0.375%) are given to each catheter as a slow injection every 6 hours.



**Figure 8.** Transverse section of the anterior abdominal wall, with depiction of Tuohy needle position and location of local anaesthetic injectate for rectus sheath block



**Figure 9.** Bilateral rectus sheath catheters in situ postoperatively

#### **LOCAL ANAESTHETIC AGENT AND DURATION OF ACTION**

0.25% bupivacaine/levobupivacaine or 0.375% ropivacaine as a 20ml bolus every 6 hours will provide effective continuous analgesia. This concentration and volume of local anaesthetic will provide a sensory block lasting 5-7 hours. Patients often notice the block is less effective in the hour before the next dose is due. My experience of lower doses or lower concentrations (such as 0.2% ropivacaine) has been that the block duration is reduced, which may be a logistical disadvantage requiring more frequent dosing.

#### **ULTRASOUND VERSUS SURGICAL PLACEMENT OF RECTUS SHEATH CATHETERS**

Surgical insertion of rectus sheath catheters intraoperatively was described in 2007.<sup>9</sup> Surgically placed catheters are an efficient use of time and have the advantage of placement under direct vision of the rectus muscle. Disadvantages of placement via the abdominal cavity include potential soiling of a sterile rectus compartment (when forceps and Tuohy needle open the posterior rectus sheath through the peritoneum), and that the subsequent hole created can cause leakage of anaesthetic agent from the rectus sheath space into the abdominal cavity with resultant loss of block efficacy.

Ultrasound placement via the anterior abdominal wall allows the posterior sheath to remain intact, avoiding leakage of local anaesthetic and protects the sterility of the rectus sheath compartment. Preincision placement of the catheters via the abdominal wall achieves intraoperative analgesia and minimises sympathetic response to the surgical procedure.

#### **DANGERS AND LIMITATIONS**

Any regional technique carries a risk of introducing infection, causing bleeding or damaging local structures. It is important to be aware that

the superior and inferior epigastric vessels run in the posterior rectus sheath and there is the potential to place the catheter or needle tip within these vessels. Intravascular administration of local anaesthetic may inadvertently occur with catastrophic consequences. Rectus sheath haematoma can occur if the epigastric vessels are damaged.

If sonoanatomy is not recognised correctly or needle position is not followed accurately with ultrasound, it is possible to puncture the posterior rectus sheath, peritoneum and bowel. Use of ultrasound technology for rectus sheath block has reduced this risk considerably.<sup>16</sup>

The superficial position of rectus sheath catheters and the distance from major nerves or major blood vessels is important in considering safety of the technique. If infection or haematoma were to occur from this technique the implications would be much less serious than would be the case with similar complications in the epidural space.

If rectus sheath catheters are given manual intermittent dosing there is increased risk of introducing infection (as the sterile system is frequently accessed). There is also a risk of serious drug error if 20ml of local anaesthetic is administered via an incorrect route, such as intravenously. These concerns may be overcome by use of a mechanical intermittent dosing device, which is connected continuously to the catheter system. This removes risk of contamination or human error with anaesthetic dosing. The disadvantage of this strategy is that extra equipment is then connected to the patient and some advantages of easy early mobilisation may be lost.

To date there have been no reported complication from ultrasound guided placement of rectus sheath catheters. Attention to strict aseptic technique, careful ultrasound guidance and vigilance to signs of intravascular placement will minimise the risks of this technique.

#### **FUTURE DEVELOPMENTS**

Clinical use of rectus sheath catheters is increasing at a rapid pace. For some anaesthetists, this technique is already routine practice for elective laparotomy. Rectus sheath catheters are very useful for emergency laparotomy, especially when epidural is contraindicated. The significant benefits in the intensive care setting after abdominal surgery are leading to increasing use for this patient group.

While anecdotal evidence to date is very encouraging, anaesthetists await quantitative data to evaluate safety and efficacy of this technique. Numerous clinical trials are currently in progress to examine the rectus sheath catheter technique.

#### **CONCLUSION**

Rectus sheath catheters are an emerging anaesthetic technique providing excellent analgesia after laparotomy. The anatomic characteristics of this block suggest minimal serious complications are likely, and this regional block is particularly useful where epidural is contraindicated. When use of ultrasound for abdominal wall imaging is familiar, this technique is very easy to learn. The excellent safety profile to date, and superb clinical utility of this technique will ensure that popularity of rectus sheath catheters for abdominal surgery will continue to grow.

## ACKNOWLEDGEMENTS

I would like to acknowledge Royal Devon and Exeter NHS Staff Specialists Dr Alex Grice and Dr Matt Grayling for their education in the field of regional anaesthesia. Figure 1 & 2 by D Wilkinson, Figure 3, 4 and 6 by K Webster & D Sutton, Figure 8 by D Wilkinson & K Webster.

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**Enhanced recovery after surgery - current trends in perioperative care**

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**Summary**

Enhanced recovery after surgery involves implementation of change to many components of surgical care pathways. The proven benefits are reduction in morbidity and mortality as well as reduced hospital stay. The evidence behind these strategies is discussed in this article.

**INTRODUCTION**

The concept of enhanced recovery after surgery (ERAS) or fast track surgery (FTS) was introduced over a decade ago and results in shorter hospital stay following operative procedures in a number of surgical specialties. These benefits have been documented for ambulatory procedures such as laparoscopic cholecystectomy and mastectomy, and also for major procedures such as abdominal aortic aneurysm repair.

This approach involves implementation of evidence-based pathways of care, incorporating slight modifications in many different aspects of clinical care. The combined effect of these multimodal strategies is to markedly decrease postoperative morbidity (such as hospital acquired infections and venous thromboembolism), length of hospital stay and time to resumption of normal activities of daily living. Some of these changes in perioperative practice are notable departures from traditional methods. Many of these techniques can be adapted to optimise perioperative care in a wide variety of healthcare settings.

**ENHANCED RECOVERY AFTER SURGERY - BACKGROUND**

The Enhanced Recovery programme is a multi-disciplinary, evidence-based approach to perioperative care that was originally pioneered in Denmark by Professor Henrik Kehlet, a gastrointestinal surgeon from Copenhagen.<sup>1</sup>

It was originally utilised in colorectal surgery but has expanded to include gynaecological, urological and orthopaedic surgery. It aims to ensure patients are optimally prepared for their surgery, both physiologically and psychologically, and to provide perioperative care that reduces the stress of surgery and improves and accelerates recovery. It uses a series of individual interventions that are more effective when implemented together than alone – ‘the sum is greater than the parts’.

The perceived benefits are multiple. Patients are more empowered and should be fitter sooner after their operations, improving their level of satisfaction by

reducing their length of hospital stay and allowing them to resume normal activity and get back to work sooner. The cost of ongoing care and interventions may be reduced and for the providing hospital, the reduced lengths of stay may increase capacity and reduce waiting times.<sup>2,3</sup> This article summarises the strategies that are directly relevant to anaesthetic practice.

**PREOPERATIVE PREPARATION**

The pre-operative preparation process is detailed and many organisational changes are required to facilitate enhanced recovery. Many hospitals have developed preoperative assessment clinics, which form a starting point for the development of an enhanced recovery service. Preparation for surgery should be conducted by staff trained specifically in this area of practice. The overall philosophy is to present the patient at their fittest to give them the best chance of dealing with the stress of surgery.

**Patient expectations and consent**

Patient satisfaction is linked to their expectations. Enhanced recovery pathways aim to ensure that treatment options are actively discussed and the likely course of events for recovery is clear in the patient's mind. A ‘contract of care’ is agreed that empowers patients, increasing their involvement and control in their subsequent care and rehabilitation. Patient diaries that describe, for example, when oral intake is likely to start and what level of mobility is expected at what stage, are integral to this process. Discharge and rehabilitation planning should occur early so that social issues do not slow discharge when the patient is medically fit.<sup>3</sup>

**Medical assessment and optimisation - ‘Prehabilitation’**

Physiological preparation for surgery is important; for patients undergoing abdominal surgery improved quality of life, reduction in postoperative pain, complication rates and overall mortality have all been reported.<sup>4</sup> When surgery becomes likely, a patient's general practitioner may be in an ideal position to optimise conditions such as diabetes, anaemia and hypertension. This reduces the chance that surgery

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will be cancelled at a late stage and gives additional time for these conditions to be improved (for example, iron supplementation for anaemia and changes to diabetic regimes). Evidence shows that treating even minor degrees of anaemia can reduce the risk of blood transfusion that in turn reduces morbidity, mortality and cost.<sup>5</sup>

### Alcohol and smoking

Alcohol abusers can reduce their increased risks of bleeding, wound and cardiopulmonary complications by abstaining preoperatively. Abstaining for a period of one month improves organ function sufficiently to reduce postoperative morbidity.<sup>6</sup> Smoking cessation for a month preoperatively can reduce the increased risk of wound and respiratory complications.<sup>7</sup>

### Preoperative assessment

A good preoperative assessment service ensures that necessary preoperative investigations are performed in plenty of time, helps reduce patient anxiety, allows time for planning and alerts teams to potential problems. Ideally all patients should be admitted on the day of surgery.<sup>8</sup>

### Nutrition

Patients who are well nourished have appropriate stores to cope with the peri- and postoperative catabolic state that is triggered by major surgery (the 'stress response'). Malnourished patients, a high proportion of whom have cancer, have smaller nutritional stores and have been shown to benefit from preoperative enteral supplementation. Preoperative nutritional supplementation is associated with a reduction in infectious complications and anastomotic leaks.<sup>9</sup> In severely malnourished patients (weight loss of more than 15%), enteral supplementation for 10 to 14 days preoperatively is suggested. These patients may also have vitamin and mineral deficiencies and these must be replaced.

### Preoperative starvation

Preoperative guidelines generally state that patients should be nil by mouth for food for six hours prior to induction and two hours for clear fluids. However we know that patients are starved for far longer than this, leading to dehydration and increased perioperative fluid requirements.<sup>10</sup> This period of starvation should be kept as close to that recommended as possible, encouraging patients to eat and drink normally as late as possible, particularly encouraging consumption of clear fluids (water, squash or black tea and coffee) for up to two hours prior to surgery.

Use of preoperative iso-osmolar carbohydrate drinks up to two hours preoperatively, reduces anxiety, prevents dehydration, minimizes the stress response to surgery, reduces insulin resistance and obtunds the development of a catabolic state. By giving a carbohydrate 'load', the patient is in the 'fed' state at the beginning of surgery. This leads to reduced postoperative resistance to insulin (Figure 1), earlier return of bowel function and shortened hospital length of stay. There is no change in gastric emptying time with the ingestion of up to 400ml of a carbohydrate solution up to 2 hours before surgery and so there is unlikely to be any increased risk of aspiration.<sup>11</sup>

### Bowel preparation

Traditional 'bowel preparation' uses enemas to clean the bowel of

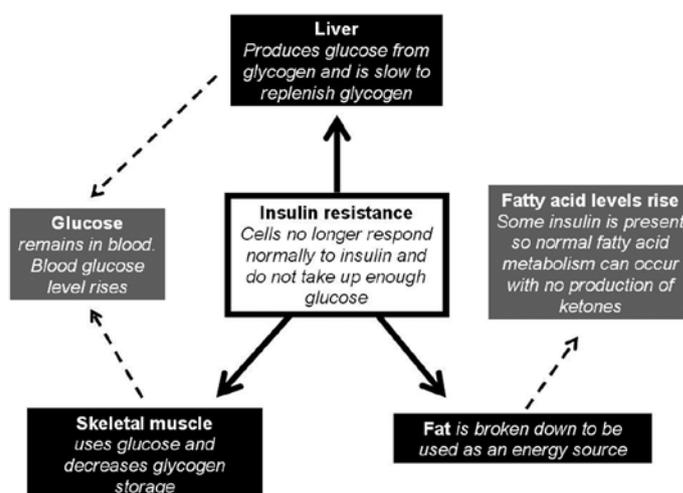


Figure 1. The consequences of insulin resistance

solid stool prior to surgery. When introduced in the 1960's there was a dramatic decrease in morbidity in colorectal surgery – the bowel was easier to handle and there was less contamination of the peritoneal cavity. The disadvantages are patient discomfort, dehydration and electrolyte disturbances. With the improvement in surgical techniques (such as transanal stapling devices) and use of perioperative antibiotics, routine bowel preparation is now being questioned. Avoiding bowel preparation can help patients to maintain a normal diet within the permitted time scales and can help reduce dehydration.<sup>12</sup>

### Premedication

Sedative premedication use is falling, although some patients will benefit from anxiety reduction. In general patients should continue normal medications such as cardiac medications and proton pump inhibitors. Exceptions include anticoagulants and some antiplatelet drugs. For these patients a plan should be made that balances the risks of continuing therapy against the risks of stopping it. Staff should be guided by local and national guidelines, which may be tailored to suite the particular needs of each patient (see page 5).

Other drugs may be considered and these may contribute to improving surgical outcome:

- *Clonidine* is an  $\alpha_2$ -agonist which has been associated with reduced postoperative opioid use, nausea and vomiting (PONV) and reduced intraoperative blood loss. Clonidine's inhibitory effects on the stress response facilitate glycaemic control in type-2 diabetic patients and reduce myocardial ischaemia after surgery.
- $\beta$ -blockers (e.g. metoprolol, atenolol) also have effects on the stress response to surgery, have analgesic and anaesthetic sparing qualities and are anti-catabolic.

### Nursing care

This aspect of ERAS is hugely important as the program relies on nursing staff to implement and support daily milestones, mobilization and discharge. This may be best implemented in the form of structured care pathways. The role may be expanded to involve preoperative assessment and post-discharge contact in the community.

## INTRAOPERATIVE MANAGEMENT

### Operative techniques

#### *Incision*

The current incision choice is based on surgical preference – transverse or vertical. It is usually based on suitable access, duration, and postoperative complications including wound dehiscence, infection and incisional hernia. However, transverse incisions are known to be less painful and provide a better cosmetic result, as well as speeding recovery.<sup>2</sup>

#### *Laparoscopic surgery*

In the UK, the National Institute for Clinical Excellence (NICE) guidance has recommended laparoscopic approaches to surgery if a patient's condition is amenable to it and the surgical expertise is available. The guidance originally referred to colorectal resections but laparoscopic techniques are increasingly used in gynaecological and urological resections.<sup>13</sup> Laparoscopic surgery offers the advantages of reduced tissue trauma, less bowel handling and possibly a reduced stress response.

### Anaesthetic technique

Propofol is the induction agent of choice and, where available, the less soluble volatiles (sevoflurane and desflurane) may facilitate more rapid emergence from anaesthesia. Nitrous oxide has anaesthetic and analgesic-sparing qualities, however infusion of remifentanyl, an ultra short-acting opioid agent, is an increasingly popular technique, allowing lower levels of volatile agent to be used (e.g. 0.5 MAC).

A laryngeal mask airway is preferred when appropriate and if endotracheal intubation is necessary, short or medium acting muscle relaxants should be used. Reversal should be routine, in order to avoid prolonged muscle paralysis and development of postoperative respiratory complications.

### Analgesia

This is one of the most important anaesthetic factors and there is a good deal of evidence to suggest that acute pain is poorly managed in hospitals. Good pain management is essential for rapid recovery from surgery.<sup>14</sup> Postoperative analgesia focuses on multi-modal pain relief, aiming to minimise side effects of the different classes of drugs, particularly opioids.<sup>15</sup>

### Regional and neuraxial analgesia

Regional analgesia has long been thought of as a tool to speed recovery. When administered appropriately this form of pain relief is often better than systemic analgesia. Thoracic epidural analgesia is a good example and is routinely practised for open colorectal surgery in many centres. There are many proposed benefits including a reduction in venous thromboembolism, decreased respiratory complications and decreased duration of ileus, attributed to reduced systemic opioid intake and decreased sympathetic outflow to the bowel.<sup>16</sup>

Not all of the studies investigating the effects of the quality of postoperative analgesia, particularly neuraxial techniques, have shown clear benefits.<sup>17,18</sup> This may be due to the use of surrogate markers such as pain scores and opioid-sparing effects as end-points, that do not reflect clinically meaningful outcome measures such as

return to oral intake or mobility. In addition, clinically significant adverse outcomes, such as cardio-respiratory events are rare and multifactorial; it has been difficult to clarify the specific role of neuraxial analgesia in their prevention.<sup>19</sup> Neuraxial analgesia also has its specific problems that are well known and well documented. When epidurals work, they work well but they have a significant failure rate, commonly accepted to be in excess of 10% and possibly as high as 50%.<sup>20</sup> Epidurals also cause hypotension due to vasodilatation and care is needed to balance the motor and sensory components of the block to avoid problems with mobilisation.

Epidural related hypotension is common and causes concern for splanchnic as well as coronary, renal and cerebrovascular perfusion. In the UK, patients with thoracic epidural analgesia are often managed in a busy ward setting which may limit the treatment options for hypotension to fluid administration. This may result in large quantities of fluid being administered and this in turn may contribute to anastomotic oedema and a possible increase in anastomotic breakdown.<sup>21</sup> Many agree that the hypotension caused by vasodilatation with epidurals should be treated with vasopressors rather than intravenous fluids and there is some published literature to support this.<sup>22</sup>

### Rectus sheath local anaesthesia (see articles on pages 9 & 12)

There is increasing interest in alternative methods of regional analgesia which cause less motor and sympathetic blockade. Rectus sheath catheters are commonly used in our hospital for open colorectal, urological and gynaecological surgery. Rectus sheath local anaesthesia can provide effective analgesia for laparotomy wounds and the catheters may be placed perioperatively, either by the anaesthetist using a percutaneous ultrasound technique or by the surgeon under direct vision. The technique can give good analgesia with limited additional PCA opioid.<sup>23,24</sup>

### Analgesia for laparoscopic surgery

There is less data available to identify the optimal analgesic regimes for laparoscopic surgery but it is known that recovery is faster if adequate pain relief can be achieved with oral analgesics after the first postoperative day.

When compared to the use of PCA morphine, thoracic epidural analgesia reduces pain scores on the first and second postoperative days after colorectal surgery and speeds the resumption of a full diet. However, this has not been shown to translate into a shorter hospital stay and does not reduce the incidence of nausea, urinary retention, hypotension and later pain scores.<sup>25,26</sup> The PROSPECT website (Procedure Specific Postoperative Pain Management - [www.postoppain.org](http://www.postoppain.org)) recommends that this form of analgesia is not recommended for laparoscopic colorectal surgery due to the poor risk:benefit ratio.

Spinal anaesthesia, in conjunction with general anaesthesia, has been used successfully for short stay laparoscopic colorectal surgery and whilst active fluid and monitoring strategies are needed to cope with the haemodynamic changes of a pneumoperitoneum and the Trendelenburg position, the technique is well tolerated.<sup>27</sup> In this study, the spinal anaesthesia group required less vasopressor and had a

reduced hospital stay compared to a group having epidural anaesthesia. Morphine consumption was significantly reduced, compared to a group managed solely with morphine patient controlled analgesia (PCA). In addition, postoperative pulmonary function was better in the spinal group than in the other two groups.

Transversus abdominus plane (TAP) blocks,<sup>28</sup> either using landmark techniques or ultrasound, have also been shown to have a place in laparoscopic surgery, significantly reducing opioid consumption.

### **Analgesia for orthopaedic surgery**

Orthopaedic surgery presents some different clinical problems. Peripheral surgery does not cause ileus and neuraxial techniques do not need to cover higher dermatomes thus reducing the chance of a sympathetic block. The focus on rapid mobilisation has tended to favour techniques which reduce motor block.

The use of peripheral nerve blocks, with or without catheters for postoperative infusion, has grown in popularity in recent years and provides effective analgesia without the need for urinary catheters or exposure to the risk of central nerve injury. A series of procedure specific and evidence-based recommendations have been available for some years at the PROSPECT website<sup>29</sup> and these generally recommend multimodal analgesia and regional anaesthetic techniques. In addition administration of local anaesthesia closer to the surgical site is well established, the idea being that this is a simple method with reduced risks of side effects and complications than more proximal regional anaesthesia.

### **Local infiltration analgesia**

A technique of 'local infiltration analgesia' has been described for knee or hip arthroplasty. A study of 325 patients demonstrated satisfactory pain scores (0-3 out of 10) in all patients with two-thirds of the group requiring no morphine at all.<sup>30</sup> These patients were mobilised early, in some cases within 5-6 hours, and 71% of the group were discharged home on the first postoperative day. The same technique has subsequently been reported on more occasions with varying results and a more detailed description of the actual infiltration process has been described by a group from Denmark.<sup>31</sup>

The regimen consists of premedication with acetaminophen (paracetamol), celecoxib (a COX-2 specific NSAID) and gabapentin, spinal anaesthesia (bupivacaine only) and local anaesthetic infiltration performed in stages during the operation, with an intra-articular catheter placed for post-operative analgesia. Up to 340 mg of ropivacaine with epinephrine was injected. Care was taken over the actual methods of infiltration with pressure bandaging and cooling applied post-operatively. Pain scores were acceptable and higher after the knee compared to hip surgery. Importantly postoperative analgesia permitted patients to be mobilised immediately after spinal anaesthesia had resolved, urinary catheters were not needed and no patients suffered hypotension, urinary retention or motor blockade. Whilst the level of analgesia achieved was inferior to that seen with epidural or peripheral nerve blocks, it was sufficient for patients to be actively mobilised and discharged back to their homes with minimal side effects and, arguably, maximum simplicity. Patient expectation must be proactively managed for this technique to be successful.

A subsequent randomised control trial comparing this technique

with injection of saline showed a significant improvement in pain scores in the first 24 hours.<sup>32</sup>

### **Intraoperative fluid management**

Major surgery is usually associated with significant fluid requirements attributable to preoperative starvation, intraoperative blood loss, pharmacological vasodilatation from neuraxial and systemic drugs, intraoperative evaporative losses and the vasodilatation that may accompany a systemic inflammatory response to surgery.

In high risk surgical patients, therapy aiming to optimise cardiac output and oxygen delivery, is associated with improved outcome.<sup>33,34</sup> Fluid administration is an essential component of this 'goal directed therapy' and fluid restriction risks organ hypo-perfusion and inadequate oxygen delivery to tissues with a variety of possible adverse consequences.<sup>35</sup> However, administration of excess fluid, particularly crystalloids, is thought to contribute to oedema, to slow gut recovery and lead to many other complications. A study in 2003 demonstrated a reduction in postoperative complications in major surgery patients in whom a restrictive fluid regimen was used. This compared favourably to the control group who received large volumes of 0.9% saline and therefore a large sodium load.<sup>36</sup> At a time when the stress response to surgery leads to sodium and water retention, it may simply be that **avoidance of fluid overload** is the important message.

Accurate fluid management and resuscitation requires regular reassessment of physiological parameters and, where available, invasive haemodynamic monitoring. Historically this has been provided by pulmonary artery catheters, but these are increasingly being replaced by targeted stroke volume optimisation with oesophageal Doppler probes. Given the relative simplicity and lack of complications, where available the latter is the recommended method of guiding fluid administration in the operating room.

Stroke volume optimisation has been described with the administration of colloid fluid challenges looking for a rise in stroke volume of 10%. Patients in whom this occurs are deemed to be on the rising part of their Starling curve and further boluses can be given until the stroke volume fails to rise after which fluid boluses are withheld until there is a fall in stroke volume. This approach may protect against relative hypovolaemia as well as fluid overload and has been shown to improve outcome.<sup>35,37-39</sup>

The NHS Technology Adoption Centre placed this technology into three NHS Trust hospitals and compared outcomes after major surgery with case-matched controls prior to implementation. There was a 67% reduction in mortality, a four-day reduction in length of stay, a 23% reduction in central venous catheter use, a 33% reduction in the readmission rate and a 25% reduction in re-operation rate. This evidence and the recommendations relating to perioperative management and enhanced recovery are presented online at the referenced websites.<sup>40</sup>

In addition, consensus guidelines with graded recommendations concerning perioperative fluid management can be viewed online.<sup>41</sup>

### **Temperature regulation**

Hypothermia is defined as a body core temperature below 36°C. Most

initial temperature loss occurs on induction of anaesthesia, however if surgery involves opening of visceral cavities, especially intra-abdominal, for longer than 2 hours, hypothermia occurs in 70%. Hypothermia causes sympathetic stimulation, vasoconstriction and shivering, leading to increased oxygen demand. Cardiac patients are particularly at risk with an increase in angina, myocardial ischaemia, and arrhythmias. Other complications include coagulation disorders, increased risk of infection, increased blood loss and longer hospital stay.

To combat heat loss, active convection warming blankets should be used – these have been shown to be superior to simple blankets or foil. Increasing the ambient temperature (of relevance to warmer countries) interestingly does not completely protect the patient from a drop in temperature. Also there should be routine use of fluid warmers for cases in which a significant amount of fluid is expected to be given.

### Glucose control

Impaired glucose homeostasis during surgery can result in hyperglycaemia, which is an independent risk factor for postoperative complications including death after cardiac surgery. Normoglycaemia should be maintained in diabetic patients and hyperglycaemia should be detected and treated in non-diabetics.

## POSTOPERATIVE MANAGEMENT

### Drains, nasogastric tubes and urinary catheters

Patients frequently emerge from surgery with various tubes attached to them or entering body cavities. Current thinking is that the use of surgical drains, urinary catheters and nasogastric tubes should be avoided if possible and appropriate. There will always be patients who will benefit from such tubes but perhaps their use should be specifically indicated rather than routinely adopted.

Some studies have shown no significant difference in the incidence of anastomotic complications, wound infections or re-interventions in colorectal surgery with or without abdominal drain placement.<sup>42</sup> In addition, avoidance or the early removal of urinary catheters facilitates mobilisation and reduces the risk of urinary tract infections.

Nasogastric tubes are often used routinely to decompress the stomach, reduce nausea, protect anastomoses and reduce pulmonary complications. However, in the absence of conditions such as bowel obstruction, it has been argued that their routine use can actually delay the return of bowel function and possibly increase nausea and hospital stay.<sup>43</sup> Patients are also encouraged to resume oral intake of diet and fluids as soon as is practicable, within the limits of their surgery - this may be on the day of surgery or on the first postoperative day. High energy drinks can help improve nutritional support in the early stages.<sup>43</sup>

### CONCLUSIONS

Enhanced recovery aims to provide better care with more patient involvement, improved patient satisfaction and a faster return to levels of pre-operative activity by reducing the stress of surgery physiologically and physically. This may in turn reduce the drain on resources in terms of bed days, length of stay and resultant hospital acquired complications.

Much of this involves a shift in thinking in terms of variation from traditional practice – the use of drains and urinary catheters, fluid management and types of analgesia techniques. There is an emphasis on getting the simple things right in an attempt to have a bigger effect on outcomes.

We may, therefore, see an increasing role for simpler analgesia techniques aimed at the site of surgery and the local tissue, avoiding the need for centrally or more proximally based techniques with increased side effects and risks.

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**Malaria for the anaesthetist**

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**Summary**

This article aims to educate the anaesthetist on the aetiology, diagnosis, pathophysiology and clinical features of this prevalent disease, along with the anaesthetic management of a patient affected with malaria.

**SELF-ASSESSMENT QUESTIONS**

The answers can be found at the end of the article, together with an explanation.

- Which of the following statement is false?
  - Malaria is a contagious disease.
  - Malaria is caused by a parasite that is transmitted from one person to another by the bite of the Anopheles mosquito.
  - Malaria is transmitted through blood transfusion or I.V. drug use when sharing needles.
- Quinine, one of the mainstay anti-malarial drugs:
  - increases the excitability of the motor end plate region.
  - prolongs the duration of rocuronium.
  - enhances the actions of neostigmine.
- Which of the following statements is true in the anesthetic management of a person infected with malaria?
  - Ketamine is an ideal inducing agent for patients with severe malaria.
  - It is generally safe for children affected with malaria to have premedication to alleviate anxiety.
  - Isoflurane is the inhalational anesthetic of choice for patients with cerebral malaria.

**INTRODUCTION**

Malaria is one of the most successful parasites ever known to mankind. After thousands of years, it remains the world's most pervasive infection, affecting 300-500 million people annually. One million people die each year from malaria - the majority are children under five. A child dies every 30 seconds from malaria, many just days after infection. Ninety percent of these deaths occur in Sub-Saharan Africa. With the high prevalence of malaria, it is important that the anaesthetist practising in the developing world is familiar with the clinical aspects of the disease.

**AETIOLOGY**

Malaria is a life-threatening parasitic disease transmitted by mosquitoes. It was once thought that the disease came from fetid marshes, hence the name *mal aria* (bad air). In 1880, scientists discovered the real cause of malaria: a single-cell parasite called Plasmodium. Later they discovered that the parasite is transmitted from person to person through the bite of a female Anopheles mosquito that requires blood to nurture her eggs.

Infection begins with a bite from an infected mosquito. The plasmodium parasite travels from saliva of the mosquito into the bloodstream, to the liver cells, where it reproduces for the next 5-30 days (the incubation period). The parasite then leaves the liver and travels in the bloodstream, where it infects red blood cells.

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The parasite reproduces again in the red blood cells, destroying the cells and releasing more parasites into the bloodstream. If another mosquito bites an infected person, that mosquito now serves as a vector that can transmit the infection to another human. Almost all deaths from malaria arise from the parasite *Plasmodium falciparum*.

Although most people acquire malaria through mosquito bites, the disease can also be transmitted through blood transfusions, organ transplants, by IV drug users sharing needles and by infected mothers to their babies in utero.

**SYMPTOMS**

After an incubation period of 5-30 days, malaria produces chills, fever, fatigue, headache, cough and severe myalgia, interspersed with temporary periods of well-being or being symptom-free. This is the hallmark of the benign form of malaria. These acute attacks or paroxysms occur when the red blood cells rupture.

Paroxysms occur in three stages.

- Cold stage:** lasting 1-2 hours characterized by chills and extreme shaking.
- Hot stage:** lasting 3-4 hours characterized by fevers which may go as high as 42°C.
- Wet stage:** lasting 2-4 hours characterized by profuse sweating.

**Table 1.** The four species of *Plasmodium* that infect humans

Organism	Region	Incubation period	Comment
<i>P. vivax</i>	India Central and South America	8-13 days	
<i>P. ovale</i>	Africa	8-17 days	Can remain in liver of partially treated individuals to recur later
<i>P. malariae</i>	Worldwide	2-4 weeks	
<i>P. falciparum</i>	Worldwide	5-12 days	Most life threatening

Paroxysms may occur every 2-3 days when caused by *P. malariae* or every 40-50 hours when caused by *P. vivax* and *ovale*. The *P. falciparum* species cause a more severe form of malaria, with persistently high fevers and sludging of red blood cells within the blood vessels. This may lead to hemiplegia, seizures, delirium and coma (cerebral malaria), coughing, haemoptysis, vomiting, abdominal pain, malaena, diarrhoea, oliguria and renal failure.

### DIAGNOSIS

A person manifesting the symptoms described above, along with a history of travel to an endemic area, or a history of blood transfusion or drug abuse strongly suggests the diagnosis of malaria. However, because symptoms of malaria mimic those of other diseases, definitive diagnosis can only be determined through laboratory identification of the parasites in the red blood cells in peripheral blood smears.

Other supplementary laboratory results that support the diagnosis are the presence of anaemia, low white blood cell count, with protein and leukocytes in the urine. In *falciparum* malaria, blood coagulation tests may reflect the presence of disseminated intravascular coagulation (DIC), characterised by low platelet count, prolonged prothrombin time, prolonged partial thromboplastin time and decreased plasma fibrinogen.

### MEDICAL TREATMENT AND PREVENTION

In order to control malaria, a comprehensive threefold approach is necessary:

#### Prevention

This includes bite avoidance by providing insecticide-treated bed nets, spraying the inside walls of houses with insecticides and administering intermittent preventative prophylaxis, especially to infants and pregnant women.

#### Diagnosis and treatments

This includes providing prompt access to diagnosis and anti-malarial drugs, and a packet of interventions through strengthened antenatal care services for pregnant women.

#### Education

Families and communities should be empowered with the knowledge and resources to combat this disease. It is important to educate the medical community to not over-treat if malaria is not a confirmed diagnosis.

Detailed and comprehensive data on the medical treatment guidelines for the different forms of malaria are available both in the World Health Organization and the Centre for Disease Control and Prevention websites. Full URLs for these links are given at the end of this article

### ANAESTHETIC MANAGEMENT

#### Preoperative considerations

Preoperative assessment should be directed towards determining the severity of the disease state and the type of malarial parasite involved. The following laboratory and diagnostic tests are most helpful preoperatively.

<i>Full blood count</i>	to determine the presence and extent of anaemia and thrombocytopenia
<i>Urea and creatinine levels</i>	to assess renal function
<i>Coagulation profile</i>	
<i>Albumin and liver function tests</i>	essential for monitoring disease progression
<i>Electrolytes</i>	
<i>Type and crossmatch</i>	for blood products
<i>Arterial blood gas, ECG, Chest Xray</i>	where available, as indicated by clinical severity (may have pulse oximetry)

Careful assessment of the patient's conscious level is essential and the Glasgow Coma Scale must be recorded. For children the Blantyre Coma Scale is useful (Table 1). The patient with impaired neurological function preoperatively is likely to deteriorate postoperatively.

Pre-medication and administration of sedative drugs is better avoided in all but uncomplicated cases of malaria and should certainly not be used in any patient presenting with drowsiness prior to securing their airway. Even slight respiratory depression may increase arterial carbon dioxide levels and cause cerebral vasodilatation that may result in cerebellar herniation in a patient in whom the intracranial pressure is already markedly elevated.

**Table 1.** *The Blantyre Coma Scale is a modified version of the Glasgow Coma Scale and is used for children too young to talk*

<b>Eye movement</b>	
Watches or follows	1
Fails to watch or follow	0
<b>Best motor response</b>	
Localizes to painful stimulus	2
Withdraws limb from painful stimulus	1
No response or inappropriate response	0
<b>Best verbal response</b>	
Cries appropriately with pain or, if verbal, speaks	2
Moan or abnormal cry with pain	1
No vocal response to pain	0

### Anaesthetic Considerations

Occasionally patients with an acute episode of malaria will require surgery e.g in pregnancy and following trauma. The mortality and morbidity of surgery and anaesthesia will be increased by malaria which can affect any organ system. Therefore the precise interaction of malaria with the anaesthesia technique used will largely depend on the organ system affected. Ideally always try to delay surgery until the malarial episode has responded to management.

#### Central nervous system

Cerebral malaria is the most serious complication of *P falciparum* infection and may result in various neurological clinical symptoms such as seizures, increased intracranial pressure (which may result in reduction in cerebral perfusion pressure) and disturbance in cerebrovascular autoregulatory mechanisms. Whereas 80% of adults have an opening pressure at lumbar puncture in the normal range, 80% of children have an opening pressure in the high range with a lumbar puncture. CT or MRI studies show increased cerebral blood volume and not cerebral oedema as the cause of slight brain swelling seen in cerebral malaria.

While general anaesthesia and control of the airway are essential, the technique should focus on agents that cause least intracranial circulatory changes. Mannitol and furosemide should be available to acutely lower intracranial pressure, if needed. Among the inhalational anaesthetics, isoflurane is the best choice for patients with cerebral malaria because it causes less cerebral vasodilatation, thus less increase in cerebral blood flow. Thiopental and propofol may be used as induction agents but ketamine is discouraged because it also causes an increase in cerebral blood flow and intracranial pressure.

Assessment of level of consciousness forms an important part of immediate postoperative care. Patients should not be discharged to the ward unless they are awake and alert and have regained or exceeded their preoperative level of consciousness.

#### Cardiovascular and respiratory system

Myocardial function is generally thought to be well preserved in patients with malaria. Pathological studies have described blocking of the coronary vessels with parasites and pigments, fatty degeneration of the myocardium and myocardial changes similar to those found

myocarditis. In view of these findings, myocardial function may be impaired in some patients with severe malaria and examination should be directed to look for signs of poor cardiac function. Where available, preoperative echocardiogram may be beneficial. Myocardial function support including inotropes should be anticipated.

Pulmonary oedema is also a common complication of severe malaria due to injury to pulmonary capillaries by the parasites. Once it has occurred it is associated with a poor prognosis. Perioperatively, the patient with severe pulmonary oedema may be helped by positioning head up. High concentrations of oxygen/diuretics/PEEP may be required. Careful titration of intravenous fluids is recommended.

#### Hematological system

Anaemia, an inevitable consequence of severe malaria, occurs due to destruction of red cells combined with marrow dysplasia. The degree of anaemia correlates with the degree of parasitaemia and total serum bilirubin levels. Blood transfusion should be considered if the hematocrit falls below 25% but caution should be taken as pulmonary oedema may be precipitated. Blood loss during a surgical procedure should be replaced to reduce the circulating parasite count. Where available, haemodynamic monitoring with a central venous pressure catheter may be helpful where significant haemorrhage occurs or is anticipated. Meticulous attention should be paid to fluid balance for any procedure where fluid shifts may be anticipated. Particular care should be taken not to administer excess crystalloid fluids as these patients are especially prone to develop fatal pulmonary oedema.

Thrombocytopenia occurs commonly in both mild and severe *falciparum* malaria and is not particularly associated with disease severity. The presence of thrombocytopenia (less than 100,000) advises against the use of a regional technique unless general anaesthesia is absolutely contraindicated.

#### Gastrointestinal system

Jaundice and deranged liver function tests are extremely common findings in patients with moderate and severe malaria. Abnormalities of hepatic function theoretically precludes the use of halothane; isoflurane may be a better choice if available.

Hypoglycaemia also occurs frequently in severe malaria. Patients particularly at risk include pregnant women and those in the hospital for more than 48 hours. Quinine, a first-line medical therapy used in malaria is one of the most potent *in vitro* stimulants of pancreatic insulin secretion. Glucose consumption may be increased due to fever and infection. Lactic acidosis is also common in children with *P falciparum* infection due to lactate production by the parasite and impaired gluconeogenesis. Hypoglycaemia associated with *falciparum* malaria is treated with an infusion of 10% glucose in normal saline together with regular assessment of blood glucose levels.

#### Renal function

Renal dysfunction in severe malaria is common and is usually due to acute tubular necrosis from microvascular obstruction. Some patients may present with pre-renal failure and renal function may be restored to normal with rehydration. Renal failure is typically oliguric and is strongly associated with hyperparasitemia, jaundice, and

hypovolemia. Although sequestration of parasitized red cells occurs in the glomerular capillaries, it is not as pronounced as in other organs such as the brain.

If available, atracurium or cis-atracurium (because of Hoffman elimination) should be used as the relaxants of choice in cases with renal dysfunction. The use of succinylcholine (suxamethonium) is generally safe in patients with renal failure, provided that there is no associated neuropathy or preoperative hyperkalemia, and that repeated succinylcholine doses are avoided (reference 7 below). The use of both vecuronium and pancuronium is discouraged in cases of established renal impairment. A major portion of pancuronium, as well as an active metabolite, are excreted in urine. The elimination half-life is doubled and the plasma clearance reduced in patients with renal failure. The rate of recovery of neuromuscular blockade is also variable and sometimes very much slower than normal. If one needs to use vecuronium, a lower initial dose should be considered, especially for undialysed patients since neuromuscular blocking effect is prolonged in usual doses.

#### Pharmacological interactions

One should be aware of the drug interactions between the anti-malarial drugs and the common drugs used in anaesthesia.

- Quinine enhances the effect of neuromuscular blocking agents and opposes the actions of acetylcholine esterase inhibitors. It decreases the excitability of the motor end-plate region so that the response to repetitive nerve stimulation and acetylcholine are reduced.
- Chloroquine reduces the effect of neostigmine and pyridostigmine.
- Tetracycline also enhances neuromuscular blockade.

Therefore, neuromuscular blockade monitoring is essential when paralyzing agents are used in general anaesthesia. If neuromuscular blockade monitoring is not available, reduce the dose of paralyzing agents used.

#### Temperature

In addition to usual vital signs monitoring, temperature monitoring should be routine for all cases, as patients frequently present preoperatively with temperatures in excess of 40°C. Finally, it should be remembered that malaria can be transmitted via needle-stick injury and universal precautions should be adopted including special care in disposing of sharps.

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#### ANSWERS TO QUESTIONS

##### 1. Answer A is false.

Malaria is not a contagious disease. Malaria is not spread from person to person like a cold or flu and it cannot be sexually transmitted. A person cannot get malaria from casual contact with malaria-infected people, such as sitting next to someone who has malaria. The cause of malaria is a one-celled parasite called Plasmodium which is transmitted from one person to another through the bite of a female Anopheles mosquito. Although most people acquire malaria through mosquito bites, the disease can also be transmitted through blood transfusions, organ transplants, by IV drug users from sharing needles and by infected mothers to their babies.

##### 2. Answer B is true.

Quinine enhances the effect of neuromuscular blocking agents and opposes the actions of acetylcholine esterase inhibitors such as neostigmine. It decreases the excitability of the motor end-plate region so that response to repetitive nerve stimulation and acetylcholine are reduced.

##### 3. Answer C is true.

Thiopental and propofol may be used as induction agents but ketamine is discouraged because it causes an increase in cerebral blood flow and intracranial pressure. Premedication and administration of sedative drugs is better avoided in all but uncomplicated cases of malaria and should certainly not be used in any patient presenting with drowsiness prior to securing the airway. Respiratory depression will increase arterial carbon dioxide levels and may cause cerebral vasodilatation that may result in cerebellar herniation in a patient in whom the intracranial pressure is already markedly elevated. Among the inhalational anesthetics, isoflurane is the best choice for patients with cerebral malaria because it causes less cerebral vasodilatation, thus less increase in cerebral blood flow.

## Pulmonary aspiration of gastric contents

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### Summary

Aspiration is a relatively rare, but potentially fatal complication of general anaesthesia occurring most commonly in emergency patients, those at light level of anaesthesia or with intra-abdominal pathology. The spectrum of symptoms ranges from nil, to severe respiratory compromise and death, and may be due to either a chemical pneumonitis or secondary pneumonia. Prevention is the key, and there are several mandatory requirements that must be fulfilled in the at-risk patient. However, in the event of aspiration occurring, treatment is essentially supportive once the airway has been secured.

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### INTRODUCTION

Aspiration was first recognised as a cause of an anaesthetic-related death in 1848 by James Simpson. Much later in 1946, Mendelson described the relationship between aspiration of solid and liquid matter, and pulmonary sequelae in obstetric patients. Today it remains a rare but potentially devastating complication of general anaesthesia, quoted as occurring in between 1 in 3000 and 1 in 6000 anaesthetics. This increases to 1 in 600 for emergency anaesthesia in adults.

Aspiration can be defined as the inhalation of material into the airway below the level of the true vocal cords. It is linked with a range of clinical outcomes, being asymptomatic in some instances and resulting in severe pneumonitis and ARDS (acute respiratory distress syndrome) in others. This article covers the pathophysiology and predisposing factors and goes on to discuss prevention and management.

### PATHOPHYSIOLOGY

The lower oesophageal sphincter (LOS) is functionally distinct from the oesophagus, and acts as a valve preventing the reflux of gastric contents. Barrier pressure is the difference between LOS pressure (normally 20-30mmHg) and intragastric pressure (normally 5-10mmHg) and both are influenced by a number of factors. LOS pressure is reduced by peristalsis, vomiting, during pregnancy (a progesterone effect) as well as pathological conditions such as achalasia and various drugs (anticholinergics, propofol, thiopentone, opioids).

Intragastric pressure is increased if the gastric volume exceeds 1000ml, and with raised intra-abdominal pressure such as that occurring with pneumoperitoneum during laparoscopy. The resulting drop in barrier pressure may increase the risk of aspiration, although it should be pointed out that studies have shown a concomitant increase in LOS pressure in anaesthetised patients undergoing laparoscopy, thus maintaining barrier pressure. Gastric volume is influenced by the rate of gastric secretions (approx  $0.6\text{ml}\cdot\text{kg}^{-1}\cdot\text{hr}^{-1}$ ), swallowing of saliva ( $1\text{ml}\cdot\text{kg}^{-1}\cdot\text{hr}^{-1}$ ), ingestion of solids/liquids and the rate of gastric emptying. The rate of gastric emptying for non-caloric clear fluids is

rapid – the half-time being about 12 minutes. Solids however, require six hours or more to be cleared from the stomach, displaying zero-order kinetics. Altered physiological states such as pregnancy, labour, abdominal pain, gastrointestinal disorders, renal failure and diabetes will alter the rate of gastric emptying, as well as drugs such as opioids.

### PREDISPOSING FACTORS

As suggested above, patients at greatest risk are those undergoing unplanned surgery, but also inadequate level of anaesthesia, those with abdominal pathology or the obese. Other examples are found below in Table 1.

### CLASSIFICATION

#### Aspiration pneumonitis

Known as Mendelson's syndrome, as described by the obstetrician in 1946, this condition involves lung tissue damage as a result of aspiration of non-infective but very acidic gastric fluid. This usually occurs in two phases:

- First, desquamation of the bronchial epithelium causing increased alveolar permeability. This results in interstitial oedema, reduced compliance and VQ mismatch.
- The second stage, occurring within 2 to 3 hours, is due to an acute inflammatory response, mediated by proinflammatory cytokines such as tumour necrosis factor alpha, interleukin 8 and reactive oxygen products. Clinically, this may be asymptomatic, or present as tachypnoea, bronchospasm, wheeze, cyanosis and respiratory insufficiency.

#### Aspiration pneumonia

This occurs either as a result of inhaling infected material or secondary bacterial infection following chemical pneumonitis. It is associated with typical symptoms of pneumonia such as tachycardia, tachypnoea, cough and fever, and may be evidenced by segmental or lobar consolidation (classically right middle lobe) on chest radiography. The disease process is similar to a community acquired pneumonia although the

**Table 1.** Predisposing factors for aspiration under general anaesthesia

<b>Patient factors</b>	Increased gastric content	Intestinal obstruction Non-fasted Drugs Delayed gastric emptying
	Lower oesophageal sphincter incompetence	Hiatus hernia Gastro-oesophageal reflux Pregnancy Morbid obesity Neuromuscular disease
	Decreased laryngeal reflexes	Head injury Bulbar palsy
	Gender	Male
	Age	Elderly
<b>Operation factors</b>	Procedure	Emergency Laparoscopic
	Position	Lithotomy
<b>Anaesthetic factors</b>	Airway	Difficult intubation Gas insufflation
	Maintenance	Inadequate depth of anaesthesia

complication rate is higher, with cavitation and lung abscess occurring more commonly.

### Particulate-associated aspiration

If particulate matter is aspirated, acute obstruction of small airways will lead to distal atelectasis. If large airways are obstructed, immediate arterial hypoxaemia may be rapidly fatal.

## PREVENTION OF ASPIRATION

### Preoperative fasting

The commonly quoted figures of a critical volume of 25ml of aspirate, with a pH <2.5 being sufficient to cause aspiration pneumonitis are derived from unpublished work on Rhesus monkeys, extrapolated to humans. In fact 50% of fasted patients have a residual gastric volume exceeding this, with an average pH of around 2.0.

Unnecessarily prolonged nil by mouth (NBM) orders lead to dehydration and possibly hypoglycaemia, with resultant thirst, hunger, discomfort and irritability. Current guidelines are:

- 2 hours for clear fluids,
- 4 hours for breast milk and
- 6 hours for a light meal, sweets, milk (including formula) and non clear fluids.

### Reducing gastric acidity

Histamine (H<sub>2</sub>) antagonists and proton pump inhibitors (PPIs) are commonly used to increase gastric pH, although they do not affect the pH of fluid already in the stomach. Oral sodium citrate solution reliably elevates gastric pH above 2.5, but it increases gastric volume,

and is associated with nausea and vomiting. H<sub>2</sub> antagonists act by blocking H<sub>2</sub> receptors of gastric parietal cells, thereby inhibiting the stimulatory effects of histamine on gastric acid secretion.

PPIs on the other hand, block the 'proton pump' of the same cell, inhibiting the stimulatory actions of histamine, gastrin and acetylcholine. An oral H<sub>2</sub> antagonist must be given 1-2 hours before anaesthesia and a PPI 12 hours in advance. A recent meta-analysis suggested that ranitidine was superior to PPIs in both reducing gastric fluid volume and acidity.<sup>4</sup> Its use is recommended in patients at risk of aspiration only, not routinely. Metoclopramide has a prokinetic effect promoting gastric emptying, but there is little evidence to support its use. It does however, remain part of the usual pre-medication for Caesarean section under general anaesthetic.

### Rapid sequence induction (RSI)

It has been shown that most cases of aspiration occur on induction and laryngoscopy, hence the following is of the utmost importance. For patients at high risk of aspiration, a RSI is the induction of choice unless presented with a sufficiently difficult airway to warrant an awake fiberoptic intubation. The patient should be on a tilting trolley, with suction to hand. Three minutes of pre-oxygenation precede the administration of an induction agent, cricoid pressure (discussed below) and the rapidly acting muscle relaxant succinylcholine.

This avoids the need for bag-mask ventilation and the possibility of gastric insufflation. Adequate depth of anaesthesia is important to avoid coughing, laryngospasm and vomiting. Cricoid pressure is not released until confirmation of appropriate placement of the tracheal tube with the cuff inflated.

## Cricoid pressure

First described by Sellick in 1961, cricoid pressure remains an essential manoeuvre performed as part of RSI despite significant controversy. The aim is to compress the oesophagus between the cricoid ring cartilage and the sixth cervical vertebral body thus preventing reflux of gastric contents. The force recommended is 30 Newtons, or that required to close the oesophagus without distorting the airway. This latter complication is the greatest limiting feature of the manoeuvre, causing malalignment, distortion of the cricoid ring and possible closure of the vocal cords. Even when applied correctly there is doubt as to its efficacy, simply causing anatomical displacement of the oesophagus in some people and non compression in others. In addition, manometry studies have shown it to reduce LOS tone thus reducing barrier pressure. Cricoid pressure should be released in the case of active vomiting to avoid oesophageal rupture.

## Nasogastric tube placement

Patients for emergency theatre with intestinal obstruction frequently have a nasogastric tube in situ. There is evidence from cadaver studies that this does not alter the efficacy of cricoid pressure. Furthermore it can be useful to empty the stomach before induction of anaesthesia. Studies have shown that there is no significant difference between the incidence of gastroesophageal reflux with large or small bore tubes.

## Airway devices

A cuffed endotracheal tube is considered the gold standard device used for airway protection. However, it has disadvantages - cardiovascular and respiratory instability, postoperative hoarseness, sore throat, increased length of stay in recovery to name but a few. It has also been suggested that microaspiration of secretions occurring between the cuff and tracheal mucosa plays a role in ventilator acquired pneumonia in the critically ill. Alternative supraglottic devices include the classic Laryngeal Mask Airway (LMA) and the Proseal LMA, the latter providing a higher seal pressure (up to 30cmH<sub>2</sub>O) and a drainage channel for gastric contents. These have excellent safety records, and can be used for positive pressure ventilation although the main contraindication to their use is an increased risk of regurgitation (see 'From the journals' in this edition of Update).

## Emergence

Remember that those patients at risk of aspiration on induction are similarly at risk on emergence. Care should be taken to ensure that their airway reflexes have fully returned before extubation occurs. Extubate patients in the left lateral or sitting position.

## MANAGEMENT OF ASPIRATION

### Initial management

Initial management involves the recognition of aspiration by way of visible gastric contents in the oropharynx, or more subtle indications such as hypoxia, increased inspiratory pressure, cyanosis, tachycardia or abnormal auscultation, when a list of differentials must be thought through. Once the diagnosis is suspected, the patient should be positioned head-down to limit pulmonary contamination, and suctioning performed to clear the oropharynx. Some advocate the left lateral position if feasible, but if unfamiliar with managing the airway in this position, then Trendelenburg is indicated.

### Differential diagnosis

- Bronchospasm
- Laryngospasm
- Endotracheal tube obstruction
- Pulmonary oedema
- ARDS
- Pulmonary embolism

Oxygen (100%) must be administered, followed by immediate RSI and securing of the airway with an endotracheal tube. At this point, tracheal suctioning should ideally precede positive pressure ventilation to avoid any aspirate being forced further down the bronchial tree. Positive end-expiratory pressure is useful at about 5cmH<sub>2</sub>O, and early bronchoscopy is recommended if aspiration of particulate matter is suspected to prevent distal atelectasis. Symptomatic treatment of bronchospasm with bronchodilators may be necessary.

### Management - key points

- Head down tilt
- Oropharyngeal suction
- 100% oxygen
- Apply cricoid pressure and ventilate
- Deepen anaesthesia/perform RSI
- Intubate trachea
- Release cricoid once airway secured
- Tracheal suction
- Consider bronchoscopy
- Bronchodilators if necessary

A clinical decision between the anaesthetist and surgeon must then be made on whether or not to proceed with surgery. This will depend on the underlying health of the patient, the extent of the aspiration and urgency of the surgical procedure.

A chest x-ray (CXR) can be useful in the case of suspected pulmonary aspiration, although in about 25% of cases there are no radiographic changes initially. If stable enough for extubation, patients should be observed carefully and those that are asymptomatic 2 hours postoperatively may be discharged from the recovery area. It is suggested that those that develop a new cough/wheeze, are tachycardic or tachypnoeic, drop their SpO<sub>2</sub> on room air (by >10% of preoperative value) or have new pathological changes on CXR should be further managed in a high dependency setting.

### Further treatment

Empirical antibiotic therapy is strongly discouraged unless it is apparent that the patient has developed a subsequent pneumonia, as

occurs in 20-30%. Treatment should then ideally only be prescribed once the organism has been identified, most commonly gram negative bacilli. Inappropriate administration has been linked to ventilator-associated pneumonia with virulent organisms such as *Pseudomonas aeruginosa* and *Acinetobacter*.

Corticosteroids should not be given prophylactically in the acute phase following aspiration, as there is no evidence to support a reduction in the inflammatory response. They may even have an adverse effect on mortality in critically ill patients.

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## Erratum

Sathishkumar S. Guidelines for management of a malignant hyperthermia (MH) crisis. *Update in Anaesthesia* 2009; **25,2**: 69-73.

The editorial team apologise that the 6th and 7th references were omitted. The references for this article should read as follows:

1. Guarney H, Brown A, Litman RS. Malignant hyperthermia and muscular dystrophies. *Anesth Analg* 2009; **109**: 1043-8.
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**Paediatric caudal anaesthesia**

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**Summary**

Caudal anaesthesia (CA) is epidural anaesthesia of the cauda equina roots in the sacral canal, accessed through the sacral hiatus. CA is a common paediatric regional technique that is quick to learn and easy to perform, with high success and low complication rates.

CA provides high quality intraoperative and early postoperative analgesia for sub-umbilical surgery. In children, CA is most effectively used as adjunct to general anaesthesia and has an opioid-sparing effect, permitting faster and smoother emergence from anaesthesia.

**INDICATIONS FOR CAUDAL ANAESTHESIA**

The indications for single shot CA are abdominal, urologic or orthopaedic surgical procedures located in the sub-umbilical abdominal, pelvic and genital areas, or the lower limbs, where postoperative pain does not require prolonged strong analgesia. Examples of appropriate surgery include inguinal or umbilical herniorrhaphy, orchidopexy, hypospadias and club foot surgery. CA is useful for day case surgery, but opioid additives to the local anesthetic agent should be avoided in this setting. When CA is used, requirement for mild or intermediate systemic analgesia must be anticipated to prevent pain resurgence at the end of caudal block. Catheter insertion can extend the indications to include surgical procedures located in the high abdominal or thoracic areas, and to those requiring prolonged effective analgesia.

**CONTRAINDICATIONS**

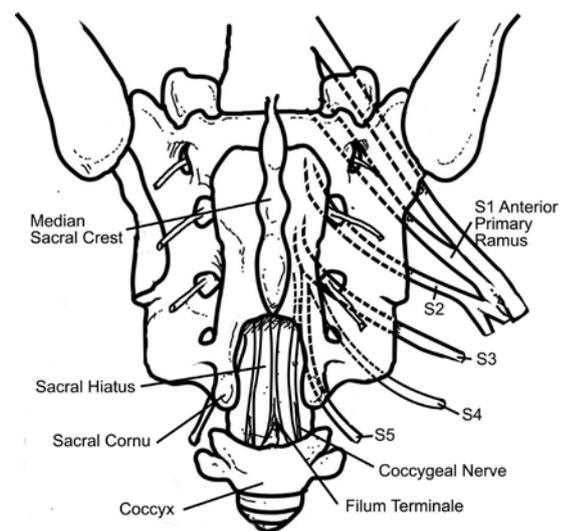
The usual contraindications to regional anaesthesia such as coagulation disorders, local or general infection, progressive neurological disorders and patient or parental refusal apply to CA. Furthermore, cutaneous anomalies (angioma, hair tuft, naevus or a dimple) near the puncture point require radiological examination (ultrasound, CT or MRI), in order to rule out underlying spinal cord malformation such as a tethered cord.<sup>23</sup> A Mongolian spot is not a contraindication to CA.

**ANATOMY****Anatomical landmarks (Figure 1)**

The sacrum is roughly the shape of an equilateral triangle, with its base identified by feeling the two posterosuperior iliac processes and a caudal summit corresponding to the sacral hiatus. The sacrum is concave anteriorly. The dorsal aspect of the sacrum consists of a median crest, corresponding to the fusion of sacral spinous processes. Moving laterally, intermediate and lateral crests correspond respectively to the fusion of articular and transverse processes.

The sacral hiatus is located at the caudal end of the median crest and is created by failure of the S5 laminae to fuse (Figure 1). The hiatus is surrounded by the sacral cornua, which represent remnants of the inferior

S5 articular processes and which face the coccygeal cornua. Palpation of the sacral cornua is fundamental to locating the sacral hiatus and to successful caudal block.



**Figure 1.** The posterior aspect of the sacrum and sacral hiatus

The sacral hiatus is the shape of an inverted U, and is covered by the sacro-coccygeal ligament, which is in continuity with the ligamentum flavum. It is large and easy to locate until 7-8 years of age. Later, progressive ossification of the sacrum (until 30 years old) and closing of the sacro-coccygeal angle make its identification more difficult. Note that anatomical anomalies of the sacral canal roof are observed in 5% of patients and this can lead to unplanned cranial or lateral puncture.

**The sacral canal**

The sacral canal is in continuity with the lumbar epidural space. It contains the nerve roots of the cauda equina, which leave it through anterior sacral foraminae. During CA, leakage of local anaesthetic agent (LA) through these foraminae explains the high quality of analgesia, attributable to diffusion of LA along the nerve roots. Spread of analgesia cannot be enhanced above T8-T9 by increasing injected LA volume.

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The dural sac (i.e. the subarachnoid space) ends at the level of S3 in infants and at S2 in adults and children. It is possible to puncture the dural sac accidentally during CA, leading to extensive spinal anaesthesia. Therefore the needle or cannula must be cautiously advanced into the sacral canal, after crossing the sacro-coccygeal ligament. The distance between the sacral hiatus and the dural sac is approximately 10mm in neonates. It increases progressively with age (>30mm at 18 years), but there is significant inter-individual variability in children.<sup>1</sup> The contents of sacral canal are similar to those of lumbar epidural space, predominantly fat and epidural veins. In children, epidural fatty tissue is looser and more fluid than in adults, favoring LA diffusion.

## TECHNIQUE

### Preparation

Obtain consent for the procedure either from the patient or, if appropriate, from the parents. After induction of general anaesthesia and airway control, the patient is positioned laterally (or ventrally), with their hips flexed to 90° (Figure 2). Skin disinfection should be performed carefully, because of the proximity to the anus. Aseptic technique should be maintained.



**Figure 2.** Preparation of patient - lateral position with the surgical site down

According to the child's size, needle diameter and length are respectively between 21G and 25G, and 25mm and 40mm. A short bevel improves the feeling of sacrococcygeal ligament penetration and decreases risk of vascular puncture or sacral perforation.<sup>2</sup> Use of a needle with a stylet avoids risk of cutaneous tissue coring, and the (theoretical) risk of epidural cutaneous cell graft. If a stylet needle is not available, a cutaneous 'pre-hole' can be made with a different needle prior to puncture with the caudal needle. Another solution is to puncture with an IV catheter, the hollow needle of which is removed before injection through the sheath.

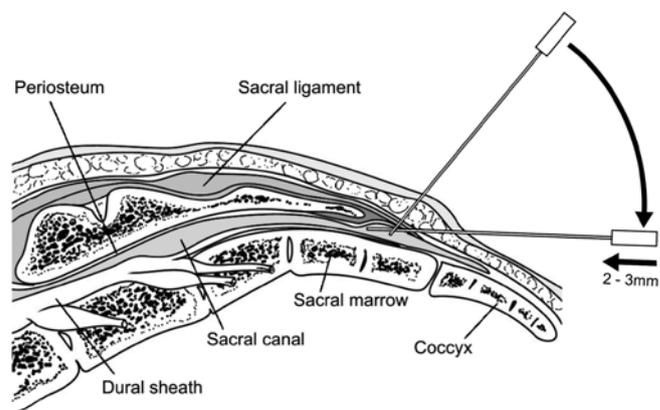
### Puncture (Figures 3, 4 and 5)

After defining the bony landmarks of the sacral triangle, the two sacral cornuae are identified by moving your fingertips from side to side. The gluteal cleft is not a reliable mark of the midline. The puncture is performed between the two sacral cornuae. The needle is oriented 60° in relation to back plane, 90° to skin surface. The needle bevel is oriented ventrally, or parallel to the fibers of the sacro-coccygeal ligament. The distance between the skin and sacro-coccygeal ligament

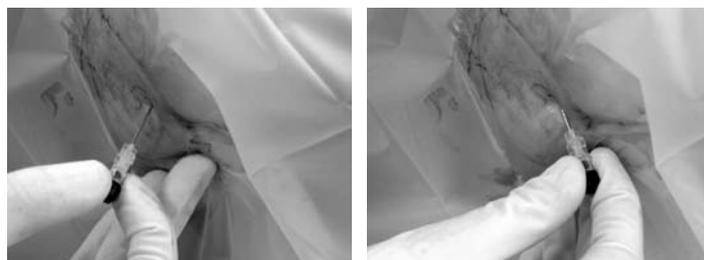


**Figure 3.** Bony landmarks

is between 5 and 15mm, depending on the child's size. The sacro-coccygeal ligament gives a perceptible 'pop' when crossed, analogous to the ligamentum flavum during lumbar epidural anaesthesia. After crossing the sacro-coccygeal ligament, the needle is redirected 30° to the skin surface, and then advanced a few millimeters into sacral canal. If in contact with the bony ventral wall of sacral canal, the needle must be moved back slightly.



**Figure 4.** Puncture - orientation of the needle and reorientation after crossing the sacro-coccygeal ligament.

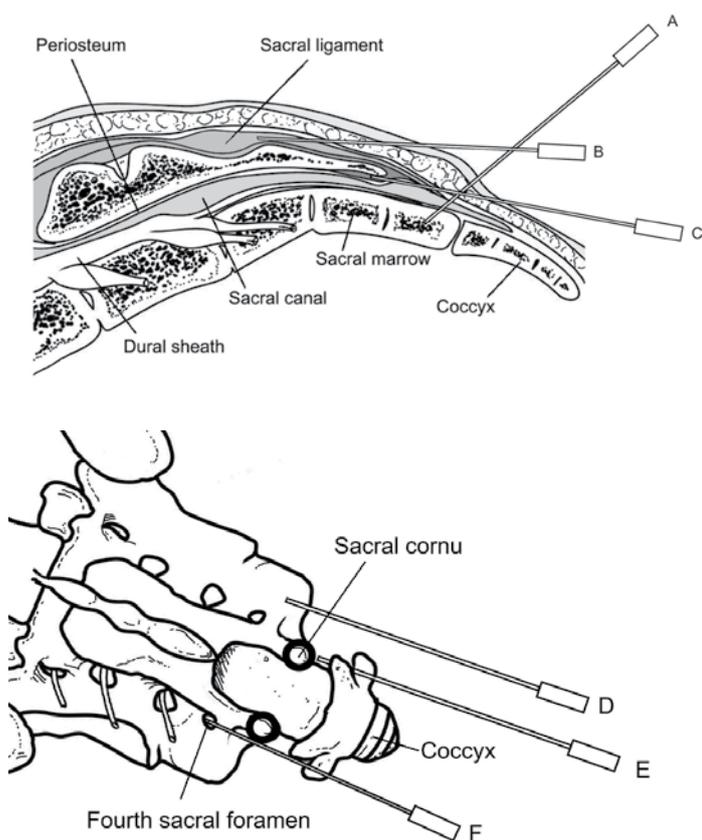


**Figure 5.** Orientation of the needle during puncture

After verifying absence of spontaneous reflux of blood or cerebrospinal fluid (more sensitive than an aspiration test), injection of LA should be possible without resistance. Inject slowly (over about one minute). Where available this may be preceded with an epinephrine

test dose under ECG and blood pressure monitoring, in order to detect intravascular placement. Subcutaneous bulging at the injection site suggests needle misplacement. Blood reflux necessitates repeating the puncture, however in case of cerebrospinal fluid reflux caudal anaesthesia should be abandoned, in order to avoid the risk of extensive spinal anaesthesia. Aspiration tests should be repeated several times during injection.

In skilled hands, the success rate of CA is about 95%, however a variety of misplacements of the needle are possible (Figure 6). The moment of surgical incision is the true test of block success, but various techniques have been suggested to authenticate the puncture success, such as injection site auscultation (the 'swoosh test'), or searching for anal sphincter contraction in response to electrical nerve stimulation on the puncture needle. No clear benefit of these techniques against simple clinical assessment have been shown.<sup>3,4</sup> More recently, ultrasound has been suggested to help sacro-coccygeal hiatus location and to visualize isotonic serum or LA injection into sacral epidural space (Figures 7 and 8).<sup>5,6</sup> These authors have also outlined the interest in ultrasound control within the context of learning the technique, rather than for use in standard practice.<sup>5,7</sup>

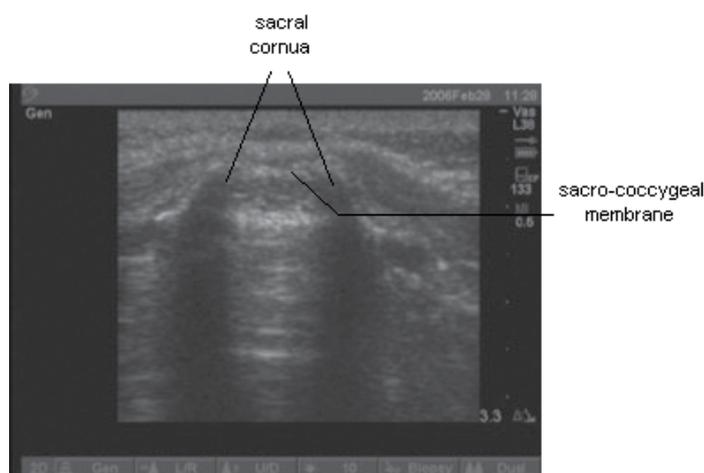


**Figure 6A and B. Needle misplacement**

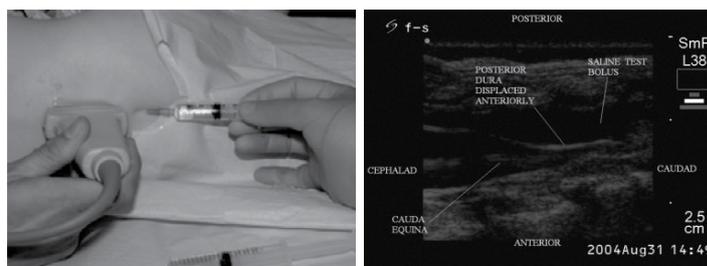
- A marrow (resistance +++ . Equivalent to IV injection)
- B posterior sacral ligament (subcutaneous bulge)
- C subperiosteal
- D "decoy" hiatus
- E intrapelvic (risk of damaging intrapelvic structures: rectum)
- F 4th sacral foramen (unilateral block).

## Catheter insertion

Although CA was initially described as a single shot technique, some authors have described use of a caudal catheter to prolong analgesic administration in postoperative period. In addition advancement of the catheter in the epidural space up to lumbar or even thoracic levels can achieve analgesia of high abdominal or thoracic areas.<sup>8</sup> However, two pitfalls restrict extension of this technique; a high risk of catheter bacterial colonization, particularly in infants and a high risk of catheter misplacement.<sup>9,10</sup> Subcutaneous tunnelling at a distance from the anal orifice, or occlusive dressings decrease bacterial colonization.<sup>11</sup> Electrical nerve stimulation or ECG recording on the catheter, or its echographic visualization have been suggested to guide its advancement in epidural space.<sup>12,13</sup> However, most anaesthetists presently prefer a direct epidural approach at the desired level that is appropriate to the surgical intervention.<sup>14,15</sup>



**Figure 7.**

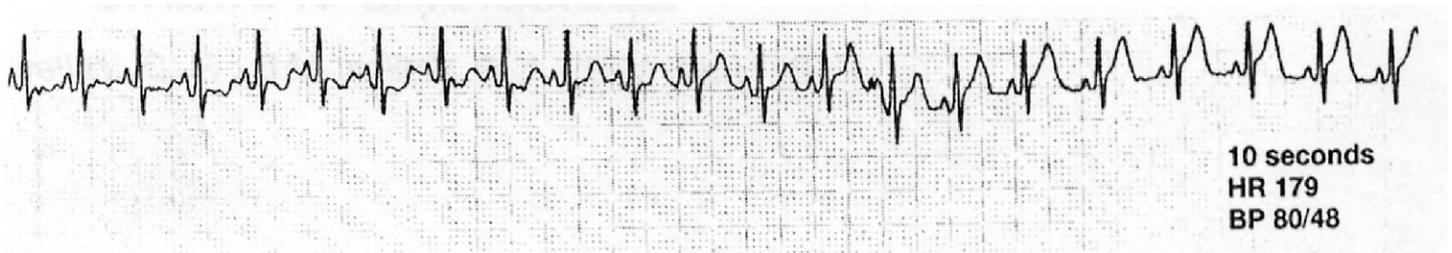


**Figures 8a and 8b.**

## LOCAL ANAESTHETIC AGENTS

### Test dose

Early neurosensory warning symptoms of LA systemic toxicity are concealed by general anaesthesia. Halogenated anaesthetic agents worsen LA systemic toxicity and can also blunt the cardiovascular signs of an intravenous epinephrine test dose injection. Aspiration tests to elicit blood reflux are not very sensitive, particularly in infants. A test dose of epinephrine  $0.5\text{mcg.kg}^{-1}$  (administered as  $0.1\text{ml.kg}^{-1}$  lidocaine with epinephrine 1 in 200 000) allows detection of intravenous injection with sensitivity and specificity close to 100%, under halogenated anaesthesia. Warning symptoms are cardiac frequency modification (an increase or decrease by 10 beats per minute), increased in blood pressure (up to 15mmHg), or T-wave amplitude change in



**Figure 9.** T-wave amplitude change after intravascular injection of a local anaesthetic agent

the 60 to 90 second period after injection (Figure 9).<sup>16,17</sup> Slow injection of the whole LA dose under haemodynamic and ECG monitoring remains essential for patient safety.

### Full dose

The volume of caudally injected LA determines the spread of the block and this must be adapted to surgical procedure (Table 1). Analgesic spread will be two dermatomes higher on the down positioned side at the time of puncture. Injected volume must not exceed 1.25 ml.kg<sup>-1</sup> or 20 to 25ml, in order to avoid excessive cerebrospinal fluid pressure.

**Table 1.** Spread of block as a function of caudally injected local anaesthetic volume<sup>18</sup>

Volume (ml.kg <sup>-1</sup> )	Dermatomal level	Indication
0.5	Sacral	Circumcision
0.75	Inguinal	Inguinal herniotomy
1	Lower thoracic (T10)	Umbilical herniorraphy, orchidopexy
1.25	Mid thoracic	

LA choice prioritizes long lasting effects with the weakest motor block possible, since motor block is poorly tolerated in awake children. Bupivacaine meets these criteria. More recently available, ropivacaine and L-bupivacaine have less cardiac toxicity than bupivacaine at equivalent analgesic effectiveness. They may also confer a more favorable differential block (less motor block for the same analgesic power) and the 2.5mg.ml<sup>-1</sup> (0.25%) concentration is optimal for these agents. Four to six hours analgesia is usually achieved with minimal motor block.<sup>19,20</sup>

Maximal doses must not be exceeded (Table 2) but use of a more dilute mixture may allow the desired volume to be achieved within the recommended maximum dose. Hemodynamic effects of CA are weak or absent in children, so intravenous fluid preloading or vasoconstrictive drugs are unnecessary.

**Table 2.** Maximal allowable doses of local anaesthetic agents

	Plain local anaesthetic (mg.kg <sup>-1</sup> )	With epinephrine (mg.kg <sup>-1</sup> )	Neonates
Bupivacaine	2	2	
Lidocaine	3	7	↓ 20%
Ropivacaine	3	3	

### Additives

**Tables 3.** Several additives prolong CA duration when added to LA.

Additive agent	Dose/concentration
epinephrine	5mcg.ml <sup>-1</sup>
fentanyl	1mcg.kg <sup>-1</sup>
clonidine	1-2mcg.kg <sup>-1</sup>
preservative-free S(+) ketamine (note - not the intravenous form)	0.5mg.kg <sup>-1</sup>

### COMPLICATIONS

Complications of CA are uncommon (0.7 per 1000 cases), are more likely if inadequate equipment is used and are more frequent in infants.<sup>16</sup> If the technique fails it should be abandoned to avoid occurrence of potentially serious complications.

Significant complications, in order of decreasing frequency, are:

- **Dural tap.** This is more likely if the needle is advanced excessively in the sacral canal when subarachnoid injection of local anaesthetic agent may cause extensive spinal anaesthesia. Under general anaesthesia this should be suspected if non-reactive mydriasis (pupillary dilation) is observed.
- **Vascular or bone puncture** can lead to intravascular injection and consequently LA systemic toxicity. Preventative measures are use of a test dose, cessation of injection if resistance is felt and slow injection under hemodynamic and ECG monitoring. Sacral perforation can lead to pelvic organ damage (e.g. rectal puncture).
- **Exceeding the maximal allowed LA dose** risks overdose and related cardiovascular or neurological complications.
- **Delayed respiratory depression** secondary to caudally injected opioid.
- **Urinary retention** - spontaneous micturition must be observed before hospital discharge.
- **Sacral osteomyelitis** is rare (one case report).<sup>22</sup>

### CONCLUSION

This technique has an established role in paediatric regional anaesthesia practice since it is easy to learn and has a favorable risk/benefit ratio. Despite being more complex to learn, alternative peripheral regional anaesthesia techniques are gaining popularity and may begin to replace caudal anaesthesia as a popular choice.

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## Intensive care management of pandemic (H1N1) Influenza

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### INTRODUCTION

This article describes the management of critically ill patients with H1N1 2009 Influenza A infection, which caused the 4th worldwide pandemic in 2009 and is currently causing a seasonal epidemic in the UK and a few other countries in the Northern hemisphere.

During the current season, forty-five deaths associated with influenza infection have been reported, the majority due to severe H1N1 2009 virus affecting the young, the pregnant, the obese and those with co-morbidities.

### CLINICAL BACKGROUND

H1N1 viral pneumonitis is caused by a novel variant of influenza A (A (H1N1)) which is similar to seasonal influenza but contains segments of genes from pig, bird and human influenza. It is an enveloped orthomyxovirus.

### EPIDEMIOLOGY

The overall case fatality during the 2009 pandemic was less than 0.5%, ranging from 0.0004 to 1.47%. Approximately 9 to 31% of hospitalised patients were admitted to an ICU, where 14 to 46% of patients died. It affected young people, with 32 to 45% of those hospitalised being under the age of 18 years. People over the age of 60 were relatively spared.

In the UK, from 17th July 2009 to 3 March 2010, there were 25,785 admissions to hospital with H1N1 of whom 9501 were children. Of these, 2326 received critical care (1863 adults and 463 children), with mean critical length of stay of 7.8 days in adults and 6.1 days in children. A total of 496 ECMO (extracorporeal membrane oxygenation) bed days were documented.

Risk factors for development of severe illness with 2009 H1N1 virus infection include:

- Age < 5 years
- Pregnancy
- Chronic congestive heart failure (but not hypertension)
- Chronic lung disease (asthma, COPD, cystic fibrosis)

- Diabetes
- Chronic neuromuscular, seizure or neurocognitive disease
- Immunosuppression
- Morbid obesity (BMI > 40kg.m<sup>-2</sup>)
- Chronic renal or hepatic disease
- Smoking

Pregnant women in the 2nd and 3rd trimester and those that are 2 weeks or less postpartum are most at risk (7 to 10% of hospitalised patients, 6 to 9% of ICU admissions and 6 to 10% of patients who died) despite comprising 1 to 2% of the population.

### CLINICAL FEATURES IN THE CRITICALLY ILL

Most patients have a prodromal illness of pyrexia, myalgia, cough and sometimes gastrointestinal symptoms, lasting between 1 and 9 days prior to admission. The principal presentation leading to ICU admission is diffuse viral pneumonitis associated with severe hypoxaemia. There may also be ARDS, shock and sometimes renal failure. This syndrome accounted for approximately 49 to 72% of ICU admissions for 2009 H1N1 virus infection worldwide. Rapid progression is common, starting on day 4 and 5 after illness onset. Bacterial co-infection may cause multi-lobar consolidation. The lower lung zones are often more affected on CT scan. There may also be multiple areas of ground-glass opacities and small pleural effusions are common.



**Figure 1.** Chest CT showing infiltrates and dense consolidation in a patient with H1N1 pneumonitis

### Summary

This article is adapted from a recent *Anaesthesia Tutorial of the Week* and is largely based on local and published clinical experience gained during the 2009 pandemic of H1N1 influenza. Summary points are:

- Remember to consider H1N1 in the differential of any persistently febrile respiratory illness and isolate or cohort the patient.
- Once level 2 dependency is reached, many patients deteriorate rapidly and early intubation and ventilation is recommended.
- Rescue strategies may be needed, including ECMO if available.
- This condition has a high mortality.

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Of 168 patients admitted to Canadian ICUs in 2009, the majority of whom had the above syndrome, 131 (81%) were mechanically ventilated on the first day of ICU admission, 128 (76.2%) invasively and 55 (32.7%) noninvasively. 47 (85.4%) who initially received noninvasive ventilation ultimately required invasive ventilation.

One third of patients required advanced ventilatory support and rescue therapies for profound hypoxaemic respiratory failure.

Other important features found in patients with severe H1N1 infection include:

- Prolonged exacerbation of asthma and COPD (about 15%) and of other underlying chronic diseases, e.g. congestive cardiac failure.
- Secondary bacterial co-infections were found in 20 to 24% of ICU patients and in 26 to 38% of patients who died during the 2009 pandemic. The most common organisms were *Staphylococcus aureus* (often MRSA), *Streptococcus pneumoniae*, and *Strep pyogenes*.
- Neurological manifestations including confusion, seizures, unconsciousness, acute or post-infectious encephalopathy, quadriparesis and encephalitis.
- Myocarditis, right ventricular dilation and dysfunction.
- Myositis and rhabdomyolysis with raised creatine kinase (CK).
- Croup/bronchiolitis in the paediatric population

### Pathological features

Pathological features at autopsy include diffuse alveolar damage with hyaline membranes and septal oedema, tracheitis, necrotising bronchiolitis, pulmonary vascular congestion, alveolar haemorrhage and pulmonary thromboemboli. Bronchopneumonia with evidence of bacterial co-infection is seen in 26 to 38% of fatal cases.

Laboratory findings at presentation in patients with severe disease typically include normal or low-normal leukocyte counts with lymphopaenia, thrombocytopenia, elevated serum aminotransferases, CK, creatine and LDH.

### Diagnosis

Clinicians should maintain a high degree of suspicion in patients with undiagnosed respiratory or pyrexial illness. The best method of confirmation is detection of viral RNA by real-time reverse transcriptase-polymerase chain reaction (RT-PCR), performed on samples taken from nasopharyngeal aspirates or swabs. Endotracheal and bronchoscopic aspirates have higher yield in patients with lower respiratory tract illness.

## CLINICAL MANAGEMENT

### Drug therapy

If there is pneumonia or evidence of clinical progression then oseltamivir 150mg bd for 10 days without interruptions is recommended. Doses of up to 450mg bd have been used successfully in healthy adults. Intravenous zanamivir (Relenza) is the preferred option for hospitalised patients with suspected or documented oseltamivir-resistant 2009 H1N1 virus infection or who are unable to absorb by the enteral route.

High dose steroids have no role in ARDS but prophylactic heparin should be prescribed.

### Ventilatory management

*The role of non-invasive ventilation (NIV) and continuous positive airway pressure (CPAP)*

Prompt intubation is indicated in many patients who are deteriorating rapidly by the time they get to ICU. There may be a role for NIV in a subset of patients whose progression is slower, or in whom it is agreed that invasive therapies are inappropriate.

### Invasive ventilation

Based on current evidence patients with H1N1 should be managed with lung protective ventilation as per the ARDS network protocol (below).

#### Protective lung ventilation strategy

- Aim for  $\text{SaO}_2 > 88\%$ , with  $\text{pH} > 7.2$ . Optimise PEEP.

- Tidal volume  $< 6\text{ml.kg}^{-1}$   
(Use ideal body weight:

Males  $50 + [0.91 \times (\text{height} - 152.4)]\text{cm}$

Females  $45 + [0.91 \times (\text{height} - 152.4)]\text{cm}$

- Plateau pressure  $< 30\text{cmH}_2\text{O}$

Permissive hypercapnia is employed to avoid higher pressures. If targeted ventilatory goals are not met then rescue therapy should be employed. This constitutes prone ventilation, increasing PEEP, recruitment manoeuvres, inverse ratio up to 4:1 and blood transfusion to improve haematocrit ( $>40\%$ ).

### PEEP

High levels of PEEP (16 to  $30\text{cmH}_2\text{O}$ ) have been used with variable response in terms of oxygenation. During weaning PEEP should be cautiously weaned to less than  $20\text{cmH}_2\text{O}$  before weaning  $\text{FIO}_2$  significantly.

### Prone positioning

Proposed mechanisms of action for proning include: alveolar recruitment, improvement in V/Q matching by improved ventilation to the dorsal lung regions, elimination of the heart's compressive effects on the lung and better drainage of respiratory secretions.

Although up to 70% of patients with ARDS show improved oxygenation, no mortality benefit has been shown. Risks include endotracheal tube obstruction, loss of central vein access during the manoeuvre and risk of pressure sores.

### Recruitment manoeuvres (RM)

These aim to open collapsed lung units and increase functional residual capacity by increasing transpulmonary pressure. RM may be usefully employed on patients on high PEEP who desaturate rapidly on disconnection from the ventilator.

There are several techniques and the patient may be prone or supine.

#### Example of a recruitment manoeuvre

- Ensure haemodynamic stability and Set FiO<sub>2</sub> to 1.0 for 15 minutes.
- Set the ventilator rate to zero and apply 30cmH<sub>2</sub>O PEEP for 40 seconds. Return to normal ventilation with PEEP of at least 15cmH<sub>2</sub>O to prevent de-recruitment.
- If unresponsive repeat with 35cmH<sub>2</sub>O for 40 seconds after 15 minutes
- If still unresponsive repeat with 40cmH<sub>2</sub>O for 40 seconds after 15 minutes.

Other techniques have been used as rescue therapies, but are generally not available in resource-poor settings. These are outlined in the table below.

#### High frequency oscillatory ventilation (HFOV)

- HFOV ventilates the lung with low tidal volumes (lower than anatomical dead space) and avoids volutrauma and barotrauma.
- No proven mortality benefit over conventional lung protective ventilation but useful for rescue therapy for unresponsive patients.
- Complications include retained secretions, mucus plugging, air trapping and airway damage attributable to high gas velocities.

#### Airway pressure release ventilation (APRV)

- Described as continuous positive airway pressure (CPAP) with regular, brief, intermittent releases in airway pressure. Unlike CPAP it facilitates both oxygenation and removal of CO<sub>2</sub>.
- Spontaneous breathing is possible.
- No proven mortality benefit over conventional methods.
- Use limited in patients with COPD and asthma due to gas trapping.

#### Cardiovascular management

It is vital to assess how well each patient responds to intravenous fluid administration. However inappropriate fluid administration may worsen ventricular function and oxygenation. Where available, echocardiography and/or invasive cardiovascular monitoring such as oesophageal Doppler, LiDCO or PICCO are useful.

#### Extracorporeal membrane oxygenation (ECMO)

This is a specialised resource but where available referral for ECMO should be considered in the first week of ventilation for refractory hypoxaemia. In several countries there has been some expansion of ECMO capacity outside of the main centres.

#### Extracorporeal carbon dioxide removal

Where available, devices such as the *Novalung*<sup>TM</sup> may be necessary to treat significant acidosis due to hypercarbia, especially in the setting of concurrent increased intracranial pressure.

#### Renal management

Achievement of negative fluid balance guided by calculation of the patient's *dry weight* by either diuretics or continuous ultrafiltration improves oxygenation. Renal replacement therapy is required in 10 to 50% of cases and may be chosen electively as the mode of fluid balance, even if renal failure is not present.

Patient's dry weight can be estimated as:

ICU admission weight – weight (= volume) of any resuscitation fluid given up to that point.

#### Nutrition management

The use of high calorie feeds to avoid fluid overload is suggested.

#### Sedation and neurological management

Many patients with H1N1 appear to need high doses of sedation due to a combination of irritable airways and encephalopathy/encephalitis. CNS imaging and lumbar puncture have a role in the exclusion other causes of fever and delirium.

#### INFECTION CONTROL

Healthcare staff should be vaccinated if offered.

Patients with suspected H1N1 should be isolated or cohorted depending on the number of cases on the unit. Isolation should take place for up to 7 days after illness onset or until 24hrs after resolution of fever and respiratory symptoms (whichever is longer) and for the severely immunocompromised this should be for the duration of the illness.

Use of personal protective equipment for care of patients with H1N1 infection is highly recommended to reduce staff infection to prevent transmission within the hospital.

Aerosol generating procedures such as suctioning, chest physiotherapy, intubation, tracheostomy care, bronchoscopy and CPR should be performed in closed single-patient areas with minimal staff present. Operators should wear single use protective gloves, gowns, eye protection and FFP3 masks or 3M respirator masks.

Entry into a cohorted area with no contact with patients requires use of hand hygiene and a surgical mask as a minimum. Close contact with a patient requires a plastic apron and gloves to be worn.

Staff do not need to keep changing masks each time they move away from the cohorted areas, however they do need to remove gloves and clean as per standard infection control precautions.

More detail on infection control is available in the UK DoH document 'Pandemic influenza: Guidance for infection control in critical care', 2008.

#### Respiratory care issues

- Disposable patient respiratory equipment must be used whenever possible.
- Closed systems should be used whenever possible, e.g. suction
- All respiratory equipment used on patients, including transport ventilator circuits and manual resuscitation aids, should include a high-efficiency bacteria/viral breathing system filter (BS EN 13328-1)
- The ventilator circuit should not be broken unless absolutely necessary.
- For planned circuit breaks, appropriate PPE & FFP3 respirators should be worn.

#### SUMMARY

Further advice is available concerning resource and contingency planning for further pandemics of H1N1 influenza from the link below. In the event of a further surge in cases, the implications for triage and limitation of therapy are huge, particularly in countries with limited resources.

It is vital to consider H1N1 in the differential diagnosis of any persistently febrile respiratory illness and to promptly isolate or cohort the patient. Those patients who deteriorate to a level where HDU admission is needed are likely to deteriorate rapidly and early intubation and ventilation is recommended. Ventilatory rescue strategies may be needed and have been briefly described. In many countries these will not be available, and in those that they are, their use will be limited to supra-regional centres. Even with these rescue therapies, this condition has a high mortality

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## Case Report

### An unusually massive leak caused by sevoflurane vaporiser

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#### CASE REPORT

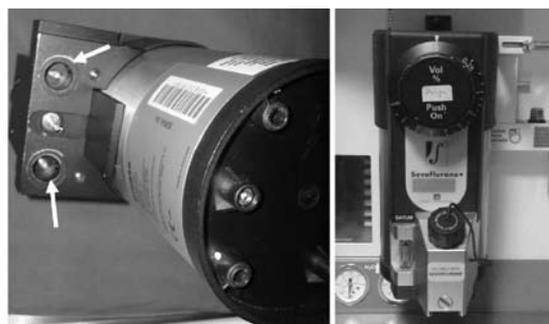
A 3-year-old female child weighing 15kg was posted for emergency oesophageal foreign body removal. The anaesthesia machine (Dräger Medical AG & CO, Lübeck, Germany), with a halothane vaporiser and the Jackson-Rees circuit, were checked as per the FDA 1993 Anesthesia Apparatus Checkout Recommendations. The operation theatre assistant was instructed to fit the sevoflurane vaporiser while ketamine (intramuscularly) premedication was being administered. A new sevoflurane vaporiser (Datum, Blease, Beech House, Chesham Bucks HP5 2P5, England) (Figure 1) which was being used for the first time was fitted to the machine.

The patient was brought to the operating theatre and we proceeded with an inhalational induction of anaesthesia using sevoflurane in 100% O<sub>2</sub> (4l.min<sup>-1</sup>). The breathing circuit was not rechecked after the sevoflurane vaporiser was fitted on to the machine. During induction, inadequate filling of the reservoir bag was noted. Meanwhile, positive pressure ventilation was attempted as the patient started desaturating. The reservoir bag remained collapsed. The anaesthetic gas analyzer showed traces of sevoflurane in the breathing gases. There was no audible leak anywhere in the breathing circuit although there was a smell of sevoflurane.

The concentration control dial was immediately turned to the off position, and ventilation attempted again with no change. The vaporiser was removed and fitted again without any improvement. In the meanwhile, some ventilation was achieved with the help of the emergency oxygen-flush, and oxygen saturation (SpO<sub>2</sub>) was maintained at 85-86%. Another source of oxygen was then used to ventilate the child with a mask and resuscitation bag, and the SpO<sub>2</sub> improved to 97-98%. The sevoflurane vaporiser was removed and further anaesthesia was managed using halothane and the same anaesthesia machine. The foreign body was removed uneventfully.

We suspected a problem in the sevoflurane vaporiser since it was the only part of the anaesthesia machine which was not checked at the start of the procedure. We tried turning off the vaporiser to isolate the

site of a potential leak, but only removing the vaporiser solved the problem. A detailed examination later revealed an ill fitting mounting mechanism which caused the leak around the inlet and outlet connection on the mounting mechanism (Figure 1). The leak was so significant that it caused a near total cut-off of fresh gas flow (FGF) from the machine. There was no audible leak at 4l.min<sup>-1</sup> FGF, however it became audible at a FGF >6l.min<sup>-1</sup>.



**Figure 1.** Sevoflurane vaporiser (Datum, Blease) showing site of leak (arrows)

#### DISCUSSION

This case is important because the vaporiser leak caused a near total cut-off of FGF even when the concentration control dial was in off position and the site of leak was uncommon. It is advisable to test the system both with the vaporiser in the 'off' and 'on' positions. The "SNIFF" method to identify vaporiser leak using carbon dioxide/anaesthetic agent sampling tube has been described.<sup>4</sup> The supplier was promptly informed and the vaporiser returned.

Leaks in the anaesthesia circuit or machine may lead to serious problems such as hypoxia, hypercarbia, delayed or difficult induction of general anaesthesia, airway problems because of instrumentation in a lighter plane of anaesthesia, awareness under anaesthesia, pollution of the operating room and wastage of the anaesthetic agent. A self-inflating resuscitation bag is an essential item for every anaesthetic. Checking equipment carefully is the duty of every anaesthetist before every patient. This should be repeated if any part of the equipment is changed.

#### Summary

Leaks in vaporisers are not uncommon and may lead to awareness under anaesthesia.<sup>1,2</sup> When a vaporiser is checked with the concentration control dial in the off position, it may not be possible to detect even major internal leaks which become apparent when the vaporiser is turned on.<sup>1</sup> The mounting mechanism is an uncommon location of vaporiser leak,<sup>3</sup> and we report a sevoflurane vaporiser which caused a major leak during induction of general anaesthesia.

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## Case Report

### Spinal anaesthesia for peripartum cardiomyopathy

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#### KEY WORDS

- peripartum cardiomyopathy,
- pregnancy,
- spinal anaesthesia,
- women

#### INTRODUCTION

The cardiomyopathies are a group of diseases that affect the heart muscle and are not the result of hypertension or congenital or acquired valvular, coronary, or pericardial abnormalities.<sup>1</sup> Peripartum cardiomyopathy is a form of dilated cardiomyopathy that is defined as deterioration in cardiac function presenting typically between the last month of pregnancy and up to five months postpartum. It is rare but can be fatal.<sup>1</sup> As with other forms of dilated cardiomyopathy, peripartum cardiomyopathy involves systolic dysfunction of the heart, with decreased left ventricular ejection fraction and congestive cardiac failure. There is an increased risk of atrial and ventricular arrhythmias, thromboembolism and even sudden death.

#### CASE REPORT

A 34-year-old booked gravida 3, para 2 Nigerian woman was admitted at a gestational age of 34 weeks with recurrent bilateral pedal oedema, facial puffiness, cough, chest pain, breathlessness, orthopnoea, weakness, fever and headache. Peripartum cardiomyopathy had been diagnosed four weeks previously and she had previously spent three weeks as an in-patient. She had had uncomplicated spinal anaesthesia one year ago for emergency caesarean section.

On examination she was 105kg and had bilateral pitting oedema up to the knee joints. Her pulse was 100 beats per minute, respiratory rate 24 per minute and her blood pressure 140/90mmHg. Auscultation of her chest revealed a third heart sound with gallop rhythm and examination of her abdomen showed non-tender hepatomegaly of 8cm.

Her laboratory results showed a packed cell volume of 37%. Urinalysis showed one plus of proteinuria. Results of serum electrolytes, creatinine and liver function tests were within normal values. An electrocardiogram

showed atrial fibrillation with left axis deviation. Echocardiography showed normal cardiac chambers with posterior wall thickening in both ventricles. A diagnosis of congestive cardiac failure secondary to peripartum cardiomyopathy was made for which she was placed on atenolol and a low salt diet.

Elective caesarean section was planned at 36 weeks gestational age, after treatment of her heart failure had improved her breathlessness and orthopnoea. Spinal anaesthesia was explained to the patient and two units of blood were made available for the surgery.

In the operating room intravenous access was established. The patient was preloaded with 500ml 0.9% saline. Spinal anaesthesia was established using 1.5ml plain bupivacaine and 20mcg fentanyl. A wedge was placed under her left side. Intraoperative monitoring consisted of pulse oximetry, non-invasive blood pressure, electrocardiography, and measurement of blood loss and urine output. Intravenous ephedrine 6mg was administered at one and ten minutes after administration of spinal anaesthesia to correct hypotension.

A live female baby weighing 3.2kg, with Apgar scores of 6 at one minute and 8 at five minutes, was delivered five minutes after commencement of surgery. Immediately after delivery of the baby, oxytocin 10 IU was administered as a slow intravenous injection and 20 IU infused slowly in 500ml 0.9% saline. Estimated blood loss at the end of surgery was 500ml. She was discharged home on the ninth postoperative day to continue management by the cardiologist.

#### DISCUSSION

Normal pregnancy is characterised by an increase in cardiac output, a reduction in systemic vascular resistance and a modest decline in mean blood pressure. Identified risk factors for peripartum cardiomyopathy include advanced maternal age, multiparity, obesity, multiple gestation and black race.<sup>2</sup> It can occur without these risk factors and is recognised in women in their first pregnancy.<sup>3</sup>

The higher incidence of peripartum cardiomyopathy is also seen in developing countries and may be due to variations in local, cultural and puerperal practices, in

#### Summary

Peripartum cardiomyopathy is a rare and life-threatening cardiomyopathy of unknown aetiology that affects women in the last month of pregnancy or in the first five months postpartum. This is a case of a multiparous patient with congestive cardiac failure due to peripartum cardiomyopathy who had spinal anaesthesia for elective caesarean section.

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addition to aetiological factors, environmental influence, diagnosis and the reporting pattern used.<sup>3</sup> The reported incidence of peripartum cardiomyopathy in non-African countries ranges from 1 in 3000 to 1 in 15000 live births. In South Africa, the reported incidence is higher (1 in 1000 live births). Higher incidences been reported from Haiti (1 in 300 live births have) and in Nigeria (1%), where it is particularly common among the Hausa and Fulani tribes.<sup>4</sup>

Patients with peripartum cardiomyopathy present with typical signs and symptoms of ventricular failure. Symptoms usually include one or more of the following: orthopnoea (breathlessness on lying flat), dyspnoea, swollen ankles, cough, palpitations and chest pain.<sup>5</sup> However, when the disease develops during the last month of pregnancy, the diagnosis of cardiac failure is difficult to make by signs and symptoms alone, since some of these symptoms such as fatigue and pedal oedema are common among normal parturients during late pregnancy. Further testing is required to establish the presence of cardiac failure. Peripartum cardiomyopathy is a disease of exclusion, wherein patients have no prior history of heart disease and there are no other known possible causes of heart failure. A high index of suspicion of peripartum cardiomyopathy is required for its diagnosis and the condition should be considered in any parturient with unexplained symptoms. Its spectrum may extend beyond the peripartum period.

Where available, electrocardiography (ECG) and echocardiography should be obtained in any woman suspected of having peripartum cardiomyopathy. However, the ECG may be normal. Echocardiography is used to both diagnose and monitor the effectiveness of treatment of peripartum cardiomyopathy.<sup>6</sup> Echocardiography is essential in identifying chamber enlargement and in quantifying left ventricular and valvular function. Peripartum cardiomyopathy is diagnosed by clinical examination in settings where echocardiography is not available. It should be suspected in patients who develop symptoms and signs of heart failure in the last month of pregnancy or within five months of delivery.<sup>7</sup>

Treatment of peripartum cardiomyopathy is similar to that for other types of congestive heart failure. Careful attention must be paid to foetal safety and to excretion of drug or drug metabolites during breastfeeding after delivery. A non-medication regimen, including restriction of daily salt and water intake, is very important particularly in women with symptoms and signs of heart failure. In general, the goal is to reduce the amount of volume returning to the heart (preload reduction), decrease the resistance against which the heart must pump (afterload reduction) and increase the contraction force of the heart (inotropy).<sup>2</sup>

Appropriate drug treatments for heart failure include diuretics to control volume overload (preload). Consider addition of a beta-blocker after signs and symptoms of heart failure have begun to improve, as they improve symptoms, ejection fraction, and survival. Other treatment options during pregnancy include hydralazine and nitrates.<sup>8</sup> Pregnant women should not receive angiotensin converting enzyme inhibitors, angiotensin receptor blockers or warfarin because of potential teratogenic effects. The teratogenic effects occur particularly in the second and third trimester with foetopathy characterized by foetal hypotension, oligohydramnios, anuria, and renal tubular dysplasia. After delivery, the treatment is identical to that for non-

pregnant women with dilated cardiomyopathy. Angiotensin converting enzyme (ACE-) inhibitors are the mainstay of treatment.

Complications of peripartum cardiomyopathy include thromboembolism, arrhythmias and organ failure. Obstetric and perinatal complications include miscarriage, premature delivery, small for dates baby, intrauterine growth retardation, foetal death and congenital malformations.<sup>9</sup> Congestive cardiac failure is associated with higher infant mortality.<sup>9</sup>

Its prognosis is related to the recovery of ventricular function. Failure of the heart size to return to normal after delivery is associated with excess morbidity and mortality. The risk of developing peripartum cardiomyopathy in subsequent pregnancies remains high, especially if left ventricular dysfunction persists. Multiparity increases the risk of irreversible cardiac damage in subsequent pregnancies. Recurrence of heart failure ranges between 21 and 80% in subsequent pregnancies.<sup>9</sup>

### **Management of labour and delivery**

The cardiovascular stress of labour and delivery may lead to cardiac decompensation. A parturient with peripartum cardiomyopathy requires special anaesthetic care during labour and delivery. The anaesthesiologist plays a vital role in managing these patients in a high-dependency area of the hospital, providing labour analgesia, optimising the medical condition of these mothers for caesarean section and administering anaesthesia for urgent or elective caesarean section.<sup>9</sup> Anaesthetic management for caesarean section in peripartum cardiomyopathy patients can be a challenge. Both general and regional anaesthesia have been used. Anaesthetic drugs with myocardial depressant effects should be used with caution. Where vasopressor and beta-adrenergic agonists are not available, ketamine offers better cardiac stability. However the sympathomimetic effects of ketamine cause tachycardia and increased afterload that may cause haemodynamic deterioration in patients with severe cardiomyopathy.

Where available, all peripartum cardiomyopathy patients should be managed in an intensive care unit or high care area as they are prone to develop left ventricular failure and pulmonary oedema in this period, requiring strict fluid management.<sup>9</sup>

Regional analgesia reduces the cardiac stress of labour pain. Peripartum cardiomyopathy during the antepartum period demands intensive foetal and maternal monitoring. A multidisciplinary approach involving an obstetrician, cardiologist, anaesthesiologist and perinatologist may be required to provide optimal care to such patients.

Once peripartum cardiomyopathy is identified, the goal of therapy is to alleviate symptoms of congestive heart failure. As mentioned, diuretics and sodium restriction can be used for preload reduction. The patient's haemodynamic status is carefully followed and fluid management is guided by data from invasive monitors. Regional techniques are safer for labour analgesia as well as anaesthesia. Invasive monitoring is recommended in severe cases.

Patients with peripartum cardiomyopathy require counselling concerning the risks of subsequent pregnancies. Collaboration among the obstetrician, cardiologist, and anaesthesiologist is essential to optimise care.

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**Case Report****Massive hydrothorax following percutaneous nephrolithotomy**

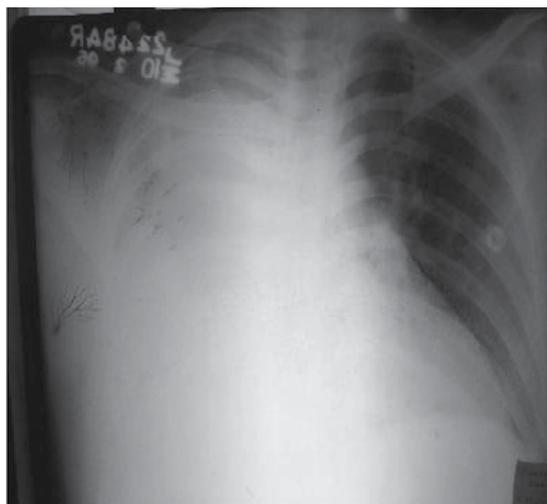
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**CASE REPORT**

A 31-year-old male patient weighing 80kg with calculus in the upper and middle calyces of his right kidney was scheduled for repeat right percutaneous nephrolithotomy (PCNL). He had undergone PCNL under general anaesthesia four days previously with no perioperative complications. There was no other significant surgical or medical history. Anaesthetic assessment was unremarkable as was a preoperative chest radiograph.

After preoxygenation anaesthesia was induced with propofol and fentanyl. The trachea was intubated after relaxation with vecuronium. Bilateral equal air entry was confirmed before and after the patient was positioned prone. Isoflurane, oxygen and nitrous oxide were used for maintenance of anaesthesia. Intraoperative vital signs were within normal limits. Peak airway pressure was 12cmH<sub>2</sub>O in the supine position and 15-20cmH<sub>2</sub>O when prone. PCNL was performed with a right supra-costal (between 11th and 12th rib) approach and lasted one hour. 1.5l Ringer's lactate was administered intravenously. 12 litres 1.5% glycine was used for irrigation and total blood loss was 50-60ml.



**Figure 1.** Postoperative chest radiograph showing opacity of the right hemithorax

Once surgery was completed, the patient was turned supine and neuromuscular blockade was reversed with neostigmine and glycopyrolate.

After extubation the patient was comfortable, undistressed, haemodynamically stable and oxygen saturation was 97% breathing 40% oxygen by mask and 94% on room air. On auscultation, air entry was slightly decreased with fine crepitations on the right side of chest, with dullness on percussion on this side. Chest radiograph revealed opacity of right hemithorax (Figure 1). A diagnosis of hydrothorax was made which was confirmed by needle aspiration through the right 5th intercostal space. An intercostal drain with underwater seal was inserted in the right 5th intercostal space in the midaxillary line. 1500ml fluid was drained in 6 hours and a further 200ml in the next 12 hours. Repeat chest radiograph 24 hours later showed full expansion of the lung and the drain was removed on the 3rd postoperative day. The patient was discharged on the 5th postoperative day.

**DISCUSSION**

PCNL was introduced in the 1970s to treat kidney stones in patients who were poor operative risks. In recent years, where available, PCNL has virtually replaced open stone removal in patients of all ages and for nearly all types of stone.<sup>1</sup> Advantages of the percutaneous method include lower mortality and morbidity, faster convalescence, greater ease of repeat procedures and greater cost effectiveness.<sup>1</sup>

Success of percutaneous nephrolithotomy depends directly on the approach to the collecting system, either subcostal or supracostal. The kidney lies tilted in the retroperitoneum with its upper pole posterior to the lower pole. When accessed from below (the subcostal route), it may be difficult to pass the rigid instrument to the upper pole because of the acute angle from the skin. An upper pole approach (supracostal route) results in a tract that is less parallel to the long axis of the kidney allowing easier access to the upper pole.

However the supracostal approach is associated with a small but significant increase in morbidity.<sup>2-4</sup> The increase in morbidity of this supracostal approach is primarily due to the potential for damage to the lung and pleura. A portion of the diaphragm is not covered by a pleural reflection and so injury to the pleura can be avoided by supracostal puncture over the most lateral portion of the 12th rib.<sup>3</sup> The lungs do not normally fill

**Summary**

Percutaneous nephrolithotomy (PCNL) is used extensively for removal of renal and upper ureteric calculi. The calyceal system of the kidney can be accessed via a subcostal or supracostal route. Supracostal puncture provides direct access to the upper, middle and lower calyx and the upper ureter, and so it is used extensively despite an increased incidence of intrathoracic complications. We encountered massive hydrothorax following PCNL which was managed by intercostal drain insertion. The literature on this subject is reviewed.

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the costophrenic recess during quiet respiration, lying approximately at the level of the 8th rib in midaxillary line and 10th rib posteriorly. This position is variable and the lungs may fill the whole costophrenic recess in patients with obstructive pulmonary disease and during deep inspiration in the prone position. All percutaneous tracts that pass between the 11th and 12th ribs posteriorly puncture the diaphragm. Puncture of the pleura is a relatively more serious problem and is a recognized risk of supracostal puncture.

Accumulation of fluid can occur due to two reasons;<sup>3</sup> first due to inadequate tamponade of the nephrostomy tract combined with inadequate drainage of the kidney after the puncture. Secondly, post-procedure hydropneumothorax may be due to failure to seal the tract with a working sheath during stone removal. For patients in the prone position, at full expiration during puncture, the quoted rates of damage to the left and right lungs are 14% and 29% respectively, when using 11th-12th intercostal space.<sup>5</sup>

Hydrothorax complicating PCNL is usually diagnosed clinically during the procedure by decreased oxygen saturation and significant increased airway pressure.<sup>6</sup> The diagnosis can be confirmed using a chest radiograph. With the patient in the prone position, fluid can be seen tracking along the lateral borders of the chest cavity and compressing the ipsilateral lung. In our patient, there was neither desaturation nor significant increase in airway pressure. Postoperatively, the patient was comfortable but a slight decrease in oxygen saturation was noted. There was reduced air entry with fine crepitations on the affected side. This clinical scenario led us to suspect an intrathoracic complication and manage it accordingly.

This case highlights the need to have a high index of suspicion for this complication even in the absence of the expected clinical signs.

In summary, hydrothorax is a known complication of PCNL by the supracostal route. We recommend strict intraoperative monitoring of airway pressure, with early intraoperative fluoroscopy where available. In symptomatic postoperative patients prompt chest X-ray should be undertaken.

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## Cerebral Challenge

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### Case 1

You are asked to anaesthetise a 46-year-old man for removal of his wisdom teeth. He is normally fit and well but reports frequent episodes of palpitations and feeling light-headed. Although the man has no symptoms

at the moment, the house officer has requested a preoperative ECG.

1. What does the ECG show?
2. How would you manage this patient?

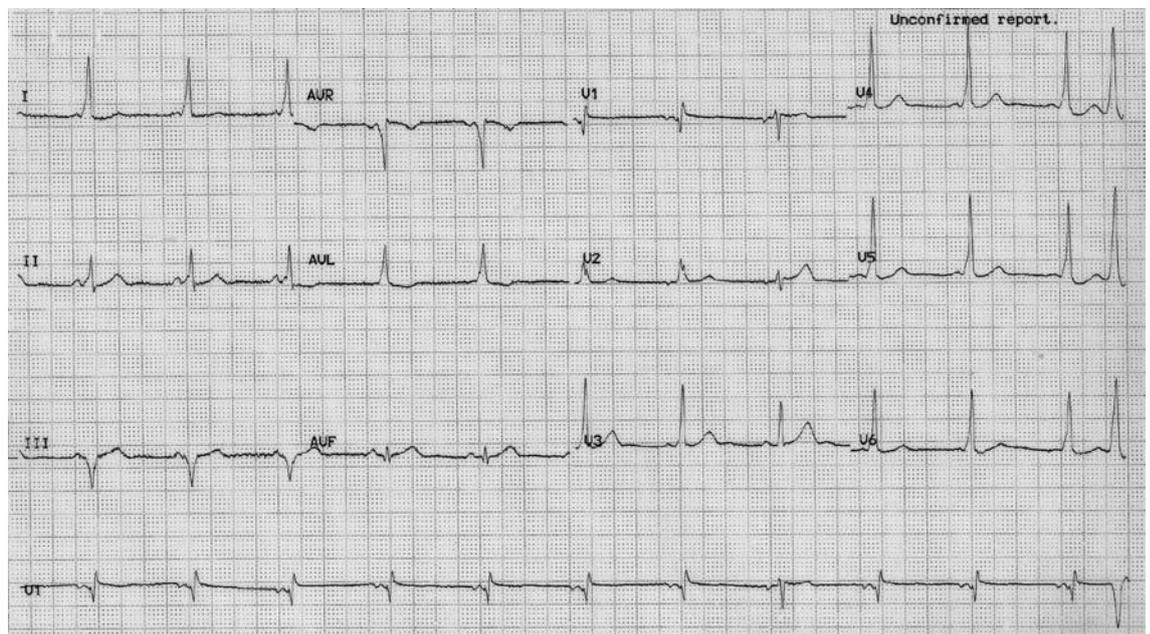


Figure 1. ECG of patient 1

### Case 2

A 76-year-old man attends the emergency department complaining of fever and chills and a sharp pain on the right hand side of his chest. He is usually fairly fit but has a longstanding cough and has lost weight in the last 6 months. He has been a smoker for 35 years. You are asked to review him because the emergency department resident is concerned that he may need intensive care.

On examination, you find that he has a BP of 91/43mmHg, pulse of 100 beats per minute, a temperature of 38.3°C and oxygen saturations of 87% on air. You note that his respiratory rate is 40

breaths per minute but there are no clear signs on chest examination. A chest X-ray has already been taken.



Figure 2. Chest X-ray of patient 2

1. What does the X-ray show?
2. What further investigations would you order?
3. How would you manage this patient?

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### Case 3

You are asked to assess a 73-year-old man who has fallen at his home. He is known to have had a stroke in the past and has a longstanding hemiparesis, although he can usually mobilise with a walking frame. He takes warfarin for long-standing atrial fibrillation. As he had a decreased level of consciousness on arrival at the hospital, he has had a CT of his head. You note that he is moaning, withdraws from pain and opens his eyes to pain.

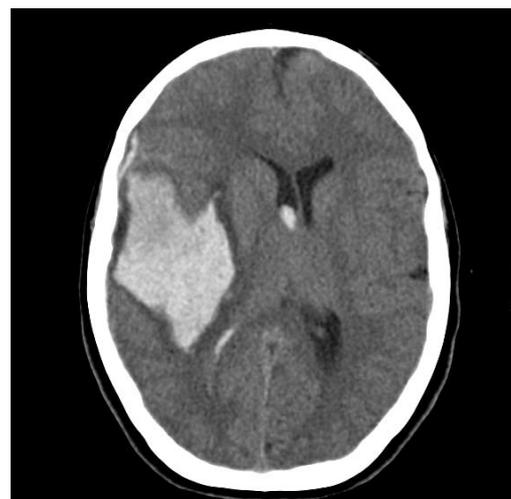


Figure 3. CT head of patient 3

1. What does this CT scan show?
2. How would you assess his decreased level of consciousness?
3. What is your plan for this patient's management?

## DISCUSSION

### Case 1

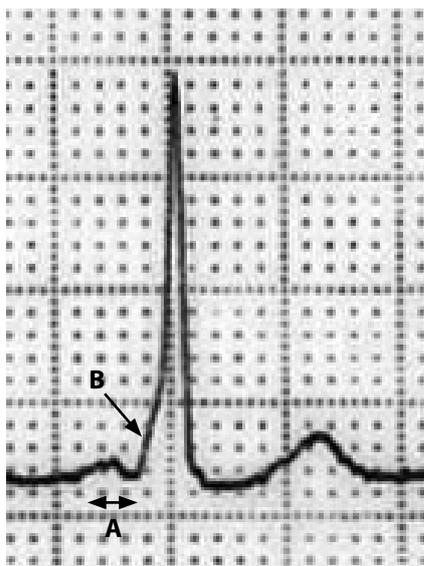


Figure 4. This ECG shows Wolff-Parkinson-White Syndrome (WPW), characterised by A - a shortened PR interval (less than 3 small squares, 120ms), B - a slurred upstroke to the QRS (the delta wave) indicating 'pre-excitation'.

WPW results from the presence of an accessory (or 'extra') electrical conduction pathway connecting the atria to the ventricles in the heart. This pathway may bypass the normal conduction route via the atrioventricular (AV) node and so the normal AV conduction delay is absent (causing the short PR interval).

Electrical impulses can travel in an anterograde (from atrium to ventricle) or retrograde (from ventricle to atrium) direction through the accessory pathway. This can predispose patients to tachydysrhythmias in a number of ways. For example, a normally conducted impulse that

has travelled from atrium to ventricle via the AV node, may then be conducted back up to the atria via the accessory pathway, causing secondary activation of the conducting system. This may generate a re-entrant tachycardia.

The incidence of WPW is 1-3% but many individuals will remain asymptomatic. Patients may present with anything from mild chest discomfort or palpitations to being severe haemodynamic compromise, cardiac arrest or sudden death. Symptomatic WPW most commonly presents with supraventricular tachycardia or atrial fibrillation.

In an asymptomatic patient with WPW, no intervention is required except periodic review.

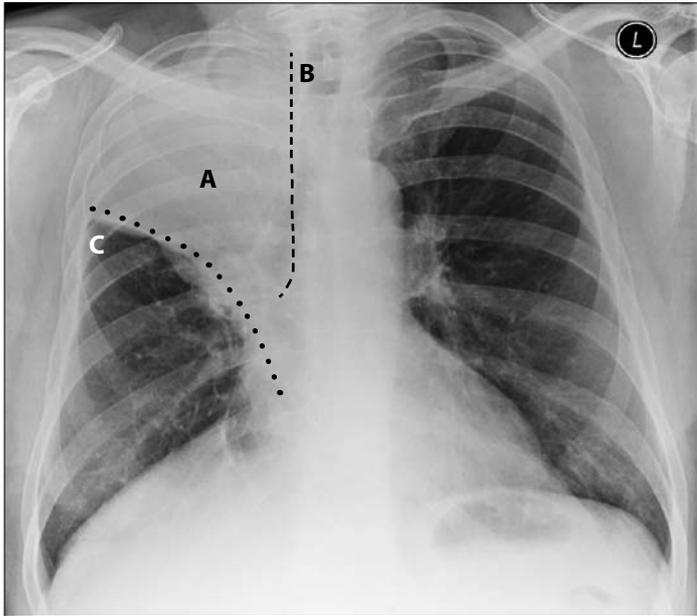
This patient is symptomatic and should be referred to a cardiologist for assessment and further treatment. The definitive treatment is radiofrequency ablation of the accessory pathway. The prognosis for WPW syndrome after this intervention is excellent. Without intervention, there is a small risk of sudden death (0.1%).

Patients with WPW who present with a regular narrow complex tachycardia (supraventricular tachycardia) with no haemodynamic compromise may be cardioverted with the short-acting AV node blocker adenosine (6mg IV followed by 12mg if needed). Adenosine should be given by large bore IV access and with oxygen and full resuscitation equipment (including a defibrillator) to hand.

If the QRS complex is irregular, the arrhythmia is likely to be atrial fibrillation and adenosine should be avoided. Atrial fibrillation in WPW is potentially fatal as rapid conduction of atrial impulses down the accessory pathway effectively causes ventricular fibrillation. This may be exacerbated by adenosine and other drugs that block the AV node (e.g. verapamil).

For patients with WPW who have cardiovascular compromise due to either AF or SVT, immediate synchronised cardioversion is indicated. Medical management of these patients should be under the direction of a cardiologist.

**Case 2 - Assessment**



**Figure 5.** The Xray shows opacification of the right upper lobe (A). On a chest Xray, where air-filled lung tissue (blacker on the radiograph) lies next to solid structures (white on the radiograph), there is a clean line between the two types of tissue. When lung tissue becomes consolidated (i.e. full of fluid or solid debris) or collapses, it absorbs more Xrays and so appears more like the surrounding solid structures. The clear line between lung and tissue is lost (B). The horizontal fissure (C), lying between expanded middle lobe and consolidated upper lobe has been pulled upwards indicating partial collapse of the upper lobe.

**Table 1.** The most common causative organisms of hospital acquired pneumonia in the UK

Typical organisms
Streptococcus pneumoniae (pneumococcus)
Haemophilus influenzae
Atypical organisms
Mycoplasma pneumoniae
Chlamydia psittaci
Legionella pneumophila

The most likely cause in this patient is community acquired pneumonia. The most likely causative organisms in the UK are shown in Table 1, however other organisms are prevalent in other parts of the world (e.g Salmonella species).

In a patient with a different history it could possibly be due to aspiration of gastric contents, a foreign body or massive pulmonary embolism. Given his cough, weight loss and smoking history, it is possible that a bronchial carcinoma has cause upper lobe collapse and secondary infection. Diagnostic bronchoscopy should be considered.

Figure 6 shows another example of a chest Xray showing right upper lobe consolidation in a patient who has had cardiac surgery. This is a relatively common finding after cardiac surgery via sternotomy and it is not usually an infective process and tends to resolve fairly rapidly.



**Figure 6.** This chest Xray is from another patient with right upper lobe pneumonia. Note that the shadowing is less dense and that the right superior mediastinal border is fairly preserved. The horizontal fissure is not displaced, indicating that there is minimal collapse of the lobe.

**Investigation**

Where available, arterial blood gas sampling, full blood count, creatinine and electrolytes and C-reactive protein will help confirm the diagnosis and assess the severity. Samples should be taken for blood and sputum cultures.

One way of assessing the severity of pneumonia is the CURB 65 score, detailed below (Table 1).

**Management**

You should administer high flow oxygen, intravenous fluids for rehydration and empirical antibiotic treatment as soon as possible. Most local guidelines recommend intravenous co-amoxiclav (augmentin) and a macrolide such as clarithromycin. You should consider prophylaxis for deep venous thrombosis (with fractionated or unfractionated heparin injections) as the patient is likely to be immobile for a few days. He should be regularly reviewed to assess his response to these treatments, because his condition may deteriorate and he may require intubation and ventilation.

**REFERENCE**

British Thoracic Society (2009), "Guidelines for the management of community acquired pneumonia in adults: update 2009". *Thorax* 2009; 64: Supplement III. Available at <http://www.brit-thoracic.org.uk/Portals/0/Clinical%20Information/Pneumonia/Guidelines/CAPGuideline-full.pdf>

**Table 2.** The CURB 65 Score for assessment of severity of pneumonia

This scoring system gives one point each for:
confusion
urea > 7.0mmol.l <sup>-1</sup>
respiratory rate > 30.min <sup>-1</sup>
blood pressure < 90mmHg (or diastolic BP <60mmHg)
age > 65 years
<ul style="list-style-type: none"> <li>• Patients who score 2 or more need hospital admission as they have a moderate risk of death (9%).</li> <li>• Patients with a score of 4 or more should be reviewed by the critical care team - the risk of death if the score is 3-5 is 15-40%.</li> <li>• The CURB score should be used alongside experienced clinical judgement.</li> </ul>

**Case 3**



**Figure 7.** This CT head shows a large intra-cerebral bleed within the right parietal lobe (A). The bleed is recent because the blood appears fairly bright grey; blood appears gradually darker on a CT scan as time passes. There is a small ring of oedematous brain (B) around the haematoma - because of its higher water content this appears darker than the surrounding brain tissue. The haematoma is causing midline shift (dashed line), and there is also blood within the compressed right lateral ventricle (arrows)

*Assessment of conscious level*

The patient's level of consciousness can be assessed using the Glasgow Coma Scale (GCS) which is scored as follows.

Best Motor Response (M)	Max score 6
Obeys command	6
Localizing response to pain	5
Withdraws from pain	4
Abnormal flexor response to pain	3
Extensor posturing to pain	2
No response to pain	1
Best Verbal Response (V)	Max score 5
Orientated	5
Confused conversation	4
Inappropriate speech	3
Incomprehensible speech	2
No verbal response	1
Best Eye Response (E)	Max score 4
Spontaneous eye-opening	4
Eye-opening in response to speech	3
Eye-opening in response to pain	2
No eye-opening	1

This patient has a GCS of M4, V2, E2 giving a total of 8 out of 15.

**Further management**

This man should be evaluated using an ABC approach. As his GCS is only 8, it is likely that he will not protect his own airway adequately. He should be placed on his side, with suction available to clear any secretions from his airway. Where facilities are available, intubation and mechanical ventilation should be considered. Prior to this, doctors, nursing staff and the patient's relatives must consider the likely or known wishes of the patient, regarding invasive treatment and ongoing care. If full treatment is felt to be what the patient

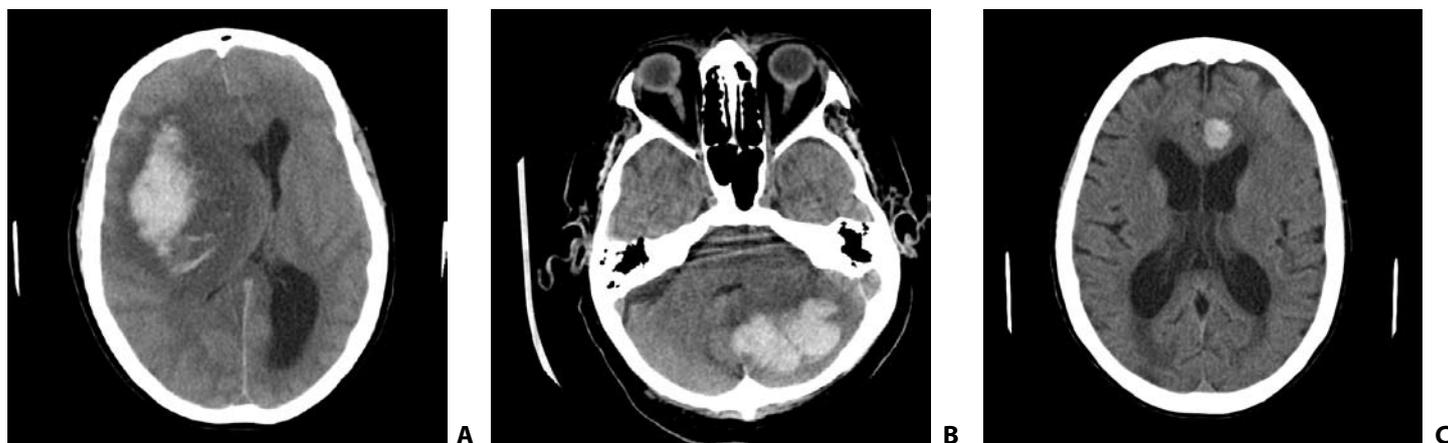
would want, he should be sedated, intubated and ventilated, aiming to achieve low-normal PaCO<sub>2</sub>, adequate PaO<sub>2</sub> and a blood pressure sufficient to achieve a cerebral perfusion pressure of 70mmHg. Head injury management is described in a recent Anaesthesia Tutorial of the Week.<sup>1</sup>

Warfarin is an oral anticoagulant used for prevention of peripheral venous thrombosis and thromboembolic disease related to atrial fibrillation. Patients taking warfarin are more vulnerable to intracranial bleeds after even minor head injury and delay in undertaking a CT scan can worsen outcome.<sup>2</sup>

Your threshold for ordering a CT head for a patient on warfarin should be low compared to patients with normal coagulation. This patient's

INR was checked urgently and found to be 5.0 (i.e. his prothrombin time was five times longer than that of a normal control sample). The effects of his warfarin should be reversed as rapidly as possible using the therapies available - vitamin K, fresh frozen plasma or prothrombin complex concentrate (PCC).<sup>3</sup>

If invasive treatment is felt to be appropriate, after consideration of the severity of this injury, his quality of life and the likelihood of a good recovery, he should be referred to the regional neurosurgical centre for further assessment and management. The neurosurgical team will consider intracranial pressure monitoring, an external ventricular drain or craniotomy and evacuation of the haematoma. Further examples of intracranial haematomas are shown in Figure 8.



**Figure 8.** A - A large right fronto-parietal haemorrhage causing massive midline shift and compression of the right ventricular system. B - A left cerebellar haematoma. C - A small left parasagittal frontal haematoma

## REFERENCES

1. Ali B, Drage S. Management of head injuries. *Anaesthesia Tutorial of the Week* March 2007. Available at: <http://totw.anaesthesiologists.org/wp-content/uploads/2010/02/46-Management-of-Head-injuries1.pdf>
2. NPSA signal alert (Ref 2193) - Anticoagulated patients and head injury (October 2010). Available at: <http://www.nrls.npsa.nhs.uk/resources?entryid45=8376>
3. Appelboom R. Anticoagulation and intracranial bleeds. *Anaesthesia Tutorial of the Week* January 2008. Available at: <http://totw.anaesthesiologists.org/wp-content/uploads/2010/08/82-AnticoagulationIntracranial-bleeds.pdf>

## From the journals

Louise Finch\* and Erica Dubb-Fuller

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### Effects of staff training on the care of mechanically ventilated patients: a prospective cohort study.

Bloos F, Muller S, Harz A, Gugel M, Geil D, Egerland K, Reinhart K, Marx G. *British Journal of Anaesthesia* 2009; **103**: 232-7

Treatment bundles are a method of ensuring multiple interventions are utilised in a specific set of patients. Low tidal volumes ventilation for patients with Acute Lung Injury, stress-ulcer prophylaxis and deep vein thrombosis prophylaxis (DVTP) are currently recommended in patients being mechanically ventilated.

This study assessed the effects of training and teaching of nurses and junior medical staff on the use of ventilator care bundles. The bundle they used, a modification of that of the Institute of Health Care Improvement, consisted of the three interventions mentioned above as well as semirecumbent positioning (i.e. lying with the patient's head up 30 degrees).

The study involved monitoring compliance with the bundle over 3 consecutive months (133 patients)

then, for 2 months, staff were taught the background and technique of the bundle on a daily basis, with a further 2 months reinforcing teaching with individual staff who were not correctly applying the bundle. Bundle adherence was then re-monitored for a further 2 months (141 patients).

Overall, compliance with bundle usage increased from 15 to 33.8% ( $p < 0.01$ ), semirecumbent positioning and DVTP were both significantly increased, ulcer prophylaxis was high throughout (>90%) but mean tidal volume remained unchanged. Days on mechanical ventilation were significantly reduced by 2 days; ICU length-of-stay, ICU mortality and rate of ventilator-associated pneumonia (VAP) remained unchanged. In patients with VAP, median length of ICU stay was reduced by 9 days but their ICU mortality remained unchanged.

### Prospective randomized controlled multi-centre trial of cuffed or uncuffed endotracheal tubes in small children

Weiss M, Dullenkopf A, Fischer JE, Keller C, Gerber AC and the European Paediatric Endotracheal Intubation Study Group. *British Journal of Anaesthesia* 2009; **103**: 867-73

Traditionally, airway management in children under 8-10 years has involved uncuffed tubes due to fears about mucosal injury. This study looked at the use of a new, high volume-low pressure cuffed tracheal tube (Microcuff PET, Kimberly Clark) with a cuff pressure release valve.

2246 children under the age of 5 years, requiring anaesthesia and tracheal intubation, were randomised to either a cuffed or uncuffed tube.

Endpoints considered were incidence of post-extubation stridor, the number of tube changes required to find an appropriate-sized tube and, for cuffed tubes, the minimal cuff pressure required to seal the airway.

The post-extubation stridor rates were not significantly different between the groups but tube exchange rate was 2.1% in the cuffed and 30.8% in the uncuffed groups ( $P < 0.0001$ ), with a significant reduction in the requirement for throat packs. A reliable capnography trace was gained significantly more frequently with the cuffed tubes. Minimal cuff pressure to seal the airway was 10.6cmH<sub>2</sub>O.

The authors state that their findings indicate no increase in post-extubation stridor with these cuffed endotracheal tubes, but that alternatively designed cuffs or those without cuff pressure control can cause airway damage and their results should not be extrapolated to other cuffed paediatric tubes.

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## Regional techniques and outcome: what is the evidence?

Hanna MN, Murphy JD, Kumar K, Wu CL. *Current Opinion in Anaesthesiology* 2009; **22**: 672-7

This article reviews the use of regional anaesthesia and analgesia with regards to both the benefits and risks inherent in their use. Regional anaesthesia can provide superior analgesia and, by blunting the stress response invoked by pain, improve outcomes, particularly in those patients with decreased physiological reserves. The largest meta-analysis of RCTs comparing neuraxial to general anaesthesia found a significant decrease in mortality but smaller, procedure-specific meta-analyses have not found any mortality difference. Database analyses have found postoperative epidural analgesia to be associated with significantly lower 7 and 30-day mortality for patients undergoing high-risk procedures e.g. colectomy and lung resection, but not lower risk procedures. However, the overall evidence for reduction of mortality with epidural analgesia is inconsistent.

The effect on individual systems was considered:

- There is consistent evidence that the use of thoracic epidural analgesia (TEA) may reduce the risk of cardiovascular morbidity in high-risk patients undergoing higher risk surgical procedures.
- There is some evidence for reduction in post-operative pulmonary morbidity in patients undergoing thoracic and abdominal surgery, that the authors feel is limited to high risk patients and procedures.

- TEA with local anaesthetic is associated with faster recovery of bowel function, reduced pain and duration of ileus compared to systemic or neuraxial opioids. The effects when used with laparoscopic surgery or on other outcomes are unclear.
- For thoracic procedures the incidence of hypotension, urinary retention and pruritis is lower with paravertebral analgesia compared to TEA.
- There is some evidence that surgery suppresses antimetastatic cell-mediated immunity and that regional anaesthesia/analgesia may diminish this response with a lower risk of recurrence with regional techniques (e.g. in surgery for breast cancer).
- Neurological complications and toxicity from local anaesthesia can occur. The use of ultrasound to guide needle placement has been associated with an increase in the success rate of nerve blocks but its effects on safety and adverse outcome rates remain unclear.

In conclusion, the use of regional anaesthesia and analgesia may improve perioperative cardiac, pulmonary and gastrointestinal outcomes, but the benefits are limited to higher risk patients undergoing higher risk procedures.

## Risk of pulmonary aspiration with laryngeal mask airway and tracheal tube: analysis on 65712 procedures with positive pressure ventilation

Bernardini A, Natalini G. *Anaesthesia* 2009; **64**: 1289-94

This was a retrospective analysis of records from an anaesthesia database in one hospital over 11 years. The database consists of prospectively collected data from cards completed by anaesthetists for each procedure they undertake. Information collected included anaesthetic procedure (airway type, anaesthesia and ventilation modalities); the type, speciality, length and nature of surgery (unplanned/elective-defined as booked >12h pre-operatively); patient demographics and ASA; any major complications. Cases that involved general anaesthesia and positive pressure ventilation via either an LMA (classic only) or tracheal tube were studied.

LMAs are contraindicated in this hospital in non-fasted patients (<6h from food, <2h from fluid), pregnancy, intestinal obstruction, unplanned surgery with fasting time <12h, airway surgery and the prone position. In 98% of these cases a tracheal tube was used leading to significant variability in the baseline characteristics (e.g.

weight, ASA, nature of surgery) of the different airway groups. 65712 general anaesthetic procedures were analysed with adjustments for this variability. 10 cases of pulmonary aspiration occurred – 4 during elective surgery (2 with LMA) and 6 during unplanned surgery (1 with LMA). Adjusted analysis showed the LMA to have an OR of 1.06 (95% CI 0.2-5.6 p=0.9). The main factor associated with pulmonary aspiration was emergency surgery, with male sex also being a risk factor.

The authors comment on the low incidence of pulmonary aspiration and of associated morbidity (2 ICU admissions) and mortality (no cases), in keeping with previous studies and making it difficult to power studies sufficiently. They also note the institution's contraindications to LMA use resulted in the comparison groups being significantly different, but conclude that the use of an LMA in properly selected patients was not associated with pulmonary complications.

## Blood transfusions: more is not necessarily better

Clark V, Waters JH. *International Journal of Obstetric Anaesthesia* 2009; **18**:299-301

Two recent retrospective audits (one from the USA, one from the UK) have shown that many parturients were transfused before transfusion triggers were met and to levels greater than 10g.dl<sup>-1</sup>. This editorial questions whether current blood transfusion practice is doing good or causing harm.

The risks of blood transfusion have the potential to impact on the lives of this young subset of the population, namely by causing immunosuppression, alloimmunization, cancer, and viral transmission. Allogeneic blood transfusions have killed more patients in the UK between 1996 to 2002 than major obstetric haemorrhage.

The only major prospective RCT of transfusion triggers (TRICC) was based on ICU patients and the youngest subset was less than

55 years. They found worse outcomes with aggressive transfusion practice.

Techniques to minimise anaemia include; optimisation of iron stores prior to delivery with either oral or intravenous haematinics, appropriate and early use of uterotonic intrapartum, cell salvage and interventional radiology in high risk cases, compression sutures and a timely hysterectomy by an experienced obstetrician. Blood transfusion should be guided by point of care testing (e.g. Haemocue®), with reassessment prior to administration of further products. Post-partum use of iron supplements is encouraged.

The authors endorse timely use of plasma and platelets, and establishment of transfusion guidelines and algorithms - treat the patient (i.e. their symptoms) and not the numbers.

## Pandemic (H1N1) 2009 influenza

Patel M, Dennis A, Flutter C, Khan Z. *British Journal of Anaesthesia* 2010; **104** (2):128-42

This is an informative review article covering the background, presentation, diagnosis, treatment and management of pandemic (H1N1) 2009 influenza, collating information from different centres worldwide. By October 2009 over 375,000 laboratory confirmed cases were reported from 191 countries and territories with more than 4500 deaths. In severe cases, the clinical picture is markedly different to cases of seasonal influenza, as many previously healthy young people were affected. During a pandemic wave, it is estimated that 12-30% of the population will develop clinical symptoms with 4% requiring hospital admission, with 1 in 5 needing ICU care.

Transmission is human to human from respiratory droplets or contaminated surfaces. It has higher transmissibility than seasonal influenza and all bodily fluids/ secretions of infected patients are potentially infectious.

Patients are usually symptomatic within a week of exposure. Critically ill patients can rapidly progress to respiratory failure and ARDS with refractory hypoxaemia. Secondary bacterial infections, septic shock and multi-organ dysfunction are frequently seen.

Diagnostic tests are considered in hospitalised patients or patients in whom diagnosis will influence management. They should not delay treatment. The rapid influenza diagnostic test (RIDT) and direct immunofluorescence assays (DFA) are available and fast to process but lack sensitivity and specificity. Viral culture and nucleic acid amplification tests (rRT-PCR) have limited availability and lengthy processing times but are used to confirm cases of pandemic (H1N1) 2009 virus.

Treatment is with antiviral neuraminidase inhibitor drugs; oseltamivir (Tamiflu) and zanamivir (Relenza). Cases of resistance to oseltamivir

have been identified. The WHO does not recommend use of antivirals for prophylaxis, rather, early treatment based on signs and symptoms is advised. Healthy patients with mild or moderate uncomplicated illness do not require treatment. High risk patients or those with signs of severe/ progressive illness require antiviral treatment, ideally within 48 hours of onset.

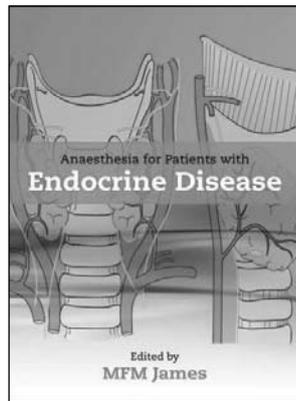
Vaccination is effective in reducing morbidity and mortality. It is effective 14 days after administration and can prevent 50-80% of influenza illness in healthy people. Vaccination is recommended for all healthcare workers, current seasonal influenza at risk groups, household contacts of immunocompromised people and in pregnancy (where there is a greater risk of developing complications secondary to immunosuppression).

Exceptional demands could be placed on healthcare resources with a further resurgence; predictions include a 4-fold increase in emergency admissions, reduced staffing levels by up to 50% and huge demand for ICU beds and ventilators. The WHO and other agencies have published guidelines on providing the greatest good for most patients with triage protocols, patient cohorting, adherence to infection control policies and effective use of personnel protective equipment.

Disease severity has the potential to change, especially if there is viral mutation. As clinicians we must be prepared for further pandemics.

### Further reading

- World Health Organization (WHO). Preparing for the second wave: lessons from current outbreaks. Available at: [http://www.who.int/csr/disease/swineflunotes/h1n1\\_second\\_wave\\_220090828/en/index.html](http://www.who.int/csr/disease/swineflunotes/h1n1_second_wave_220090828/en/index.html)



## Anaesthesia for Patients with Endocrine Disease

Edited by MFM James. Oxford University Press 2010

ISBN: 0199570256

This first edition, 266-page hardback book is written by an international collection of authors and edited by MFM James, Professor of Anaesthesia at Groote Schuur Hospital, Cape Town. It will prove a useful reference text for many but its target audience is primarily consultant and trainee anaesthetists. It draws together a wealth of information some of which is not easily found elsewhere and throughout educates by placing clinical advice squarely in the context of its underlying science.

Its eleven chapters consider topics ranging from basic science to the management of patients with endocrine disease for both endocrine and non-endocrine surgery. The opening chapter revises some relevant molecular biology but rapidly progresses to a more clinically orientated examination of the role of endocrinology in the stress response. The subject is remarkably readable despite containing a good level of detail, which is a tribute to its clarity and structure of presentation, traits present throughout the book.

Thirty pages are devoted to the perioperative management of patients with diabetes mellitus and include a useful update on the pharmacology of newer oral hypoglycaemic agents and insulins, as well as a review of the effect of diabetic control on postoperative outcomes.

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Six of the book's eleven chapters focus on anaesthesia for surgery involving particular endocrine pathology (pituitary, thyroid, parathyroid, carcinoid, adrenal cortex and medulla). These chapters follow a broadly similar format of anatomy and physiology, pathophysiology, diagnosis and anaesthetic management. The reader is drawn along a path from revision of underlying science to practical anaesthesia, but for those in search of a quick answer each chapter ends with a concise summary of "Key Clinical Management Points". The typical case presentation of the anaesthetic management of a patient with a

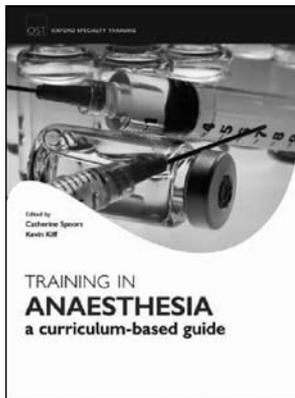
small bowel carcinoid tumour was valuable surrogate experience for a reader with little clinical familiarity with this condition and additional examples would be welcome additions to a future edition.

Two chapters (Endocrine Emergencies and Hormones as Pharmaceutical Agents) were not expected as they are perhaps more relevant to critical care medicine than anaesthesia. The management of endocrine emergencies is certainly amply covered in other more readily available texts and, while the use of hormones (primarily glucocorticoids and vasopressin) in anaesthesia and critical care medicine has been included for completeness, these chapters will be out of date a long time before the rest of the book.

Finally, "Endocrine Surgery: a personal view" gives a surgeon's perspective on some different aspects of endocrine surgery and although there is some overlap with the content of previous chapters there are several insights that would be hard to glean from other anaesthetic texts.

There are plenty of illustrations throughout the book and a handful of colour plates are included. The radiology and histology are refreshingly well reproduced but some of the medical illustration is disappointing as it ranges in standard from really very high (chapter 2, the pituitary) to distinctly amateurish (representations of the adrenal gland, for example) which is unfortunate in a book of otherwise high quality. One hopes they will be revised in the second edition.

Although it is too detailed (and at £75, too expensive!) to become core reading for the final FRCA examination, many anaesthetists (both generalist and endocrine) could benefit from thumbing through a departmental copy of this well written book as it is much more than a simple "how to" for endocrine anaesthesia.



## Training in anaesthesia

Edited by Catherine Spoons and Kevin Kiff. Oxford University Press 2010

ESPN: 978-0-19-922726-6

I was halfway through my revision for the Primary FRCA exam when I was asked to use and review this book. Until then I had found it quite frustrating having to switch back and forth between different textbooks and various online materials. I was absolutely thrilled to discover a textbook (finally!) that has it all.

This text is innovative in the way it combines basic sciences with clinical knowledge, as well as describing practical applications of a given subject or system. It has made it much easier for me to digest the information and relate the basics to my daily practice.

The authors have been very disciplined and each subject is limited to two pages - the first with text and the second with diagrams and figures. Only relevant information is included which makes revision more manageable and less overwhelming. The sections on physics, strong ion difference, closing capacity, gas transport and exchange, the cardiac cycle, statistics and pharmacokinetics are very well written. Anatomy relevant to anaesthesia is included and presented in a concise and friendly way. There are great practical sections that, whilst less relevant to FRCA revision, are crucial for clinical practice.

The visual layout of the book is excellent - the colourful diagrams have the relevant information highlighted and plenty of space for notes. It is printed as paperback in a small font and is therefore easy to carry around. This text is full of facts presented in a digestible way to aid the revision process and most of the factual knowledge needed to successfully get through the primary FRCA are included.

My only criticism is that there are a rather high number of spelling mistakes that were missed during the editorial process. Examples include muscuocutaneous (musculocutaneous, page 121), circulating (circulating, page 238), phenoxybenzamine is an antagonist not agonist (page 238), Bainbirdge (Bainbridge, page 256), 'closure of the aortic valve at the start- ... printed twice (page 253).

Compared to other textbooks this book is very reasonably priced and well worth the price. I regret not having it sooner.

Overall this book is a great "fusion" textbook and I would definitely recommend it to all trainees entering their core training years.

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# Update in Anaesthesia

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## Guide for Contributors

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*Update in Anaesthesia* is primarily an educational journal, which aims to provide ongoing learning and support for anaesthetists working in situations with limited resources.

*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](http://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@rdefn.nhs.uk](mailto:Bruce.McCormick@rdefn.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.
- Papers are subject to editorial revision.
- 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\\_viewgid,67Itemid,49/](http://www.worldanaesthesia.org/component/option,com_docmantask,cat_viewgid,67Itemid,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<sup>-1</sup> 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

Three levels of heading may be used CAPITALS, **bold** and *italic*. Please do not employ different fonts within the text. Bullet points can be helpful.

#### 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.

Tables or figures reproduced from other published texts should be accompanied by a statement that permission for reproduction has been obtained from the author or publisher. An acknowledgment should be included in the caption and the full reference included in the reference list.

#### 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, Carlidge 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 is 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@rdefnhs.uk](mailto:Bruce.McCormick@rdefnhs.uk)

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