Update in
Anaesthesia

Education for anaesthetists worldwide

Editor-in-chief: Bruce McCormick

- Using a facemask during anaesthesia

- An algorithm to support anaesthetic decision making

- Management of bronchospasm during general anaesthesia

- Inserting peripheral intravenous cannulae – tips and tricks

- Fibreoptic intubation

- Acute pain management for opioid tolerant patients

- Paediatric anaesthesia at a tertiary hospital in Nigeria

The Journal of the World Federation of Societies of Anaesthesiologists

Update in Anaesthesia

Editorial

Fluid resuscitation in critically ill African children

When confronted with a sick child with a septic illness, our management is guided by well-established algorithms from the American College of Critical Care.[1] These guidelines recommend that, after assessment of the airway and breathing, haemodynamic instability is treated with fluid boluses of 20ml.kg^{-1}. These boluses should be repeated after re-evaluation of the child's condition and, where indicated, should be repeated to a total of 60ml.kg^{-1} within 15 minutes of their arrival in the Emergency Department. The evidence for these recommendations comes from studies in developed countries where facilities for invasive ventilation are available, allowing fluid administration to be more liberal.[2]

However, a recent large randomised, controlled study has made us question practice that would previously be considered an established gold standard of therapy, in this case administration of fluid boluses to septic children.[3] The FEAST (Fluid expansion and supportive therapy) trial was conducted at six hospitals in sub-Saharan Africa (4 in Uganda, 1 in Kenya and 1 in Tanzania). This impressive trial of over three thousand children was undertaken because of a perception that children in developing areas with sepsis and poor perfusion do not receive prompt aggressive fluid resuscitation therapy that may improve their survival.

The study enrolled children aged between 60 days to 12 years of age, suffering a febrile illness with either impaired consciousness, respiratory distress or both, and with impaired perfusion, indicated by one or more of the following:

- a capillary refill time of 3 or more seconds,
- a lower limb temperature gradient,
- a weak radial-pulse volume, or
- severe tachycardia.

Enrolled children were stratified into two groups; by the inclusion criteria above the majority were poorly perfused, but not hypotension and therefore not 'shocked'. Those with hypotension formed a small minority and will not be described further here. Patients were randomly assigned to receive 20ml.kg^{-1} 0.9% saline or 20ml.kg^{-1} 5% albumin or no bolus of fluid. At 1 hour they were administered an additional 20ml.kg^{-1} 0.9% saline or 5% albumin if they still had signs of poor perfusion. Importantly, children with infective gastroenteritis and severe malnutrition were

among those excluded from the study. The primary endpoint was mortality at 48 hours and it was assumed that this would be about 15% in the control (no bolus) group.

All staff underwent triage and emergency life support training. Pulse oximetry and non-invasive blood pressure machines were provided and all other therapies - maintenance fluids, antimalarials, antipyretics, anticonvulsants and transfusion parameters (20ml.kg^{-1} if Hb less than 5.0g.dl^{-1}) - were the same for both treatment groups and the control group.

3170 patients were enrolled with 3141 entering the main (non-hypotensive) arm of the study; however the study was stopped at this stage (short of the planned 3600 patients) due to safety concerns in the intervention groups. The baseline characteristics of the three groups were similar and of note 57-59% had malarial parasites in their blood film, although it is unclear how many of these had malaria as their primary diagnosis. One third in each group were profoundly anaemic with a haemoglobin level below 5g.dl^{-1}. 3-5% were HIV positive. Both bolus groups received 20ml.kg^{-1} in the first hour of treatment, compared to 1.2ml.kg^{-1} in the non-bolus group, demonstrating that fluid protocols were followed accurately in all groups.

The mortality rates at 48 hours were 10.6% in the albumin bolus group, 10.5% in the saline bolus group and 7.3% in the no bolus group. Put another way, children were 1.45 (95% confidence intervals, 1.13-1.86; p=0.003) times more likely to die if given a fluid bolus, compared to the children who received no fluid bolus. This difference in outcome was still clear at 4 week follow-up. There was no difference between the albumin and saline bolus groups. Further analysis shows that children who were not given fluid boluses had better survival in almost all subgroups, including those with malaria, profound anaemia, worse acidosis and higher lactate levels.

This study that has shown clearly that survival of children with poor perfusion due to sepsis in Africa is 33% worse if treated with fluid boluses of albumin or saline. However it is essential that the results are interpreted in the context of this particular study population. There are several aspects of the study that mean the results should not be generalized for other patient populations in other settings.

Update in
Anaesthesia

It is appropriate that emergency medical management of conditions such as sepsis is guided by algorithms and protocols. On presentation, a working diagnosis is made on the basis of a clinical syndrome, in this case poor perfusion due to a septic illness. It is only later in the child's clinical course, when microbiological investigations are complete, that a final diagnosis may be made. In Africa, a group of children presenting with a syndrome of sepsis are in fact a very heterogeneous group when the exact diagnosis is considered. Some have bacterial sepsis (although only 12% had a positive blood culture) and may have benefited from fluid therapy. Children with pneumonia, cerebral malaria and other causes of encephalopathy may be harmed by fluid therapy as they have high levels of ADH (antidiuretic hormone) resulting from their underlying disease. The high numbers of children with severe anaemia may be harmed by liberal fluid administration, since haemodilution in profoundly anaemic children may reduce oxygen delivery below a critical level needed for adequate organ oxygenation.

Perhaps the most important message from this study is that the mortality rate that was achieved in the control group (7.3%) was considerably lower than predicted (15%) and it is likely that this reflects the training in triage, basic life support and regular monitoring that was introduced as part of the study. In a broader context, this study highlights the potential hazards of introducing protocols from better-resourced settings into developing world hospitals, without considering the enormous variability in patients, pathology and facilities in each specific setting.

The headline message from this study is that over hydration with fluid therapy worsens outcome in children with malaria and that protocols for all-comers with sepsis are not appropriate for countries where malaria is endemic. It is also important to remember that children with dehydration due to gastroenteritis were excluded from the study and it would be disastrous if fluid therapy were withheld from children with this form of septic illness.

REFERENCES

1. Brierley J, Carcillo JA, Choong K et al. Clinical practice parameters for haemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine. *Crit Care Med* 2009; **37**: 666-88.

2. Han YY, Carcillo JA, Dragotta MA et al. Early reversal of paediatric-neonatal septic shock by community physicians is associated with improved outcome. *Pediatrics* 2003; **112**: 793–9.

3. Maitland K, Kiguli S, Opoka RO et al. Mortality after Fluid Bolus in African Children with Severe Infection. *N Engl J Med* 2011; **364**: 2483-95.

Bruce McCormick
Royal Devon and Exeter NHS Foundation Trust
Exeter
Devon EX2 5DW
UK

Editor's Notes

Dear Readers,

Welcome to *Update in Anaesthesia* 27,1.

As promised this edition contains a variety of articles focusing on more basic aspects of anaesthesia, dealing with specific skills such as cannulation and use of an anaesthetic face mask. I remember finding that one of the most confusing aspects of anaesthesia in the first few weeks was understanding the process of choosing a suitable anaesthetic technique for each patient. The algorithm presented by Drs Hellewell and Rogers is the first I have seen of its kind and I think this will help many trainees in their first weeks and months of training.

I have included an interesting assortment of case reports and brief reports covering areas as varied as incremental spinal anaesthesia, outreach cleft lip surgery in Kenya, paediatric surgery in Nigeria and an audit of cancellation of surgery in Uganda.

The next edition of *Update* will be an expanded special edition of Intensive Care Medicine articles – an area of rapid expansion in many developing world hospitals. Looking further ahead, 2012 will see a standard edition similar to this one, followed by an extended Paediatric special edition towards the end of the year.

As always, please contact me if you have any suggestions for future topics or more general suggestions for the future direction of Update in Anaesthesia.

We are continually aware that we must strive to keep the mailing list up to date and so we ask that if you wish to continue to receive the journal after this edition, please return the enclosed reply slip with your current postal details, or alternatively email Carol Wilson at worldanaesthesia@mac.com

Bruce McCormick
Editor-in-chief
Update in Anaesthesia

News from the WFSA

Update on the Global Oximetry Project

The idea of providing oximeters to those in need first came about at the World Congress in Paris in 2004, when members of the Safety and Quality Committee were discussing ideas around improving patient safety. With the assistance of the Association of Anaesthetists of Great Britain and Ireland (AAGBI) and GE Healthcare, who provided the oximeters, they developed projects in 4 countries – India, Philippines, Uganda and Vietnam. They found that there was a huge need for oximeters and that significant education was required in how to use them and how to respond to the information provided by them. (*Anaesthesia* 2009; **64**: 1051-60).

At the same time, the World Health Organization (WHO) was developing its Safe Surgery Saves Lives initiative, led by Dr Atul Gawande of the Harvard School of Public Health and a surgeon at the Brigham and Women's Hospital in Boston. This resulted in the provision of a surgical checklist. Studies showed that using the checklist, no matter what resources were available, resulted in a reduction in surgical morbidity and mortality. (*N Engl J Med* 2009; **360**: 491-9).

The use of a pulse oximeter was included as one of the points on the checklist because of the importance of this form of monitoring to patient safety, but also because it was recognized that a significant portion of the anesthesia world lacked pulse oximeters. In October 2008, WHO gathered together interested parties such as the WFSA, Harvard School of Public Health, procurement experts, industry and others. This group embarked on a project to provide low cost pulse oximeters to anesthesiologists in need of this technology to support the care of their patients. Teams were formed to determine the specifications of a suitable oximeter, to set up a procurement process, to secure financing and to develop educational materials.

All have done their work admirably. The chosen oximeter is ISO and CE certified, with all of the qualities and safeguards required. It comes with extra features, such as long-lasting batteries, which make it suitable for use in austere environments. The successful manufacturer is able to provide this state-of-the art oximeter at the incredibly low cost of $250 US. This should enable governments and hospitals in low and middle-income countries to purchase oximeters for a fraction of their usual cost. We also hope groups, organizations and even individuals will donate them to those in need.

The project has gathered new partners such as AAGBI and Smile Train. Many people have donated their expertise in areas required by such a huge undertaking, for example management, branding, law and public relations. These are people outside of the world of anesthesia, and even the medicine. They are contributing because they believe in the value of the project to improve patient safety during anesthesia and surgery.

Research done as the project developed shows that about 77,000 operating rooms in the world lack pulse oximetry. This equates with about 35 million patients per year having anesthetics without an oximeter (*Lancet* 2010; **376**: 1055-61). In addition, there is a lack of oximeters in Recovery Rooms, Obstetric Units, Neonatal Units or Intensive Care Units. The potential for improving patient safety with these devices, supported by appropriate education, is enormous.

The education team has created materials for use in self-learning or for teaching. Each pulse oximeter that is distributed will have a CD-ROM with it which will include materials on the Surgical Safety Checklist and the oximeter. These include a manual describing oxygen transport, use of an oximeter, an algorithm on what to do when the oxygen saturation is falling, two power-point presentations, scenarios for use in teaching, quizzes and a prize-winning video made especially for this project by Dr Rafael Ortega, an anesthesiologist at Boston University. All of the material has been produced by us in six languages – English, French, Spanish, Chinese, Russian and Arabic. It will also be available free of charge from the WHO website. The content and quality of this material makes it relevant to any anesthesia provider – not just those in economically constrained settings.

We are calling on all of our member societies to assist us with the teaching programmes.

We are pleased to announce that this project will shortly be set up as a not-for-profit organization called , with a board led by Dr. Atul Gawande and including representation from WFSA. This will allow us to develop a sustainable structure, generate funds for the donated distribution of oximeters and target on-site education programmes. Importantly, it will allow the WFSA to continue to promote our anaesthesia mission.

We will soon have a website dedicated to this project where, for just $250 US including delivery costs, eligible facilities can purchase oximeters for themselves, and donors can buy on their behalf, specifying the recipient if they wish. In time we will maintain a database of global need, so you can see exactly how we are working to target the oximetry gap, and where donations are needed next.

Aims to distribute 5000 oximeters during 2011, and 12,000 in the first two years, through a combination of sales and donations. Ultimately we will target the 70,000 plus operating rooms worldwide without oximeters.

If you are, or you know of, sites and anaesthesia providers who are working without pulse oximeters; if you are able to help us with coordinating distribution; if you would like more information about the project please contact lifebox@anaesthesiologists.org.

Please also watch the WFSA website, www.anaesthesiologists.org, for updates of the work and our website, www.lifebox.org, which will be accessible early in 2011.

Angela Enright and Alan Merry

Using a facemask during anaesthesia

Nicholas Boyd* and Anna Negus
*Correspondence email: nicholasboyd@doctors.org.uk

INTRODUCTION

The facemask has been used since the origins of anaesthesia and it remains an essential and versatile piece of equipment. It offers a simple, non-invasive method for delivering both oxygen and anaesthetic gases and vapours to the patient and it is widely used for both induction and maintenance of general anaesthesia. It is an effective way to ventilate the unconscious patient and therefore also has a major role during resuscitation. Every anaesthetist should be confident in using this piece of equipment.[1]

This article addresses the practical aspects of its use.

Table 1. *Uses of the facemask*

- Pre-oxygenation prior to induction of anaesthesia
- Inhalational induction of anaesthesia
- Bag-mask ventilation (BMV) prior to intubation
- Maintenance of anaesthesia
- BMV during resuscitation
- Non-invasive ventilation for respiratory failure

TYPES OF FACEMASK

The 'facemask' is a general term that includes many different designs, but essentially there are two main types.

The first is an 'open' type, such as the Hudson mask, which is commonly used for delivering supplemental oxygen (Figure 1). It does not require a tight seal against the patient's face and there are often additional holes in the mask to allow expired gases to escape. It cannot therefore be used to ventilate a patient or administer volatile agents safely. In the theatre environment, this type of mask can be used to provide oxygen to a spontaneously ventilating patient during intravenous anaesthesia or sedation and is widely used in recovery areas.

'Closed' facemasks are designed to provide a complete seal around the patient's mouth and nose. This feature allows safe delivery of volatile agents and, if

Figure 1. *A 'Hudson' oxygen mask*

required, for the patient to be ventilated with positive pressure. This type of mask is commonly used during resuscitation and general anaesthesia. Many different designs have been described, all comprising a rim, a body and a connector (Figure 2). The rim is soft and air-filled, allowing a good seal to be formed against the patient's face. Some models have a filling valve to enable the degree of pressure in the rim to be regulated (Figure 2). The body is firmer and may be made of plastic, neoprene or rubber. In some cases a wire stiffener is incorporated to allow the mask to be moulded around the patient's face. The connector is hard plastic or metal and should be of a standard 22mm inner diameter (ID) to allow attachment of connector hosing or a self-inflating bag.

Many facemasks are now made of a transparent plastic which have the benefit of allowing visualisation of skin colour, fogging and signs of regurgitation.[2] In addition, many facemasks also have a plastic or metal ring with hooks to allow the attachment of a harness (Figure 2, label D). In many parts of the world use of a facemask with harness has now been superseded by the laryngeal mask airway.

The internal volume of the mask is part of the apparatus dead space. In the adult, this is relatively insignificant but in the neonate it could constitute 30% of their tidal volume.[3] Therefore masks have been developed to minimise this dead space for paediatric use and various designs are in use today (Figure 3).

Summary

Effective and safe use of the anaesthetic facemask is a core skill of the anaesthetist. It is used less for maintenance of anaesthesia in well-resourced countries, having been largely superseded by the laryngeal mask airway (LMA). In resource poor settings drug and equipment availability have limited use of the LMA and so the choice for airway management in general anaesthesia remains facemask or endotracheal tube. This article outlines the roles of facemasks in anaesthesia and provides advice on overcoming pitfalls in their everyday use.

Nicholas Boyd
Specialist Registrar in Anaesthesia
Derriford Hospital
Plymouth
Devon
UK

Anna Negus
Anaesthetic Fellow
Starship Hospital
Grafton
Auckland
New Zealand
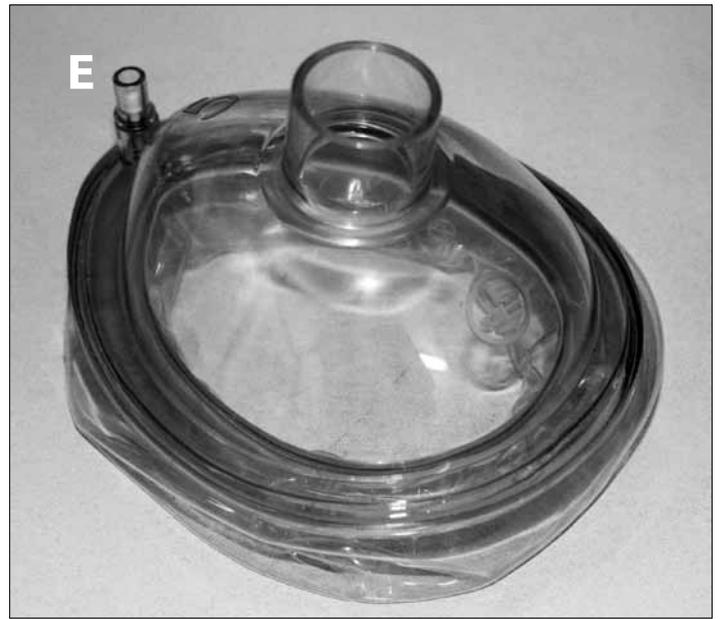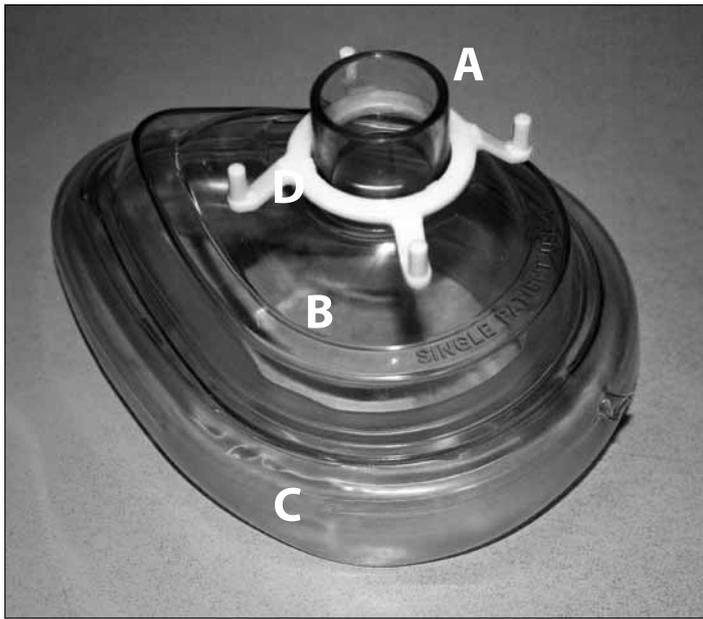
Figure 2. *The parts of an anaesthetic facemask; A - the connector; B - the body; C - the rim; D - hooks for attachment of harness; E - valve for adjusting inflation of rim*

Figure 3. *Some examples of paediatric facemasks*

USES OF THE FACEMASK

The main areas of use for the facemask are listed in Table 1. In addition to holding a facemask correctly for a spontaneously breathing patient, effective bag-mask ventilation (BMV) is an essential skill for the anaesthetist. It is interesting that much attention in airway teaching focuses on tracheal intubation, particularly for patients who are difficult to intubate. However, the severe adverse outcomes that can occur are not due to the inability to place an endotracheal tube but result from a failure to adequately oxygenate the patient. Many guidelines are available for managing these scenarios and central to all the algorithms is adequate oxygenation rather than repeated attempts at intubation.[4] Facemask ventilation remains central to achieving this.

TECHNIQUE FOR USING A FACEMASK

The aim in using an anaesthetic facemask is to ensure a complete seal between the mask and the patient's face whilst exerting the minimum of pressure that may cause soft tissue damage.[1]

First, it is important to choose the correct size for your patient. It should sit over the bridge of the patient's nose with the upper border aligned with the pupils. The sides should seal just lateral to the nasolabial folds with the bottom of the face mask sitting between the lower lip and chin. In the awake patient the mask is held in this position either by hand or by attaching a harness behind the patient's head. Standard sizes are available for adults - a size 3 or 4 will fit most females and size 4 or 5 suits the majority of males.

When the patient is unconscious the airway must be held open whilst maintaining this seal. It is crucial to ensure the airway is patent since gases applied under positive pressure may otherwise insufflate the stomach and increase the risk of aspiration. The most effective method of opening the airway in this setting is to employ a *jaw thrust* technique. This can be achieved by using either a one-handed or two-handed technique.

Jaw thrust

One-handed technique

- Place correct sized mask over the nose and mouth.

- Use your **non-dominant hand** to position the facemask, holding the body of the mask between your thumb and index finger.

- Use your remaining 3 fingers to support the jaw, with your little finger hooked behind the angle of the mandible. Be careful not to place pressure on sub-mandibular soft tissues as this may occlude the airway, especially in paediatric patients

- Lift the mandible **upwards,** towards and into the mask to create an air-tight seal.

- Slight **head extension** may improve airway patency.

- Ventilate the patient with your **dominant hand** by squeezing the bag or using bellows.

- Continually assess the adequacy of the technique by observing bilateral chest movement, listening for air leaks and assessing for signs of inadequate facemask ventilation (Table 2)

Figure 4. *A one-handed technique for applying jaw thrust whilst holding a face mask*

It is advisable that you can perform this task as effectively with your hands reversed since there may be theatres or anaesthesia rooms in your institution where the room set up is opposite to that with which you are familiar.

The main benefit of using a one-handed technique method is that it enables one person to create an air-tight seal with the facemask, leaving the other hand free to ventilate the patient. However, even for the experienced anaesthetist it is not always possible to obtain a good seal while keeping the airway open. In addition, it is tiring for one person to maintain this hand position for any length of time and it can be particularly difficult for people with small hands to reach behind the angle of the jaw. A two-handed technique should therefore be considered early and must not be seen as a sign of failure.

Table 2. *Signs of inadequate facemask ventilation*

- Poor chest expansion.

- Absent or quiet breath sounds.

- Audible gas leak or inability to generate positive pressure with bag.

- Visible gastric insufflation or audible insufflation with stethoscope.

- Absent or poor end-tidal CO_2 trace (if available).

- Patient cyanosis or, if available, low oxygen saturation (<92%).

- Haemodynamic consequences of hypoxaemia or hypercarbia (tachycardia, hyper- or hypotension). **Note that these are late signs.**

Two-handed technique

As with the one-handed technique, the aim is to ensure a complete seal of the mask to the patient's face and maintain airway patency. There are two main approaches for this technique (Figure 5). The first uses a similar approach to the one-handed technique described above, with the additional hand adopting an identical position on the other side of the mask and face (Figure 5a). Alternatively, the mask can be supported with the thumbs while the index and middle fingers hook behind the angle of the jaw (Figure 5b). Whether a one- or two-handed technique is used, it is important to ensure the airway is opened by lifting the mandible towards the mask, rather than applying downwards pressure onto the mask.

DIFFICULT FACEMASK VENTILATION

Facemask ventilation is not always easy. The overall incidence of difficult facemask ventilation is approximately 5% and the patient factors associated with this are shown in Table 3. It is important to look for these factors at preoperative assessment.

Difficult or inadequate ventilation must be identified early. Signs include reduced chest movement, significant air leak, cyanosis, desaturation or haemodynamic deterioration (Table 2). It is important that the anaesthetist recognises this early and has a clear plan to improve the situation. Common problems and solutions are listed in Table 4 and a few are discussed below in more detail.

Use of an oropharygeal (e.g. Guedel) airway can often significantly improve airway patency and many anaesthetists advocate its use routinely for facemask ventilation in unconscious patients. A nasopharyngeal airway can also be used, even in awake patients

where an oropharyngeal airway would not tolerated. The use of these supraglottic airway adjuncts reduces the incidence of difficult BMV to less that 0.5% and therefore should be considered early whenever there is concern about facemask ventilation.[3]

Figure 5. *Two-handed techniques for applying jaw thrust whilst holding a facemask*

Table 3. *Patient factors associated with difficult facemask ventilation[5]*

- Presence of facial hair
- Lack of teeth (edentulous)
- Patients with sunken cheeks
- Obesity (BMI >25)
- History of obstructive sleep apnoea
- Age >55yrs
- History and signs of upper airway obstruction

Older patients tend to have less supportive soft tissues due to a loss of collagen with age and therefore creating an adequate seal around the mask can be difficult. If a one-handed technique is being used, this leak can be particularly marked on contra-lateral cheek. This can be improved by an assistant lifting the skin and soft tissue of this cheek towards the mask rim to create a seal, although opting for a two-handed technique may be more effective. In addition, it is common for this age group to have dentures or a complete absence of teeth (edentulous). If dentures are secure, it is often helpful to leave these in place for face mask ventilation as this helps to support the mouth and prevent the cheeks becoming sunken. However, loose dentures should be removed as they can potentially shift and occlude the airway. For edentulous patients, a recent study has advocated placing the lower pole of the facemask over the lower lip itself, thus reducing the air leak at the cheek.[6]

The presence of facial hair can make it very difficult to create a seal even if there are no other airway problems. A number of techniques have been described to improve the seal. These include applying aqueous gel to the beard underneath the rim of the face mark or using a large occlusive air-tight dressing over the beard with a hole cut for the mouth. However, it may be worth considering a method that would avoid facemask ventilation such as using a laryngeal mask airway or an endotracheal tube.

Finally, if there are preoperative signs and symptoms of upper airway obstruction, face mask ventilation is likely to be difficult and may be impossible. Approach these cases with extreme caution and make a careful anaesthetic plan. A gas induction to maintain spontaneous ventilation before ventilating may be indicated but in severe cases, consider avoiding facemask ventilation altogether by opting for a awake fibreoptic intubation or tracheostomy.

FACEMASK VENTILATION DURING GENERAL ANAESTHESIA

Using a facemask for maintenance of general anaesthesia is common, particularly for short operations or where alternative airway equipment is less available. Many of the techniques described above are relevant in this setting but there are a few additional points to consider.

- Allowing the patient to breath spontaneously has many advantages, especially for longer procedures. Even with a good technique there is likely to be gastric insufflation during positive pressure ventilation which increases the risk of gastric reflux, particularly with pressures over 20cmH$_2$0. The facemask will not protect the airway from aspiration if this occurs. In addition, it reduces the potential for the partial pressure of carbon dioxide (PaCO$_2$) to rise significantly.

- Maintaining the mask seal and keeping the airway open for prolonged periods is tiring. To address this, the facemask can be kept in place by using a harness and an oropharyngeal or nasopharyngeal airway is helpful to maintain airway patency.

- When using breathing circuits that use high pressure gases (such as the Boyle's machine or circle systems) the Adjustable Pressure Limiting valve allows a simple conversion from spontaneous

to positive pressure ventilation. Ensuring the valve is open during spontaneous ventilation will reduce gastric insufflation.

CONCLUSION

The facemask is an essential piece of equipment for anaesthesia and confidence in bag-mask ventilation is a core skill for every anaesthetist. It is important to identify patients who may be difficult to ventilate with a face mask, to recognise early when ventilation is inadequate and to know what steps to take to improve this.

A facemask can be used for maintenance of general anaesthesia and spontaneous ventilation is desirable in this setting. However, it is important to understand the limitations of the technique and in particular that prolonged positive pressure ventilation can lead to gastric insufflation. In addition, the airway remains unprotected from tracheal aspiration. However, the facemask remains a versatile aid to airway management and should be present during every anaesthetic.

When used correctly, it can provide an effective and rapid method for patient ventilation and oxygenation.

REFERENCES

1. Miller, RD. Miller's Anesthesia. 6th ed. Philadelphia, Pa: Elsevier Churchill Livingstone; 2005:1617-25.

2. Stoelting RK, Miller RD. Basics of Anesthesia, 5th Ed. Churchill Livingstone; 2006; 215-6.

3. Moyle J, Davey A Ward's. Anaesthetic Equipment, 4th Ed. Edited by Ward C. WB Saunders Company Ltd; 1998: 139-145.

4. Budd A and Pott L. Management of unanticipated difficult tracheal intubation: routine induction and rapid sequence induction of the non-obstetric patient. *Update in Anaesthesia* 2009; **25,2**: 9-14.

5. Atlee JL. Complications in Anesthesia 2nd Ed. WB Saunders Company Ltd; 2006; 159-73.

6. Racine S, Solis A. Face Mask Ventilation in Edentulous Patients. *Anesthesiology* 2010; **112**: 1190 –3.

Table 4. *Problems and suggested solutions for inadequate facemask ventilation*

Problem	Solutions
Poor mask seal *Indicated by audible leak, poor chest expansion or difficulty generating positive pressure in bag*	• Use two-handed technique and ensure good jaw thrust. • Ask assistant to support soft tissues of cheek around rim of mask. • Consider using an oropharyngeal or nasopharyngeal airway to improve airway patency. • Ensure no leaks in equipment or circuit. • See below for advice on special cases. • If unsuccessful, consider using laryngeal mask airway early.
Partial or complete airway obstruction *Indicated by high airway pressures, poor chest movement, cyanosis or low oxygen saturations*	• Optimize patient head position with slight head extension. • Use two-handed technique and ensure good jaw thrust. • Use an oropharyngeal or nasopharyngeal airway. • Consider possibility of laryngospasm – often giving additional intravenous anaesthetic agent (e.g. propofol) can improve this. • Ensure no occlusion in equipment or circuit – consider reverting to self-inflating bag and mask. • If unsuccessful, consider using laryngeal mask airway early.
SPECIAL CASES **Presence of facial hair**	• Use of aqueous gel or occlusive dressing. • Consider using larygneal mask airway or endotracheal tube early.
Patients with dentures, edentulous patients or sunken cheeks	• Consider leaving dentures in place if secure. • Use oropharyngeal airway and/or nasopharyngeal airway. • Consider placing lower pole of face mask over lower lip itself in edentulous patients. • Ask assistant to support soft tissue of cheeks against mask.
Obese patients	• Pre-oxygenation is essential (with continuous positive pressure if possible) in head up position. • Recognise that facemask ventilation and maintaining adequate oxygenation can be difficult. • When facemask ventilating, keep patient 5-10° head up position, with anaesthetist standing on a platform or step if necessary to achieve this. • Use two-handed technique with oropharyngeal airway. • Endotracheal intubation is often indicated for surgery.

Figure 1. *Anaesthetic Novice Decision Support Algorithm (ANDSA)*

Figure 1. Anaesthetic Novice Decision Support Algorithm (ANDSA)

Update in Anaesthesia
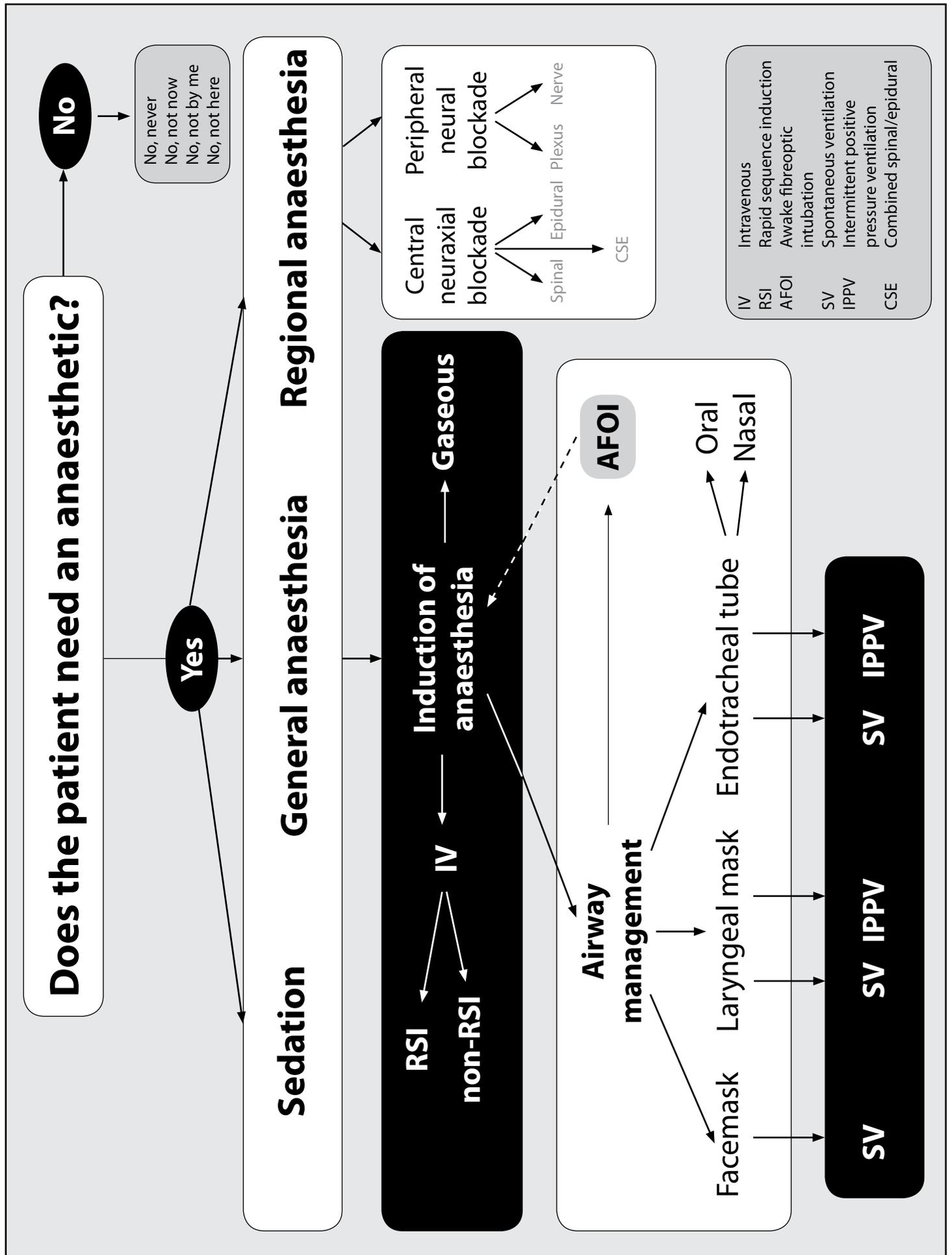
An algorithm to support anaesthetic decision making

Rachel Rogers and Alistair Hellewell*
*Correspondence email: Alistair.Hellewell@rdeft.nhs.uk

INTRODUCTION

On entering anaesthesia novice anaesthetic trainees can be bewildered by the apparent complexity of the specialty. For each patient, you must choose the most appropriate anaesthetic technique after considering patient factors, surgical factors and anaesthetic factors.

The overall goal of training is that you arm yourself with the knowledge and skills to be able to tailor your anaesthetic technique to suit a particular patient having a particular operation, by a particular surgeon. Different senior anaesthetists show some variety in the anaesthetic pathway that they would choose to use and this can lead to confusion for a new trainee.

We present an algorithm that allows the novice trainee to conceptualise the process in a simple, logical and sequential way. We believe it clarifies the apparent complexity of these decisions and allows novice anaesthetists to reach safe and sensible conclusions.

There is undoubtedly a large amount of knowledge that underpins the decisions within the algorithm but we believe it will act as a skeleton on which to hang this knowledge as it is acquired.

Over the 10 years that I (SAH) have used this algorithm as a teaching aid for anaesthesia and critical care trainees, it has received positive feedback suggesting that it helps to clarify certain aspects of anaesthesia in the early stages of training. It is worth pointing out that this algorithm is a framework and neither it nor this article can provide a complete answer for every clinical situation encountered.

The algorithm asks a number of key questions.

DOES THIS PATIENT REQUIRE AN ANAESTHETIC?

To a new trainee, it may feel that once a patient's name is written on the emergency surgery list, there is little that can be done to alter the course of events. As anaesthetists we have a very important overview of the emergency list as we see all the cases, covering different surgical specialties. This gives us a 'moderating role' in the cases listed for theatre and just because a case is listed for theatres does not mean an operation is necessarily in the patient's best interest.

No

Consider why you feel the anaesthetic is not required and qualify your decision, by considering how you would categorise it:

- **No, never**
- **No, not now**
- **No, not by me**
- **No, not here**

The decision that a patient *never* needs this operation should follow a dialogue between several groups or individuals including the surgeons, the anaesthetist, the patient and their family. This decision could be made based on palliation for a terminal disease process, or because the benefits of a proposed operation are outweighed by the risks of the anaesthetic and surgery.

Not now applies to those patients who require either further investigation or optimisation before an operation could be performed safely. This is especially relevant in emergency surgical patients where a period of fluid resuscitation and monitoring (including invasive monitoring) may facilitate safer anaesthesia and surgery.

Not by me describes cases that go beyond your level of competence, experience and confidence as an anaesthetist. You should request senior input that may range from discussion and reassurance to 'hands-on' support in theatre.

No not here applies to specific cases, such as DC cardioversion, endoscopy or radiological procedures especially if the patient presents a particular anaesthetic or physiological risk. They should be moved to a place of safety and familiarity for the anaesthetist.

Yes

If, after thorough assessment of the patient and liaison with their treating team, you feel the procedure and therefore the anaesthetic intervention is indicated, the algorithm can be used to support this process.

Summary
As a new trainee in anaesthesia one of the most important skills to acquire is anaesthetic decision making, in particular choosing the most suitable anaesthetic for a particular patient. We propose an algorithm that allows the novice trainee to conceptualise the process in a simple, logical and sequential way. Using this algorithm, we discuss certain key principles which will help guide these decisions.

Rachel Rogers
Core Trainee in Anaesthesia

S Alistair Hellewell
Consultant Anaesthetist
Royal Devon and Exeter NHS
Foundation Trust
Barrack Road
Exeter EX2 5DW
UK

Anaesthetists have a number of techniques they can use to facilitate operative conditions for each patient's operation. They fall into three broad categories and may be used in isolation or in combination;

- Sedation
- General anaesthesia
- Regional anaesthesia

WOULD LOCAL, REGIONAL OR GENERAL ANAESTHESIA BEST SUIT THIS PATIENT?

There are several factors that determine whether a local, regional or general anaesthetic technique is most appropriate. Examples of surgical, patient and anaesthesia factors are shown in Table 1.

Surgical factors

Clearly the type of operation being planned has a major bearing on the type of anaesthetic that will be most suitable. The location of the operative site is particularly relevant. For example, a distal operation such as an in-growing toe nail removal could be performed under a range of different techniques as shown in Figure 2.

The other factors, listed in Table 1, will influence you in deciding which of these modalities would be most suitable for your patient. For example, if the patient is an anxious young child, you are unlikely to put them through the distress of having the procedure performed under local anaesthetic. Conversely, if they are an adult with major comorbidities, there would be strong indications to choose this option and opting for one of the less invasive techniques would offset the impact of this comorbidity. Similarly, an epidural carries a risk of complications which would generally outweigh the benefits for this minor procedure.

Duration of surgery

A very short minor operation would not demand the long term block afforded by an epidural. Conversely, an operation lasting several hours will not be possible under local anaesthetic. It is not recommended practice to plan to change from one technique to another mid-
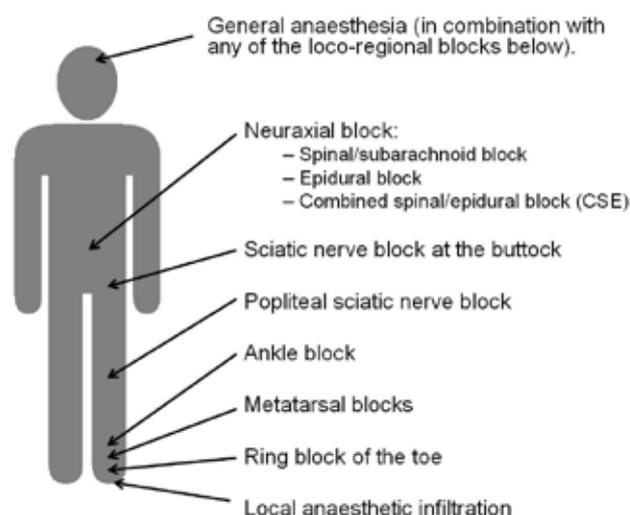

Figure 2. *The options for providing loco-regional anaesthesia for an operation on the big toe, which may be used alone or in combination with general anaesthesia*

procedure (for example proceeding under local or regional block, knowing that the procedure will outlast the block and planning to convert to general anaesthesia when indicated).

Anticipated postoperative course

You must consider and plan for postoperative analgesia - for procedures with significant postoperative pain a long acting method such as a block or epidural may be beneficial. Bear in mind that the attitude of the surgeon and the ward team is important. After total knee arthroplasty many surgeons now plan for their patients to be mobilised on the first postoperative day. For this reason, epidurals and long-lasting nerve blocks are used less in favour of subarachnoid block, often using an opioid additive. In addition, many procedures are now planned as day case surgery; a patient is more likely to be mobile and ready for discharge home more quickly after a general anaesthetic (GA), compared to a spinal or epidural block. Similarly,

Table 1. *Examples of the surgical, patient and anaesthetic factors to consider when planning a patient's anaesthetic*

Surgical factors	Patient factors	Anaesthesia factors
Type and site of surgery	Age	Anticipated difficult intubation
Duration of surgery	Comorbidities	Equipment available
Anticipated postoperative course (day-case or in-patient)	Obesity	Family history (e.g. malignant hyperpyrexia)
Requirement for muscle relaxation	Anatomical considerations	Fasting status, oesophageal reflux etc
'Shared airway' between anaesthetist and surgeon	Patient's preference	Anaesthetist's preference or experience
Likelihood of major blood loss		
Surgeon's preference		

for those at risk of postoperative nausea and vomiting, avoidance of GA or, if unavoidable, using a total intravenous anaesthetic technique that avoids use of anaesthetic agents, would be most appropriate.

Patient factors

Age has a large influence on anaesthetic choice, examples being young children and the comorbidities associated with old age. In the elderly, maintenance of cardiovascular stability during anaesthesia is a priority and the relative cardiovascular risks and benefits of general versus neuraxial anaesthesia must be considered.

Other patient factors which may influence the type of anaesthesia include the body habitus and anatomy of the patient – for example a spinal may be extremely difficult to perform in patients with obesity or arthritic fusion of the spine.

Patient choice is of increasing importance, given that our patients are now generally better informed and have opinions about the available techniques. Prior experience of one technique or other will influence a patient's attitude to experiencing the same technique again. Ultimately, however, the anaesthetist should decide on the most appropriate anaesthetic pathway and explain this to the patient.

For patients with comorbidities that put them at significant risk from general or regional anaesthesia, the necessity of the surgery should be considered. You may try to dissuade a patient with unstable angina from undergoing a cosmetic procedure, but may accept the risks if the same patient presents again needing a bowel resection for colonic carcinoma.

For non-urgent surgery it is essential that all treatable comorbidities are optimised. This will usually involve review by their general practitioner or sometimes referral to a specialist physician. The most commonly encountered comorbid conditions are respiratory, cardiac and endocrine diseases. Cessation of smoking should be strongly advised. For some patients, surgical correction of other conditions may make future anaesthesia and surgery far less risky; examples are angioplasty and stenting for critical coronary artery disease and carotid endarterectomy for carotid stenosis.

A proportion of patients will require repeat investigations for known conditions or new investigations for previously undiagnosed comorbidities. For example, patients diagnosed with bronchial carcinoma commonly have obstructive airways disease and respiratory function tests are useful to make the diagnosis, assess the severity of the disease and also to gauge the response to a trial of steroids.

Anaesthetic factors

Airway and breathing

If you have concerns about difficult intubation, this may sway your decision in favour of a local or regional anaesthetic technique. It is, however, still important to have a plan in case general anaesthesia is subsequently required, for example following a high neuraxial block or anaphylaxis following local anaesthesia.

Regional anaesthesia

The anaesthetist's preference and experience is important, but where a particular block would be best, it is advisable to seek assistance from a colleague if you are not personally proficient in that technique, rather than persisting with a less suited type of anaesthetic. An example of this situation is to perform mastectomy in an awake patient under paravertebral block, where GA would be hazardous due to severe respiratory disease. Time constraints of theatre lists can be significant and may require logistical arrangements in order to allow a block adequate time to work before surgery commences.

Risks of regional anaesthesia

Some patients have conditions that relatively or absolutely preclude regional or neuraxial anaesthesia. For example, spinal anaesthesia is hazardous in patients with severe aortic stenosis, and neuraxial blocks create a risk of spinal canal haematoma in patients taking combined antiplatelet drugs.

In addition there is a list of potential adverse effects of these procedures, including nerve damage, haemorrhage, infection and local anaesthetic toxicity. Informed consent, summarizing these risks, should be sought prior to a regional technique.

PLANNING A GENERAL ANAESTHETIC

If you have decided that general anaesthesia best suits your patient for the planned procedure, then there are further decisions which must be made.

1.   Mode of induction
2.   Airway management plan
3.   Mode of ventilation.

Mode of induction of anaesthesia

There are 4 options here:

Rapid sequence induction (RSI)
- The patient has a significant risk of aspiration of stomach contents into the respiratory tract, due to either a full stomach or a high regurgitation risk (hiatus hernia, pregnancy).

Standard intravenous induction
- For patients who are starved with low risk of reflux.

Inhalational induction
- Usually for children where obtaining IV access is not possible or too distressing.

- For adults with needle phobia.

- Useful for emergency anaesthesia where the airway is compromised by swelling due to infection (e.g. epiglottitis).

Awake fibreoptic intubation (AFI) - see article on page 27
- Where airway difficulties are anticipated or known.

- This ensures that the airway is secured before spontaneous ventilation is abolished.

Airway maintenance

The options for airway maintenance are heavily influenced by the decisions made concerning spontaneous breathing or ventilation.

- *Facemask*
  +/- oropharyngeal or nasopharyngeal airway.

- *Laryngeal Mask Airway (LMA)*
  Use of the LMA is not widespread in poorly resourced centres, as it is difficult to use effectively without propofol, which obtunds laryngeal reflexes and allows LMA insertion very effectively.

- *Variant of the classic LMA - Proseal™ or LMA supreme™*
  These devices include an oesophageal port so regurgitation will be quickly visible and can be managed accordingly. They also have an altered cuff profile that allows a better seal around the laryngeal opening, allowing more effective IPPV and lowering the threshold for using an LMA in overweight patients.

- *Endotracheal tube (ETT)*
  The gold standard for airway control, the ETT may be inserted orally or nasally and may be cuffed or uncuffed.

There are certain pairings from the above options which work particularly well together and these will form your most frequently used anaesthetic combinations. The first of these is the spontaneously breathing LMA anaesthetic and the second is the ventilated intubated anaesthetic, indicated in the shaded portions of Table 2.

Although this table highlights that the majority of anaesthetics fit into the two main categories, there is considerable scope for tailoring your anaesthetic to meet the particular requirements for each patient. In the early part of an anaesthetist's career it is advisable to stick to simple techniques. Part of becoming a more senior anaesthetist is that you develop the ability to refine your technique depending on patient and surgical factors. For example, most would intubate and ventilate a patient for a laparoscopic sterilisation, however, if working on a weekly basis for a surgeon who completes the procedure in 10 minutes, it is reasonable to use a ventilated LMA anaesthetic for slim, fit patients.

Mode of ventilation

Spontaneous breathing or controlled ventilation

The decision to employ spontaneous ventilation (SV) or intermittent positive pressure ventilation (IPPV) is closely linked to your choice of airway (see above).

CASE EXAMPLE

The following is a fairly complex example, with multiple pathologies and factors to consider and weigh against each other. The conclusion is hopefully a pragmatic solution but any of the techniques suggested

Table 2. *Broad classification of general anaesthesia techniques*

	SV	IPPV
Face mask/ LMA	A common combination	Most supraglottic airway devices work very well with paralysis and ventilation. Many studies comparing these devices assess them under these conditions.
ETT	• Some degree of muscle relaxation is generally used (but not essential) to facilitate tracheal intubation. • With deep anaesthesia ETT is tolerated. • Popular where long-acting neuromuscular blockers are not available.	Commonly used for the indications in Table 3.

Table 3. *Examples of factors to consider when deciding if a GA should be spontaneously breathing or ventilated*

Factors	Spontaneously breathing		IPPV	
Surgical	*ENT*	Surgeon wishes to assess vocal cord function under GA	*Muscle relaxation required*	Laparotomy, large paraumbilical hernia repair, reduction of dislocated THR)
	Avoidance or neuromuscular block	Localisation of facial nerve during parotidectomy	*Ventilatory support required*	One lung anaesthesia for thoracic surgery
			CO_2 control	Neurosurgery
Patient	*Obesity*	Limits the duration of SV (hypoxia more likely)	*Full stomach, reflux disease*	Endotracheal tube required (and so usually IPPV)
	Respiratory disease	If peripheral surgery, SR may be better tolerated for short procedures	*Respiratory disease*	Copious secretions may require suction of secretions (bronchiectasis)
Anaesthetic	*Anticipated difficult intubation*	Rheumatoid arthritis affecting cervical spine		

may be successful depending on the anaesthetist's experience and skills, the surgical technique and duration, and the desires and beliefs of the patient.

> A 66-year-old woman has a gangrenous foot and lower leg and she requires an above knee amputation. She has rheumatoid arthritis and severe COPD with saturations of 88% on air. Her exercise tolerance is 10-20 yards and respiratory function tests have shown her FEV_1 (forced expiratory volume in one second) to be 0.7 litres (37% of her predicted value). She required ventilation for 3 days after general anaesthesia for a hernia repair 2 years ago. Two coronary stents were inserted 4 months ago for unstable angina.
>
> She has an ejection systolic murmur and an echocardiogram has confirmed moderately severe aortic stenosis (gradient of 77mmHg) and a hypertrophied ventricle with good systolic function. She took clopidogrel and aspirin until 4 days ago. Your job is to give her an anaesthetic.

DISCUSSION

It is sensible and useful to discuss cases such as these with a colleague and even to share the responsibility of the anaesthetic with a second anaesthetist.

This is not a case for a trainee surgeon. The case should be completed as quickly as possible by a senior surgeon.

Does she need an anaesthetic?
She has a condition that will worsen without surgical attention and she will become less fit as sepsis develops. The surgeons have opted for an amputation as definitive surgery and so we should do our utmost to facilitate this.

General or regional anaesthesia?
In this case there are factors in favour of both a general or regional technique. The factors that push us away from embarking on a general anaesthetic are:

1. *Severe COPD*. Her respiratory disease is severe based on her functional ability and the respiratory function tests. Her FEV_1 is such that her cough may be poor postoperatively - there is no absolute figure that predicts this but a reading less than 40% of the predicted value for height and weight is a risk factor for postoperative complications.[1] Of note she needed a period of ventilation after previous minor surgery and this is likely to be the case again.

2. *Rheumatoid arthritis*. She may have cervical spine disease (atlanto-axial subluxation) and there is a risk that laryngoscopy may cause cervical cord damage.

The factors that are against regional anaesthesia are:

1. *Moderately severe aortic stenosis*. The vasodilatation resulting from a single-shot subarachnoid block is likely to cause profound hypotension in patients with significant aortic stenosis. The loss of afterload caused by sympathetic blockade will impair diastolic

coronary blood flow. In addition her hypertrophied left ventricle is more at risk of ischaemia during periods of hypotension.

2. *Antiplatelet therapy*. She is taking dual antiplatelet therapy. It is usually recommended that clopidogrel is stopped 7 to 10 days prior to neuraxial block.

So our options are:

1. General anaesthesia

One approach would be to recognise that she has a risk of postoperative respiratory difficulties, and plan for her to be admitted to a high-dependency area postoperatively. This will be strongly influenced by the resources available for postoperative ventilation, should the need arise.

Induction would be hazardous in view of her aortic stenosis and invasive blood pressure monitoring would be desirable. A vasopressor agent should be available and drawn-up. Where no vasopressor agent is available, ketamine is probably the induction agent of choice, although the tachycardic side effects of this drug are not ideal in aortic stenosis.

Airway management / SV or IPPV

If she tends to produce a large amount of sputum, tracheal intubation to aid suction of secretions is preferred. Her cervical spine should be managed with caution, avoiding excessive flexion or extension. If sputum is minimal a face mask or LMA anaesthetic, with spontaneous breathing should be adequate.

We should avoid large doses of opioids, so ask the surgeon to insert a wound catheter to administer local anaesthetic postoperatively.

2. Regional anaesthesia

Nerve blocks

A combination of femoral and sciatic nerve blocks may not provide sufficient cover of the surgical field to avoid general anaesthesia. Performing a lumbar plexus block in place of the femoral nerve block would improve this, but this block is more invasive and is relatively contraindicated with antiplatelet drugs such as clopidogrel.[2]

Neuraxial block

A single shot subarachnoid block with this degree of aortic stenosis would probably cause considerable hypotension. A spinal catheter would allow titrated administration of the subarachnoid block and consequently improved haemodynamic stability (see case series on page 45 of this edition of *Update*). Epidural anaesthesia is an option to consider, but the block may be less reliable for awake surgery than a subarachnoid block.

There is a risk of bleeding and haematoma formation with all of these regional techniques and the risk of this must be weighed against the benefits of avoiding a general anaesthetic in this patient. The patient must be monitored very carefully for symptoms and signs of spinal cord haematoma and compression postoperatively.

We decided that the risk of a bleeding complication from a neuraxial block was strongly outweighed by the anticipated difficulties of general anaesthesia. We felt that a spinal catheter technique would minimise the haemodynamic consequences of neuraxial block.

We opted to insert a spinal catheter, which was uneventful. With the patient lying with the operative leg down, three doses of 1.0ml 0.5% hyperbaric bupivacaine were administered at 15 minute intervals. A good unilateral block was achieved. Metaraminol (a vasopressor α-agonist) was available but there was no significant drop in blood pressure (invasively monitored). Above knee amputation was performed by a senior surgeon and completed in 1 hour.

We removed the catheter in the postoperative period, in order not to mask spinal cord haematoma and we infused bupivacaine via a surgically-placed wound/stump catheter for 3 days postoperatively.

The patient made an uneventful recovery.

Invasive blood pressure monitoring is desirable for a neuraxial technique in view of the degree of aortic stenosis.

CONCLUSION

The aim of ANDSA is to aid novice anaesthetic trainees to clarify and simplify some of the decision making that can appear complex on entering the speciality. We would welcome feedback and suggestions for improvement.

REFERENCES

1. Portch D, McCormick B. Pulmonary function tests and assessment for lung resection. *Update in Anaesthesia* 2009; **25,1:** 13-21. Available at: http://update.anaesthesiologists.org/wp-content/uploads/2009/10/Pulmonary-Function-Tests-and-Lung-Resection.pdf

2. Barker J, Telford R, Bolton T. Perioperative management of antiplatelet drugs. *Update in Anaesthesia* 2010; **26**: 5-8. Available at: http://update.anaesthesiologists.org/wp-content/uploads/2011/03/Perioperative-management-of-antiplatelet-drugs.pdf

IMPORTANT NOTICE

Periodically we need to check that *Update in Anaesthesia* is being posted to the correct recipients. If you wish to continue receiving the journal please send the following details to us:

Name

Institution

Postal address

Email address *(if you have one)*

Number of recipients wishing to receive *Update* at this address

Please send this information:

By email to: **worldanaesthesia@mac.com**

or by mail to: Carol Wilson
Pound Cottage
Christow
Exeter
EX6 7LX
United Kingdom

Management of bronchospasm during general anaesthesia

Alex Looseley
Correspondence email: alex.looseley@nhs.net

INTRODUCTION

Bronchospasm during general anaesthesia can present in isolation or as a component of a more serious underlying pathology such as anaphylaxis. It is characterised by prolonged expiration, wheeze and increased peak airway pressures during Intermittent Positive Pressure Ventilation (IPPV). Untreated it can cause hypoxia, hypotension and increased morbidity and mortality. Suspected bronchospasm during anaesthesia should be assessed and treated promptly. Ongoing management should address the underlying cause.

BRONCHOSPASM

Bronchospasm and wheeze are common features of *reactive airways disease*. Patients with bronchial asthma and some with chronic obstructive pulmonary disease (COPD) show hyperreactive airway responses to mechanical and chemical irritants. In these groups there is a combination of constriction of bronchial smooth muscle, mucosal oedema and mucous hypersecretion with plugging. Perioperative bronchospasm in patients with reactive airways disease is however relatively uncommon. In patients with well-controlled asthma and COPD the incidence is approximately 2%. The overall incidence of bronchospasm during general anaesthesia is approximately 0.2%.[1]

Exposure to tobacco smoke, history of atopy and viral upper respiratory tract infection (URTI) all increase the risk of bronchospasm during anaesthesia. In many patients with bronchospasm during anaesthesia there is no history of reactive airways disease.

RECOGNITION OF BRONCHOSPASM

Bronchospasm during anaesthesia usually manifests as prolonged expiration. An associated expiratory wheeze may be auscultated in the chest or heard in the breathing circuit. Wheezing requires movement of gas through narrowed airways and so in severe bronchospasm wheeze may be quiet or absent. Similarly, breath sounds may be reduced or absent. With IPPV, peak airway pressures are increased, tidal volumes reduced, or both. Bronchospasm is not the only cause of wheeze or increased peak airway pressures during anaesthesia (Boxes 1 and 2). With capnography, narrowed airways and prolonged expiration result in a delayed rise in end-tidal carbon dioxide, producing a characteristic 'shark-fin' appearance (Figure 1). However, this is not diagnostic, representing an obstruction at some stage in the expiratory pathway. With limitation in air flow, a prolonged period of exhalation is needed for alveolar pressure to normalise. Positive pressure ventilation delivered before exhalation is complete can result in 'breath-stacking' and the development of an intrinsic (or auto) positive end-expiratory pressure (iPEEP or autoPEEP). Intrinsic PEEP can increase intrathoracic pressure, decrease venous return and impair cardiac output.[2]
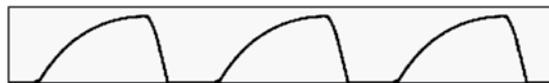

Figure 1. *The characteristic 'shark-fin' capnograph suggestive of airway obstruction*

Box 1. *Causes of wheeze during general anaesthesia*

Partial obstruction of tracheal tube (including ETT abutting the carina or endobronchial intubation)

Bronchospasm

Pulmonary oedema

Aspiration of gastric contents

Pulmonary embolism

Tension pneumothorax

Foreign body in the tracheobronchial tree

Box 2. *Causes of increased peak airway pressure during IPPV*

Anaesthetic equipment
    Excessive tidal volume
    High inspiratory flow rates

Airway device
    Small diameter tracheal tube
    Endobronchial intubation
    Tube kinked or blocked

Patient
    Obesity
    Head down position
    Pneumoperitoneum
    Tension pneumothorax
    Bronchospasm

Summary

Bronchospasm is a relatively common event during general anaesthesia. Management begins with switching to 100% oxygen and calling for help early. Stop all potential precipitants and deepen anaesthesia. Exclude mechanical obstruction or occlusion of the breathing circuit. Aim to prevent/correct hypoxaemia and reverse bronchoconstriction. Consider a wide range of differential diagnoses including anaphylaxis, aspiration or acute pulmonary oedema.

Alex Looseley
Core Trainee
Department of Anaesthesia
Royal Devon and Exeter NHS
Foundation Trust
Barrack Road
Exeter EX5 1JT
UK

DIFFERENTIAL DIAGNOSIS

Bronchospasm occurs most commonly and approximately equally during the induction and maintenance stages of anaesthesia and is less often encountered in the emergence and recovery stages.[3] Bronchospasm during the induction stage is most commonly caused by airway irritation, often related to intubation.

During the maintenance stage of anaesthesia, bronchospasm may result from an anaphylactic or serious allergic reaction. Drugs (antibiotics, neuromuscular blockers), blood products (red blood cells, fresh frozen plasma) and other allergens (latex) are the agents commonly responsible. Other features of allergic or anaphylactic reaction include cutaneous signs (rash, urticaria, angioedema) and cardiovascular signs (tachy/bradycardia, hypotension, circulatory collapse).

When assessing bronchospasm there are other important differential diagnoses and contributing factors to consider:

Mechanical obstruction

A kinked (see case report in this edition), blocked (mucous plug, cuff herniation) or misplaced (endobronchial, oesophageal) tracheal tube or occlusion in the breathing circuit can mimic severe bronchospasm. Unless rapidly recognised and corrected this can have disastrous consequences. A recent death in the UK (initially treated as severe bronchospasm) was found to be due to blockage of the breathing circuit with the protective cap from an IV giving set. The subsequent Department of Health report 'Protecting the Breathing Circuit in Anaesthesia' (2004) reiterated the importance of checking the breathing circuit prior to each patient and ensuring the availability of another means of ventilation (i.e. a self-inflating bag).[4]

Laryngospasm

This should be considered and excluded. In non-intubated patients acute laryngospasm can produce upper airway noise (usually inspiratory), reduced breath sounds and difficulty in ventilation. Laryngospasm can present with signs of airway obstruction including increased respiratory effort, tracheal tug and paradoxical movement of the chest and abdomen ('see-saw' respiration).

Bronchial hyperreactivity

If the patient is known to be at increased risk of bronchial hyperreactivity the suspicion of bronchospasm is increased. The main patient groups are those with reactive airways disease, especially poorly controlled asthma and COPD. Bronchial hyperreactivity is also associated with preoperative exposure to tobacco smoke, upper respiratory tract infection (URTI) and a history of atopy. Many of these factors also predispose to laryngospasm.

Inadequate depth of anaesthesia

Manipulation of the airway or surgical stimulation under light anaesthesia increases the risk of bronchospasm. Certain surgical procedures have highly stimulating stages that can trigger bronchospasm (and laryngospasm). Examples of these include anal or cervical dilatation, stripping of the long saphenous vein during varicose vein surgery and traction on the peritoneum. These are often predictable and can be prevented or countered by an intravenous bolus of opioid and/or anaesthetic agent such as propofol.

Pharmacological

Certain volatile anaesthetic agents (isoflurane, desflurane) if introduced quickly can trigger bronchospasm. IV agents including beta-blockers, prostaglandin inhibitors (NSAIDs) and cholinesterase inhibitors (neostigmine) are implicated. Histamine release (thiopentone, atracurium, mivacurium, morphine, d-tubocurarine) can also precipitate bronchospasm; care should be taken with these drugs in higher risk patients.

Airway soiling

Unexplained bronchospasm, especially in patients without increased risk of airway hyperreactivity, should prompt consideration of airway soiling due to secretions, regurgitation or aspiration. This is particularly true with the use of the laryngeal mask airway (LMA) but may also occur with an uncuffed endotracheal tube (ETT) or an inadequately inflated/punctured cuff. A history of gastro-oesophageal reflux or sudden coughing in a patient breathing spontaneously with an LMA should increase the suspicion of airway soiling.

PREVENTION OF BRONCHOSPASM

Patients with asthma and COPD should be thoroughly assessed and care taken to ensure they are optimised for surgery. Wheezing, cough, increased sputum production, shortness of breath and diurnal variability in peak expiratory flow rate (PEFR) indicate poor control. Recent or frequent exacerbations or admission to hospital may be an indication to postpone non-essential surgery. Patients should be encouraged to continue their medication until the time of surgery. Preoperative bronchodilators, inhaled or oral corticosteroids, chest physiotherapy and referral to a respiratory physician may all be appropriate.

A careful medication history should be taken with particular reference to drug sensitivities. NSAID-induced bronchospasm in adult asthmatics may be as high as 15% and so a thorough history is vital.[5]

All patients should be counselled and encouraged to stop smoking preoperatively. Six to eight weeks of abstinence before surgery significantly reduces the risk of respiratory complications including bronchospasm.[6]

URTI in children increases the risk of bronchospasm and so it may be necessary to postpone surgery. The complete resolution of symptoms (approximately 2 weeks) correlates well with a decreased incidence of airway hyperreactivity.[7]

Pretreatment with an inhaled/nebulised beta agonist, 30 minutes prior to surgery, induction of anaesthesia with propofol and adequate depth of anaesthesia before airway instrumentation reduces the risk of bronchospasm.

The use of an LMA (in suitable patients) has been shown to reduce the incidence of bronchospasm compared to tracheal intubation.[8] Regional techniques where appropriate can also avoid the need for general anaesthesia and intubation.

Figure 2. *Algorithm to guide management of intraoperative bronchospasm. Red numbers refer to notes over leaf.*

Management of patient with suspected bronchospasm during general anaesthesia

A

On suspecting bronchospasm
- Switch to 100% oxygen
- Ventilate by hand
- Stop stimulation / surgery
- Consider allergy / anaphylaxis; stop administration of suspected drugs / colloid / blood products

Difficulty with ventilation/falling SpO$_2$ **CALL FOR HELP**

B

Immediate management; prevent hypoxia & reverse bronchoconstriction
- Deepen anaesthesia **1**
- If ventilation through ETT difficult/impossible, check tube position and exclude blocked/misplaced tube **2**
- If necessary eliminate breathing circuit occlusion by using self-inflating bag
- In non-intubated patients exclude laryngospasm and consider aspiration
- DRUG THERAPY; see Box D **3**

Consider transfer to HDU / ICU

C

Secondary management, provide ongoing therapy and address underlying cause
- Optimise mechanical ventilation
- Reconsider allergy/anaphylaxis - expose and examine the patient, review medications
- If no improvement consider pulmonary oedema/pneumothorax/pulmonary embolus/foreign body
- Consider abandoning / aborting surgery
- Request & review chest X-ray
- Consider transfer to a critical care area for ongoing investigations and therapy

D

1st Line Drug Therapy	2nd Line Drug Therapy
Salbutamol	**Ipratropium bromide:** 0.5mg nebulised 6 hourly
• Metered Dose Inhaler: 6-8 puffs repeated as necessary (using in-line adaptor/barrel of 60ml syringe with tubing or down ETT directly)	**Magnesium sulphate**: 50mg.kg^{-1} IV over 20min (max 2g)
	Hydrocortisone: 200mg IV 6 hourly
• Nebulised: 5mg (1ml 0.5%) repeated as necessary	**Ketamine**: Bolus 10-20mg. Infusion 1-3mg.kg^{-1}.h^{-1}
	IN EXTREMIS: Epinephrine (Adrenaline)
• Intravenous: 250mcg slow IV then 5mcg.min^{-1} up to 20mcg.min^{-1}	**Nebulised**: 5mls 1:1000
	Intravenous: 10mcg (0.1ml 1:10,000) to 100mcg (1ml 1:10,000) tirtrated to response

Follow up. If a serious allergic/anaphylactic reaction was suspected or identified the anaesthetist must ensure the patient is referred to a specialist allergy/immunology centre for further investigation. The patient, surgeon and general practitioner should also be informed.

MANAGEMENT OF BRONCHOSPASM - Figure 2

Notes on the algorithm

1. Increasing the inspired concentration of all volatile anaesthetic agents will produce bronchodilatation (the exception is desflurane, which at higher alveolar concentrations has been shown to increase airway resistance[9]). If bronchospasm is severe, the effective delivery of volatile anaesthetic agents will be difficult. An intravenous agent may be necessary and propofol is desirable as it obtunds airway reflexes to a greater degree than thiopentone. If propofol is not available, ketamine is widely available and produces bronchodilatation.

2. Exclude oesophageal/endobronchial intubation. Consider a kinked tube or obstruction caused by secretions, mucous, cuff herniation, or the tube abutting the carina. A suction catheter may be passed down the tracheal tube to assess patency and clear secretions.

3. Box D covers in more detail the main agents used to treat acute bronchospasm. In the first instance treatment is with an inhaled beta agonist such as salbutamol. This can be repeated several times or given 'back-to-back'. Administration must be downstream of the heat and moisture exchange filter (HMEF) and can be with an in-line adaptor (Figure 3), nebuliser, or if these are not available, the metered dose inhaler (MDI) can be placed in the barrel of a 60ml syringe, the plunger replaced and a 15cm length of IV tubing attached to the end by Luer lock (Figure 4). This tubing is then fed down the ETT and reduces the deposition of aerosol on the tracheal tube. As an emergency, the MDI can be discharged directly down the ETT although much of the aerosol will not reach the patient's airways.

Salbutamol can also be given intravenously. Anticholinergic drugs such as inhaled ipratropium bromide block parasympathetic constriction of bronchial smooth muscle. In unresponsive bronchospasm, consider the use of epinephrine (adrenaline), magnesium sulphate, aminophylline, or ketamine.

Figure 3. *A metered dose inhaler (MDI) adaptor fitted in the breathing circuit, on the patient side of the heat and moisture exchanger. Depress the canister by hand during inspiration to administer the drug*

Table 1. *Drug doses for use in bronchospasm*

Drug	Adult dose	Paediatric dose
Salbutamol	*MDI* (metered dose inhaler) 6-8 puffs *Nebulised* - 1ml 0.5% (5mg) *IV* - 250mcg slow IV then 5mcg.min^{-1} up to 20mcg.min^{-1}	*MDI* 6-8 puffs *Nebulised* <5yrs 2.5mg, >5yrs 2.5-5mg *IV* – 4mcg.kg^{-1} slow IV then 0.1-1mcg.kg^{-1}.min^{-1}
Epinephrine (Adrenaline)	*IV* - 10mcg-100mcg (0.1-1.0 ml 1:10,000) titrated to response *IM* – 0.5-1.0mg if no IV access *Nebulised* 5ml 1:1000	*IV* – 0.1-1.0mcg.kg^{-1} (0.01- 0.1ml.kg^{-1} of 1:100,000) *IM* - <6 months 50mcg, 6 mths-6yrs 120mcg, 6-12 yrs 250mcg, >12yrs 500mcg *Nebulised* 0.5ml.kg^{-1} 1:1000 (max 5mls)
Ipratropium bromide	*Nebulised* 0.5mg 6 hourly	*Nebulised* (2-12yrs) 0.25mg 6 hourly
Magnesium sulphate	2g IV over 20min (unlicenced)	50mg.kg^{-1} IV over 20min (max 2g, unlicensed)
Ketamine	Infusion: 1-3mg.kg^{-1}.h^{-1} Bolus dose: 10-20mg	Infusion: 1-3mg.kg^{-1}.h^{-1}
Aminophylline	5mg.kg^{-1} IV over 20min then 0.5mg.kg^{-1}.h^{-1} infusion Omit loading dose if taking theophylline	5mg.kg^{-1} IV over 20min then 1mg.kg^{-1}.h^{-1} (<9yrs), 0.8mg.kg^{-1}.h^{-1} (9-16yrs) infusion Omit loading dose if taking theophylline
Hydrocortisone	200mg IV 6 hourly	<1yr 25mg, 1-5yrs 50mg, 6-12yrs 100mg 6 hourly
Chlorphenamine	10mg slow IV	<6 months 250mcg.kg^{-1} IV, 6 months-6yrs 2.5mg IV, 6yrs-12yrs 5mg IV

Figure 4. *An MDI canister can be placed in the barrel of a 60ml syringe and a 15cm length of IV tubing attached via the Luer lock. Feed the tubing down the ETT and press the plunger to administer the drug, then reconnect the breathing circuit and ventilate*

SECONDARY MANAGEMENT

The secondary management of acute bronchospasm should provide ongoing therapy and address the underlying cause. Corticosteroids and antihistamines (Box D) have a role in the secondary treatment of bronchospasm and should be given early if the problem is not settling with initial measures.

Further consideration should be given to allergy/anaphylaxis and a thorough examination made for cutaneous and cardiovascular signs. Review the medication history and consider all drugs given in the perioperative period. Examine the patient and reconsider alternative diagnoses such as acute pulmonary oedema, tension pneumothorax, pulmonary embolism or foreign body.

If the indication for surgery is not life-threatening, consider abandoning surgery, especially if there is ongoing difficulty with ventilation, falling oxygen saturations or haemodynamic compromise. In a non-intubated patient with severe bronchospasm, it may be necessary to intubate the trachea and mechanically ventilate the lungs while therapy is initiated. If this is the case then avoidance of histamine release is important and an appropriate muscle relaxant should be used (e.g. rocuronium or vecuronium if available).

If the bronchospasm has resolved or improved with initial management, so that there is no ongoing compromise of the respiratory or cardiovascular systems, it may be appropriate to wake the patient and provide any subsequent therapy on the recovery ward.

Mechanical ventilation

The primary aim of mechanical ventilation in acute bronchospasm is to prevent or correct hypoxaemia. Tidal volumes may need to be reduced to avoid high peak airway pressures and barotrauma.

Hypercapnia is tolerated if oxygenation is adequate, as long as severe acidosis does not develop (pH<7.15).

Ventilation should incorporate a long expiratory time to allow complete exhalation and reduce 'breath-stacking' and intrinsic PEEP. Intrinsic PEEP can increase intra-thoracic pressure, decrease venous return and cause hypotension. Minimising intrinsic PEEP is best achieved with a slow respiratory rate, an inspiratory:expiratory ratio of at least 1:2. If bronchospasm is severe, only 3-4 breaths per minute may be possible if you allow full expiration - it is useful to either auscultate or listen at the end of the disconnected endotracheal tube to confirm that expiration has finished, before commencing the next breath. Rarely, to facilitate this, it is necessary to apply manual external pressure to the chest. There is no consensus on application of (external) PEEP, but many advocate trying to match the applied PEEP to the estimated iPEEP.

POSTOPERATIVE CARE

With ongoing symptoms a chest radiograph should be requested and reviewed to exclude pulmonary oedema and pneumothorax. If appropriate, regular therapy (bronchodilators, corticosteroids, chest physiotherapy) should be arranged. With ongoing bronchospasm, arrangements should be made for the patient to go to a high dependency or intensive care unit.

In the event that a serious allergic or anaphylactic reaction was identified or suspected, remember to take samples for mast cell tryptase. It is the responsibility of the anaesthetist to ensure the patient is referred to a specialist allergy/immunology centre for further investigation. The patient, surgeon and general practitioner should also be informed.

REFERENCES

1. Olsson GL. Bronchospasm during anaesthesia. A computer-aided incidence study of 136,929 patients. *Acta Anaesthesiol Scand* 1987; **31**: 244-52.

2. Pepe PE, Marini JJ. Occult positive end-expiratory pressure in mechanically ventilated patients with airflow obstruction: the auto-PEEP effect. *Rev Respir Dis* 1982; **126**: 166-70.

3. Westhorpe RN, Ludbrook GL, Helps SC. Crisis management during anaesthesia: bronchospasm. *Qual Saf Health Care* 2005; **14**: e7.

4. Department of Health 2004. Protecting the Breathing Circuit in Anaesthesia--Report to the Chief Medical Officer of an Expert Group on Blocked Anaesthetic Tubing Available from: www.dh.gov.uk

5. Szczeklik A, Stevenson D. Aspirin-induced asthma: Advances in pathogenesis, diagnosis, and management. *J Allergy Clin Immunol* 2003; **111**: 913–21.

6. Dudzińska K, Mayzner-Zawadzka E. Tobacco smoking and the perioperative period. *Anestezjol Intens Ter* 2008; **40**: 108-13.

7. Nandwani N, Raphael JH, Langton JA. Effects of an upper respiratory tract infection on upper airway reactivity. *Br J Anaesth* 1997; **78**: 352-5.

8. Kim ES, Bishop MJ. Endotracheal intubation, but not laryngeal mask airway insertion, produces reversible bronchoconstriction. *Anesthesiology* 1999; **90**: 391-4.

9. Dikmen Y, Eminoglu E, Salihoglu Z, Demiroluk S. Pulmonary mechanics during isoflurane, sevoflurane and desflurane anaesthesia. *Anaesthesia* 2003; **58**: 745–48.

Update in
Anaesthesia

Inserting peripheral intravenous cannulae – tips and tricks

Eoin Harty
Correspondence email: eoin.harty@rdeft.nhs.uk

Summary

The insertion of intravenous catheters is one of the most frequently performed procedures by anaesthetists. It is one of the major concerns of patients and can also provoke a significant stress response.[1] This article describes different types of cannula, troubleshoot common problems with cannula insertion and consider how and when to use local anaesthetic drugs in adults.

INTRODUCTION - CATHETERS, CANNULAS AND 'VENFLONS®'

The terminology used to describe peripheral intravenous (IV) access can be confusing to the newcomer. 'Cannula' and 'catheter' both mean exactly the same thing – a flexible tube inserted into the body to administer or withdraw fluids or to keep another tube patent. Venflon® is a trade name common in the United Kingdom. All of these terms are used interchangeably in anaesthetic rooms and operating theatres. In this article **cannula** will mean the whole instrument and **catheter** to refer to just the plastic tube that remains after withdrawal of the needle part of the cannula.

WHAT SIZE CANNULA SHOULD I CHOOSE?

The calibre of the needle within the cannula is expressed as a Stubs iron wire gauge and illustrated in the Table 1, along with maximal flow rates through the catheter. The flow rate through the catheter is proportional to the fourth power of the radius (r^4 - a simplification of Poiseuille's equation).

Unfortunately different manufacturers use different colour schemes, so it is important to know the sizes and the flow rates in your hospital. Also bear in mind that flow rate varies inversely with the length of the cannula, meaning that '*short and thick does the trick*' if rapid infusion of fluid is required.

The size that you select depends on the indication for cannulation in a particular patient. Fluid and drug infusions can be run through any size cannula. Administration of fluid in shocked adult patients needs to be done rapidly, so an 18G or larger cannula is required. Non-urgent blood transfusion can be reliably achieved through 18G cannulae and larger, though some units use 20G cannulae.

PRACTICAL TECHNIQUE FOR CANNULA INSERTION

The technique of cannula insertion can be taught in many different ways. The following is a combined account of techniques the author has been taught that has been modified with experience.

1. Prepare your patient – explain what will happen and gain verbal consent. Consider using local anaesthesia (discussed in more detail later).

2. Select your site – site selection is discussed in more detail below: the default position is usually the dorsal hand, forearm or antecubital fossa. Apply a tourniquet proximally and encourage fist clenching to engorge the veins. Look for a straight, wide, 'spongy' vein, with no evidence of valves.

3. Prepare the site with locally approved antiseptic – the author's institution preference is for 2% chlorhexidine in 70% alcohol wipes, wiped for 30 seconds and left to dry before cannulation.

Eoin Harty
Core Trainee
Department of Anaesthesia
Royal Devon and Exeter NHS
Foundation Trust
Barrack Road
Exeter
EX2 5DW
UK

Table 1. *Characteristics of different gauge cannulae*

Gauge	Colour	Maximal flow rate (ml.min^{-1})	Time to infuse 1000ml fluid
24G ('neoflon')	yellow	13	77min
22G	blue	31	32min
20G	pink	67	15min
18G	green	103	10min
17G	white	125	8min
16G	grey	236	4.2min
14G	brown/orange	270	3.7min

4. Warn the patient that you are starting the procedure. Be honest - 'a small scratch' is not accurate, 'a sharp sting' may be better.

5. Insert cannula with your dominant hand, using your other hand to tether and slightly stretch the skin over the target vein.

   a. With the bevel facing up, slide the cannula through the skin and into the vein until first 'flashback' is seen (Figure 1a). This indicates that the needle tip has penetrated the vein. The cannula should then be angled about 5-10 degrees to the skin.

   b. Advance the cannula a few millimetres further to ensure the catheter as well as needle tip enters the vein (Figure 1b).

   c. Withdraw the needle until a second flashback is seen in the catheter itself (Figure 1c). This indicates that the catheter alone is in the vein.

   d. Keeping the needle still, advance the catheter to the hilt.

   e. Apply digital pressure over the catheter tip and remove the needle. Attach the giving set or bung.

   f. Flush your cannula with 0.9% saline to confirm placement, watching for extravasation of fluid.

6. Place a locally approved dressing over the cannula.

The above is an 'ideal' cannula insertion which is achieved in the majority of cases. A discussion of potential pitfalls and problems follows.

TROUBLESHOOTING

'I can't find a vein'

This is probably the most common problem in IV cannulation, particularly in patients who have had multiple venous punctures, such as renal patients and intravenous drug abusers (IVDAs). There are two ways to solve this problem.
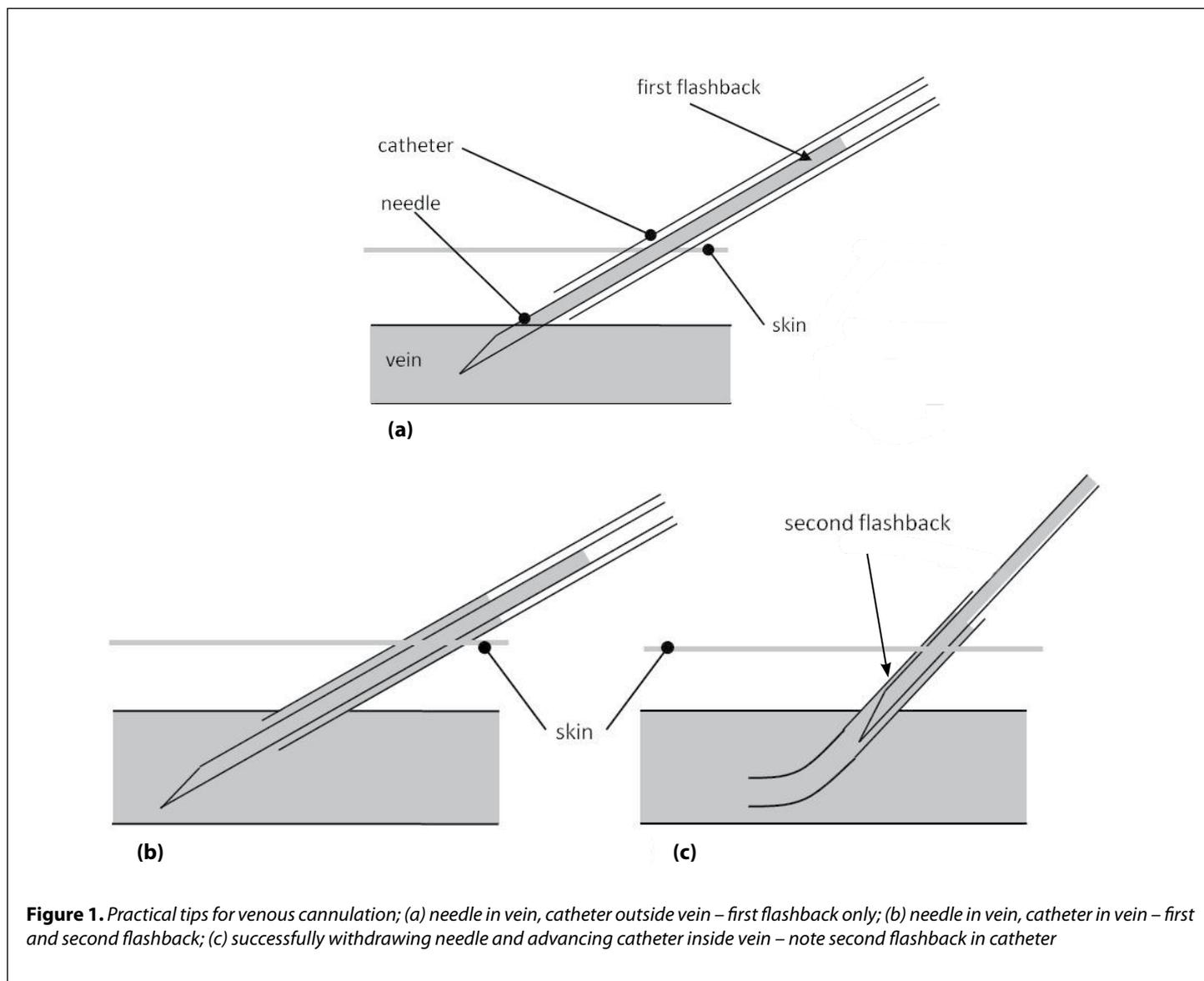
Figure 1. *Practical tips for venous cannulation; (a) needle in vein, catheter outside vein – first flashback only; (b) needle in vein, catheter in vein – first and second flashback; (c) successfully withdrawing needle and advancing catheter inside vein – note second flashback in catheter*

Look for alternative sites

Many longterm patients and IVDAs will be able to tell you where their best veins are. Otherwise think about insertion in:

- The ventral forearm or wrist – this area is often overlooked and usually has some wide flat veins. The inside of the wrist is a tender area with small branching veins that will only accommodate smaller cannulae.

- Feet – veins here tend to be small and friable, but sometimes suitable veins are found over the third, fourth and fifth metatarsals. In patients who have undergone bilateral axillary clearance for breast cancer, the arm veins must be avoided and this site is usually chosen.

- Long saphenous vein at the ankle. This vein is found just anterior to the medial malleolus. It may be difficult to palpate, but can be located using a 'tap test' – transmission of a finger tap can be felt 2 cm proximally if there is a column of blood present. This site is particularly useful in children and is almost always present if the site has not been used before (see Figure 2). Blind puncture at this site will often be successful, even if the vein cannot be palpated. This site is useful for adults undergoing superior (or cervical) mediastinoscopy, when it is useful to have reliable large bore IV access into an inferior vena cava (IVC) tributary in case a major neck vein (draining into the SVC) is damaged.

Figure 2. *Cannulation of both long saphenous veins in a 3-year-old undergoing a procedure with potentially high blood loss*

- Neck – often the external jugular vein is prominent (Figure 3). This requires a **very shallow approach** (<5 degrees) and often a slight anterior-posterior bend in the needle is helpful. Tilt the patient head-down and ask an assistant to place a finger along the superior border of the clavicle to compress the lower end of the vein and engorge the more cephalad section. There is often a valve in this vein so it is frequently not possible to insert the catheter fully - it can be fixed in the position that allows best flow. This site is particularly useful in cardiac arrest or emergency situations and provides convenient access for the anaesthetist.

Figure 3. *The external jugular vein*

- Note that in patients with peripheral oedema, the oedema can be compressed for a minute, driving the interstitial fluid elsewhere, and veins will come into view.

- Finally, the interosseous route should be considered if immediate access is required. Emergency paediatricians will attempt venous cannulation for 2 minutes before placing an interosseous needle. This is commonly done in the anterolateral tibial surface two centimetres below the tibial tuberosity, but they can also be placed in the medial femoral condyle or the head of humerus.

Optimise the veins you can see

Sometimes patients will not possess any veins that are suitable for cannulation. Here you will need to further engorge the veins you can see using a combination of the following techniques.

- Fist clenching and unclenching with tourniquet applied. This increases venous return from the muscles supplying the intrinsic hand muscles and thenar eminence.

- Tapping veins – often the local irritation of two or three of your fingers tapping along the length of the vein will cause the vein to dilate.

- Warm the hand. This will encourage venodilation and can be accomplished by immersing the hand **in hot water** or **wearing latex gloves** on the way to theatre.

Consider alternative induction techniques

On occasion it will be sensible to proceed to a gas induction using halothane or sevoflurane. This is frequently the case in children,

particularly in the age group between 6 months and 3 years. Venous cannulation is generally easier with the venodilatation of these agents, but make sure the patient is adequately anaethetised prior to skin puncture.

Laryngospasm without the back-up of IV access is a dangerous situation. Many would advocate the presence of two anaesthetists for this technique but local staffing may make you reliant on a trusted and skilled assistant to maintain the airway while you perform cannulation or vice versa.

'The catheter won't advance'

This is usually because the catheter is not in the vein. If there's been a first flashback but no second flashback in the catheter itself, then the catheter is usually in one of two places:

• It has passed through the vein and out of the other side. This situation may be salvaged by pulling the needle a centimetre or so out of the catheter and then **very slowly** withdrawing the whole cannula, as you look for a second flashback of blood in the catheter. Once this is present, the catheter is in the vein and it may be possible to advance it.

Figure 4. *Unsuccessful attempt to advance catheter while still outside vein. This is avoided by step (b) in Figure 1.*

first flashback

skin
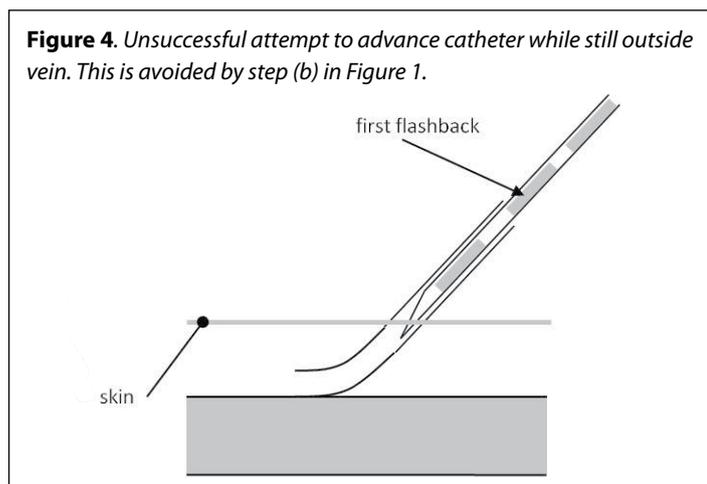
• It is superficial to the vein – i.e. only the needle tip has entered the vein, not the catheter itself (See Figure 4). This happens if the cannula is not advanced 1-2mm after the first flashback as in step 4(b) in the technique described above. If you have already withdrawn the needle then this is unsalvageable as it is not good practice to reinsert the needle into the cannula.

'A haematoma or bruise is forming at the site of cannulation'

This means that the needle has gone through the vein and out of the other side, with extravasation of blood into the surrounding tissues. This can be salvageable by withdrawing the whole cannula and needle again, looking for a second flashback. Once this is present, the catheter can be advanced into the vein and past the haematoma. It's particularly important to flush the cannula to be sure it is truly in the vein.

'This vein is very mobile'

Subcutaneous connective tissue typically degrades in the elderly, allowing veins to be relatively mobile under the skin. Tethering the skin with your other hand can help to immobilise them, and a speedy approach will pierce the vein before it has time to move away.

'I've hit a valve'

If a catheter, that was advancing well within the lumen of a vein, comes to a stop before it is in place, you may have hit a valve within the vein. This can sometimes be remedied by flushing the catheter with 0.9% saline while advancing – the hydrostatic pressure opens the vein or dislodges any clot allowing the catheter to slide further. If this proves impossible, and the catheter is stuck but still flushing well, secure it well and use as normal. Bear in mind flow rates through a 'half-in' catheter will be less and they are very prone to being dislodged.

LOCAL ANAESTHESIA FOR VENOUS CANNULATION – WHAT TO USE AND WHEN?

Anaesthetising the skin before cannulation helps allay patient anxiety and reduce pain. It has been shown that cannulation results in an increase in mean arterial blood pressure by 10-15%, an effect which is abolished by intradermal injection of local anaesthesia (LA).[1] The vast majority of patients and healthcare workers would prefer to have local anaesthetic for cannulation even with a 22G needle.[2]

There are two methods – application of cream containing local anaesthetic or direct intradermal injection of local anaesthetic at the venupuncture site. The advantages and disadvantages are shown in Table 2.

Intradermal injection is used commonly in the UK as it works quickly and provides good, reliable analgesia. A comparison of intradermal injection and local anaesthetic cream found them to be equally effective in relieving venepuncture pain.[3]

Table 2. *Advantages and disadvantages of different techniques for providing local anaesthesia for IV cannulation*

	Advantages	Disadvantages
Intradermal injection	Works quickly	Requires a second skin puncture
	Good analgesia	Increases chance of needlestick injury
		Pain on injection
		Can make cannulation more difficult by obscuring the target vessel
Cream	No needles required	Takes an hour to work reliably

The ideal intradermal anaesthetic would be cheap, fast acting, effective and cause minimal pain on injection. Morris et al compared etidocaine, bupivacaine, mepivacaine, chloroprocaine and lidocaine and found that the latter two were least painful to administer intradermally.[4] Further work has found that alkalinised lidocaine is less painful than plain, but this approach may be unnecessarily complex for cannulation.[5] Lidocaine is also the fastest acting and the cheapest of the available local anaesthetic agents.[6,7]

It is often argued that intradermal LA distorts tissues surrounding the vein and makes cannulation more difficult, but there is certainly no evidence to support this. Röhm et al found that intradermal LA made no difference to cannulation success rate in 301 patients,[8] while Holdgate et al found the same in 166 patients.[9]

Do smaller cannulas require LA in the same way? While McNaughton et al found that LA made a difference to pain scores in 22G needles, another study compared 14, 16, 17, 18 and 20G needles, finding that there was significant difference in pain scores with the two largest needles, 14 and 16G.[8] The evidence on smaller needles is conflicting: it is probably best to use LA in patients who request it, or that you think may benefit from it.

Various other methods of analgesia have been tried, such as entonox[10] or capsaicin cream.[11] There is no evidence that any are superior to intradermal lidocaine.

CONCLUSION

In this article we have looked at selecting your cannula, practical insertion technique, common problems and reviewed the evidence for local anaesthesia. This is only a guide and there is no substitute for inserting a large number of cannulae yourself. In this way you will develop your own method and salvage techniques and your success rate will improve.

REFERENCES

1. Langham BT. Harrison DA. The pressor response to venous cannulation: attenuation by prior infiltration with local anaesthetic. *British Journal of Anaesthesia* 1993. **70**: 519-21.

2. Valdovinos NC et al. The use of topical anesthesia during intravenous catheter insertion in adults: a comparison of pain scores using LMX-4 versus placebo. *Journal of Emergency Nursing* 2009. **35**: 299-304.

3. Soliman IE et al. Comparison of the analgesic effects of EMLA (eutectic mixture of local anesthetics) to intradermal lidocaine infiltration prior to venous cannulation in unpremedicated children. *Anesthesiology* 1988. **68**: 804-6.

4. Morris R et al. Comparison of pain associated with intradermal and subcutaneous infiltration with various local anesthetic solutions. *Anesthesia & Analgesia* 1987, **66**: 1180.

5. Nuttal GA et al. Establishing intravenous access: a study of local anaesthetic efficacy. *Anesthesia & Analgesia* 1993, **77**: 950-3.

6. Peck TE, Hill SA and Williams M. Pharmacology for Anaesthesia and Intensive Care. 3rd ed. Cambridge: Cambridge University Press; 2008.

7. Joint Formulary Committee. British National Formulary. 60th ed. London: British Medical Association and Royal Pharmaceutical Society; 2010.

8. Rohm KD et al. Do we necessarily need local anaesthetics for venous cannulation? A comparison of different cannula sizes. *European Journal of Anaesthesiology*, 2004 **21**: 214-6 .

9. Holdgate A. Wong G. Does local anaesthetic affect the success rate of intravenous cannulation? *Anaesthesia & Intensive Care* 1999 **27**: 257-9.

10. Robinson PA et al. Lignocaine is a better analgesic than either ethyl chloride or nitrous oxide for peripheral intravenous cannulation. *Emergency Medicine Australasia* 2007. **19**: 427-32.

11. Agarwal A et al. Comparative evaluation of myolaxin and EMLA cream for attenuation of venous cannulation pain: a prospective, randomised, double blind study. *Anaesthesia & Intensive Care* 2007. **35**: 726-9.

Fibreoptic intubation

Sarah Barnett*, Irene Bouras, Simon Clarke
*Correspondence email: sarahfbarnett@googlemail.com

INTRODUCTION

Awake fibreoptic tracheal intubation is a valuable technique that achieves safe airway management of patients who have known or potential difficult direct laryngoscopy. It is a skill in which most anaesthetists would like to be proficient, however, due to a perceived lack of opportunities, a large proportion are not confident in performing this type of laryngoscopy.

Fibreoptic intubation can be performed on awake or anaesthetised patients. An awake technique is chosen when it is considered unsafe to anaesthetise the patient before guaranteeing the ability to secure their airway, usually when difficult laryngoscopy and difficult bag-mask ventilation are expected. Table 1 shows the vital steps in this procedure.

Table 1. *Ten essential steps to performing awake fibreoptic intubation*

1. Ensure appropriate indication
2. Explain procedure to patient and give premedication as appropriate
3. Prepare equipment; assemble and check fibrescope, railroad endotracheal tube (ETT) over fibrescope, prepare local anaesthetic solutions
4. Monitoring, oxygen, intravenous access
5. Commence sedation if being used
6. Position patient and ensure appropriate level of sedation
7. Anaesthetise airway
8. Perform intubation
9. Confirm correct ETT position
10. Administer general anaesthesia

PATIENT SELECTION

The principal indication for awake fibreoptic intubation is patient safety in the setting of a documented history of difficult intubation and/or facemask ventilation. Other indications include:

- patients at risk of aspiration of gastric contents (unfasted or severe reflux) who require intubation but are known or potentially difficult to intubate, and

- situations where it is beneficial to assess a patient's neurological status after intubation, but prior to surgery, for example those with an unstable cervical spine injury.

As with any procedure, there are contraindications to performing the technique, particularly patient refusal or non-compliance with the technique.

Table 2. *Contraindications to awake fibreoptic intubation*

Patient refusal

Inexperience

Local anaesthetic sensitivity

Non-compliance / uncooperative e.g. children, special needs patients

Airway bleeding

Critical airway (see below)

A patient with stridor has an airway that may become obstructed with minimal provocation (sometimes termed a '*critical airway*'). This is a relative contraindication to the technique - insertion of a fibreoptic scope through the narrowest part of the airway may cause complete obstruction. Therefore in cases of severe upper airway obstruction alternative techniques, such as inspection under deep inhalational anaesthesia or awake tracheostomy, should be considered to secure the airway. In cases of airway bleeding, whether due to trauma or tumour, a fibreoptic approach to intubation is not advised as the blood obscures the field of vision.

ORAL OR NASAL APPROACH

Awake fibreoptic intubation can be performed via the mouth or the nose. Many anaesthetists prefer the nasal approach initially, as this tends to offer an easier line of access to the larynx and it is usually better tolerated by patients. Nasal pathology and a current or previous history of epistaxis are contraindications to this route.

The mouth has a greater volume than the nose, but it can be easier to stray from the midline position when inserting the scope. In this situation a split oral airway (Berman or Ovassapian – Figure 1) can help.

Summary

Awake fibreoptic intubation is a useful technique where difficult intubation is anticipated on the basis of airway examination or previous anaesthesia. Intubating fibrescopes are not universally available, but are increasingly found in resource poor settings as donated equipment. The indications, contraindications, equipment and preparation required for awake fibreoptic intubation are discussed. Sedation is desirable although not essential and the drugs used to achieve this depend largely on availability. Adequate anaesthesia of the airway is essential for a safe successful procedure and we describe our preferred technique along with alternatives.

Sarah Barnett
Perioperative Clinical Research Fellow

Irene Bouras
Locum Consultant Anaesthetist

Simon Clarke
Consultant Anaesthetist
University College London Hospital
London NW1 2BU
UK

Avoid oral intubation if there is major oral pathology or the tube will interfere with surgical access.

Figure 1. *Berman Airway - These airways are similar to conventional oropharyngeal airways, the difference being that they allow passage of both the fibrescope and the railroaded endotracheal tube. Their design allows them to be removed from the mouth without dislodging the fibrescope or the tube.*

PREPARATION - EQUIPMENT

Ensure that prior to commencing anaesthesia your room is fully equipped with an anaesthetic machine, suction, tilting patient trolley, emergency drugs and equipment for cricothyroid puncture. This is essential to achieving smooth and efficient conduct of the awake intubation. A skilled assistant, with prior experience of this procedure, will be required to help you. It is also useful to have a third member of staff to support and reassure the patient during the procedure.

Fibrescope (Figure 2)

It is important that you, as the operator, can set up the scope and monitor. The steps required to do this are as follows:

1. Ensure there is a functioning light source that is compatible with the fibreoptic scope.

2. Focus the fibreoptic laryngoscope by visualising fine print.

3. Attach the camera (if you have one) and refocus the camera lens.

4. Perform a 'white balance' if you are using a camera.

5. Make sure that the camera is orientated correctly by ensuring the black triangle (or other marker in the visual field of the scope) is at the 12 o'clock position.

6. Load the endotracheal tube (ETT) onto scope, securing it with a small piece of tape (Figure 3)
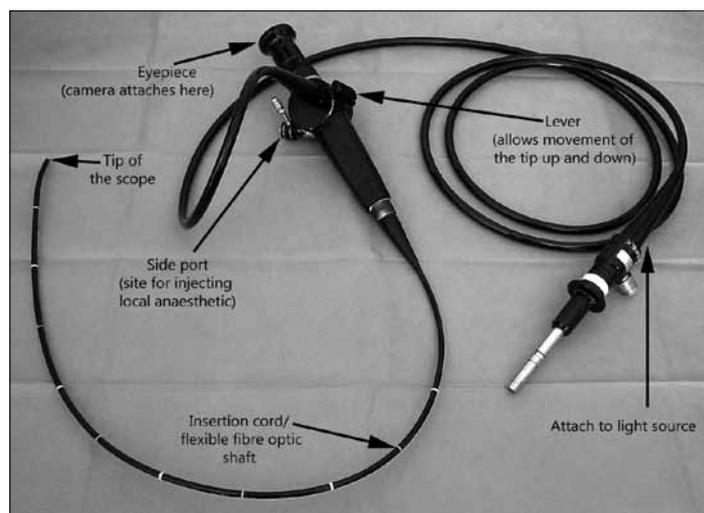
Figure 2. *The fibreoptic scope*
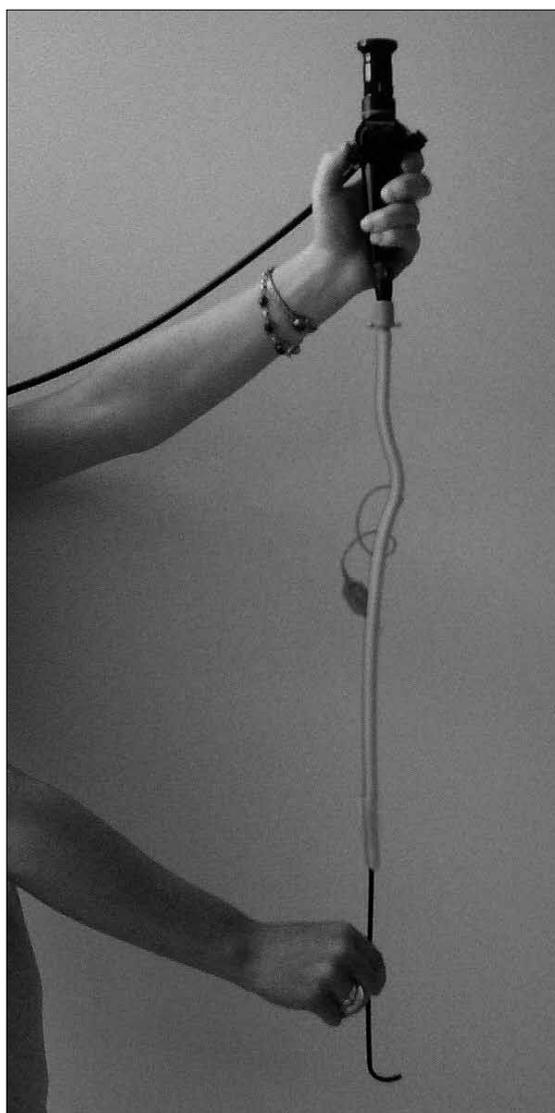
Figure 3. *Fibreoptic scope loaded with north-facing Portex endotracheal tube*

Sterile gloves should be worn when handling the fibrescope. The fibrescope should always be held at its most distal point (i.e. as close as possible to the patients' nose or mouth as possible) and be kept straight to avoid kinking and fracture of the fibreoptic strands contained within it. Hold the scope in your dominant hand with the lever on the control body pointing towards you; in this configuration moving the lever up with your thumb will move the tip of the scope down, and moving the lever down with your thumb down will move the tip up. There are three possible movements:

1. tip up/down,

2. scope inserted deeper or withdrawn,

3. clockwise/anticlockwise rotation or the scope. If the scope is kept straight the rotation of the control end will cause exactly the same movement of the tip
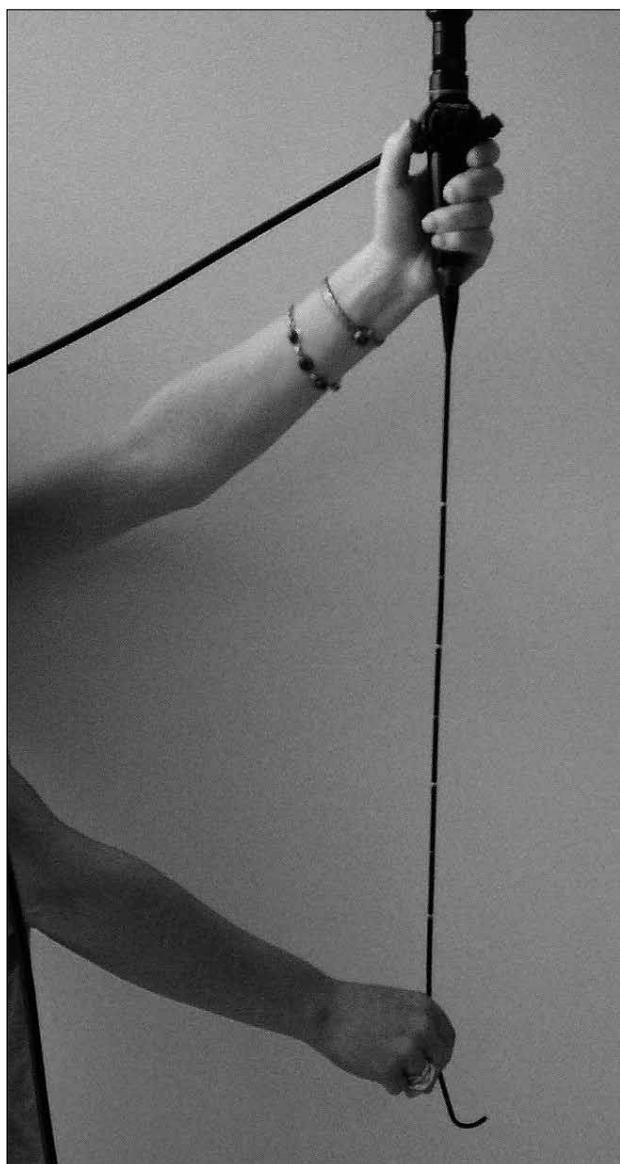
Figure 4. *Looking to the left is achieved by elevating the tip (i.e. lever down, tip up) and rotating the scope 90° anticlockwise or by depressing the tip (i.e. lever up, tip down) and rotating 90° clockwise*

The fibreoptic scope usually has a 1.0 - 1.5mm working channel but suctioning of secretions is often ineffective through a port of such a narrow calibre. Careful suctioning of the mouth with a Yankeur sucker (or of the nose with fine bore suction catheter) will often clear secretions more reliably. This is generally well tolerated after application of topical local anaesthetic (see later).

Endotracheal tube (ETT)

The choice of endotracheal tube depends upon the clinical situation and tube availability. Reinforced ETTs are commonly used (e.g. Mallinckrodt), which can be placed orally or nasally. The ETT that comes with the intubating Laryngeal Mask (ILMA) has a curved Tuohy style tip, allowing the leading edge of the tube to run closer along the scope when it is pushed over it. This reduces the likelihood that the tube will get caught at the arytenoids or vocal cords (Figure 5).
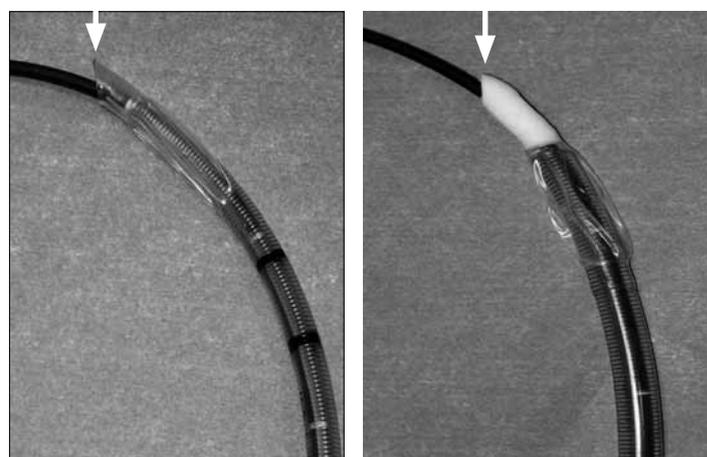

Figure 5. *Different profile of an armoured ETT (on the left) with a prominent 'lip', as indicated by the arrow and an ILMA tube (on the right)*

North facing Portex nasal tubes, (typically size 6 for females and 6.5 for males) are often used for maxillo-facial procedures. These tubes are made of soft material. The catheter mount connection is positioned away from the surgical field, thereby improving surgical access.

Figure 6. *Portex north-facing nasal tube*

PREPARATION OF THE PATIENT

General aspects

Appropriate preparation of the patient is a key factor in achieving a calm and controlled environment to perform a successful awake

intubation. The procedure should be explained and consent obtained. Explain to the patient that sedation is not anaesthesia and some degree of recall for events is possible. They may have undergone the procedure before so it is important to know whether this was a good or bad experience.

Full monitoring should be applied before starting the procedure.

An anti-sialogogue is generally recommended to reduce secretions that may obscure the fibreoptic view. Dry mucous membranes may also allow the topicalisation with local anaesthetic to work more effectively. Glycopyrronium is usually used and it can be given subcutaneously or intramuscularly an hour before the intubation. Alternatively it can be given intravenously when the patient arrives in the anaesthetic room. The standard dose is 4mcg.kg^{-1} for all routes. Atropine (20mcg.kg^{-1} to a maximum of 500mcg) is a suitable alternative.

Patient and operator position (Figure 7)

The patient can be positioned sitting up, with the operator facing the patient, or lying supine with the operator standing behind the patient at the head of the trolley. The choice is usually influenced by prior experience - many anaesthetists will be more comfortable at the head of the bed, whereas most physician bronchoscopists stand facing the patient. If you use an unfamiliar position the image you see will be inverted.

OXYGEN DELIVERY

Oxygenation during the procedure is important, especially if administering sedation. It may be slightly awkward to adequately oxygenate the patient while maintaining access for instrumentation of the nose or mouth. Helpful devices include single nasal prongs, a nasal sponge (Figure 8) or a Hudson facemask cut appropriately to allow access to the nostril of the patient.
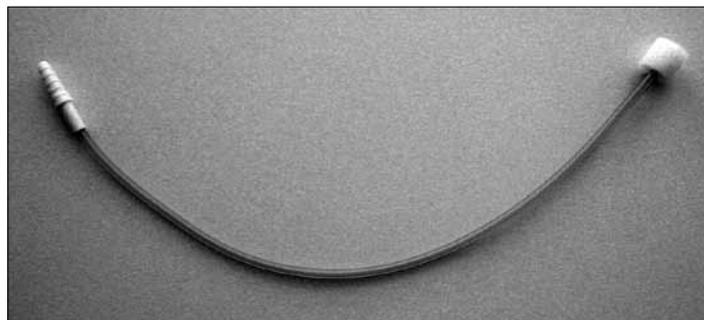

Figure 8. *Nasal sponge*

SEDATION

Sedative drugs and techniques

Provided that safety is not compromised, conscious sedation is desirable to minimise awareness of the procedure. Remember that

Figure 7. *Intubation with the operator standing behind the patient (A) and in front of the patient (B)*

Table 3. *Benefits of the sitting and supine position*

Benefits of sitting position *(Operator in front)*	**Benefits of supine position** *(Operator behind)*
• Eye contact between patient and operator	• Familiarity with position
• Less pooling of secretions	• Good line of access
• More comfortable for operator (i.e. less tiring on operating arm)	• Better for patients unable to sit up e.g. cervical spine injury
• More comfortable for patient	
• Airway more open / patent	
• Better patient ventilation e.g. COPD	

good local anaesthesia is the essential ingredient in this technique and avoidance of sedation may be the safest option in some settings for some patients. The goal is to provide analgesia and amnesia in a calm and cooperative patient who can follow verbal commands while maintaining a patent airway, adequate oxygenation and ventilation. Some degree of airway reflex and cough suppression is also beneficial.

There are a variety of sedation techniques used by anaesthetists and choice is largely determined by availability. There is no single ideal agent. Fentanyl and alfentanil are commonly used. An infusion of remifentanil has become popular in UK due to its advantageous pharmacokinetic profile. It has a constant context sensitive half-time, which means that it does not accumulate and once the infusion stops the analgesic and sedative effect wears off quickly. Sedation with ketamine[2] has been described, either used alone or in conjunction with other drugs.

Remifentanil provides good conditions for the patient and operator with its analgesic, antitussive and sedative properties. This, combined with its short duration of action allows appropriate titration to the stimulation associated with airway manipulation. Caution is required when using this drug as apnoeas are not always obvious and can occur when the patient appears to be 'awake'. Capnography and a gentle reminder to 'breathe' can help to avert this situation.

A recent study demonstrated similar satisfaction scores by patients when comparing remifentanil to propofol despite a higher level of recall when using remifentanil.[3]

The table below illustrates some of the possible drug regimens which can be used for sedation. Approximate dose ranges are included, but the actual dose required may vary depending upon the age and physiological status of the patient. All drugs should be administered cautiously and titrated to effect.

Table 4. *Suggested dosing regimens for some sedative drugs*

Drug	Dosage
Propofol	*Target controlled infusion*: Start with a target of 0.75-1.5mcg.ml^{-1} and adjust by 0.25-0.5mcg.ml^{-1}
	Simple infusion: Start with a 1% propofol solution running at 10ml.h^{-1} and titrate up to 30ml.h^{-1} as needed
Remifentanil	*Target controlled infusion*: Start at 1.5-2ng.ml^{-1} and adjust by 0.25-0.5ng.ml^{-1}.
	Simple infusion (mcg.kg^{-1}.min^{-1}): Start at 0.05-0.1mcg.kg^{-1}.min^{-1} and titrate accordingly (0.025-0.05 increments) alternatively infuse 5-10ml.h^{-1} of a 50mcg.ml^{-1} solution.
	Remember that it may take over 5 minutes for the steady state of remifentanil to be reached.
Midazolam	*Intermittent intravenous bolus*: Dilute 10mg of midazolam to a total volume of 10ml 0.9% sodium chloride (1mg.ml^{-1}) and administering 0.5-1mg intravenously as boluses.
	Diazepam is an alternative.
Morphine	Intermittent intravenous bolus: 0.5-1mg bolus
Fentanyl	Intermittent intravenous bolus: 20-40mcg bolus
Ketamine	Intermittent intravenous bolus: 0.25-0.5mg.kg^{-1} bolus

Table 5. *Advantages and disadvantages of remifentanil and propofol sedation*

Remifentanil		Propofol	
Advantages	*Disadvantages*	*Advantages*	*Disadvantages*
Short-acting	Respiratory depression	Short-acting	Respiratory depression
Constant context sensitive half-time	Less effective anxiolysis	Rapid clearance	Haemodynamic instability
Less effective amnesia	Rapid clearance	Dose related sedation time	Variable context sensitive half
Antitussive	Haemodynamic instability (high doses)	Dose related amnesia	No analgesic properties
Analgesic	Muscle rigidity (high doses)	Non dose related anxiolysis	
Sedative	Nausea and pruritus		

LOCAL ANAESTHESIA OF THE AIRWAY

Once sedation has begun, a vasoconstrictor applied nasally will decrease localised blood flow (thus reducing the risk of epistaxis) and prolong the effect of the local anaesthetic (by reducing the rate of absorption). Typical vasoconstrictors are epinephrine (0.1%), ephedrine (0.5%), phenylephrine (0.5%-1%) and xylometazoline (0.05%). 1-2 drops in each nostril should achieve vasoconstriction. Be cautious in patients with pre-existing medical conditions such as hypertension. A combination of vasoconstrictor plus local anaesthetic can be used e.g. Co-Phenylcaine (50mg.ml^{-1} lidocaine, 5mg.ml^{-1} phenylephrine).

There are many ways to anaesthetise the airway for fibreoptic intubation. We describe our favoured technique (Table 6), but have also mentioned alternative techniques. The exact choice of technique or combination of techniques is dictated by local availability of drugs and administration devices and by personal choice and experience.

In patients with distorted airway anatomy or friable tumours, invasive nerve blocks should be avoided. Lidocaine may be used in a variety of concentrations; the maximum safe topical dose for airway mucosa has been shown to be up to 9mg.kg^{-1}.[6]

Table 6. *Easy steps to anaesthetise the airway*

Nasopharynx	Co-Phenylcaine 'sniffed' up both nostrils and Instillagel® to both nares
Oropharynx	Mucosal Atomising Device (MAD) (purpose designed or improvised - see text): 10ml 1% lignocaine
Larynx	Spray-as-you-go 4% lignocaine (2ml x3) down side port of the scope, above the larynx and onto the vocal cords (where available using an epidural catheter)

Box 1. *Summary checklist of equipment required for awake fibreoptic intubation*

Fully operational scope/TV monitor – set up and checked

Monitoring equipment/ Resuscitation facilities, Skilled assistant

Suction apparatus

Oxygen supply: face mask/nasal sponge, green tubing

Different types/size ETT's (6.0, 6.5 flexible reinforced ETT's)

Split oral airway (Berman or Ovassapian)

IV cannula, glycopyrrolate 4mcg.kg^{-1}

Co-phenylcaine 2.5mls (to nostril)

Laryngo-Tracheal Mucosal Atomisation Device

Epidural catheter 16G (with tip cut off)/open ended catheter

2% lidocaine gel ('Instillagel') 5ml to mouth to gargle

1% lidocaine 10ml via MAD over back of tongue directed to larynx

4% lidocaine 2ml x 3 (in 5ml syringe with 2ml air)

Warm sterile saline (to soften tube), KY Jelly (nose)

Saline (lubrication for railroading tube over scope)

Anaesthetising the nasopharynx

The trigeminal nerve provides the sensory fibres to the nasal mucosa via the sphenopalatine ganglion, which also innervates the superior segments of the tonsils, uvula and pharynx. There are different techniques to anaesthetise the nose. Our choice is Co-Phenylcaine followed by Instillagel® (2% lignocaine and chlorhexidine) to the nares.

Lidocaine can sting when applied to mucosal surfaces. However, if topicalisation is commenced at a low concentration and increased to a stronger concentration, it tends to be better tolerated by the patient. Warming the local anaesthetic to body temperature may also reduce the 'stinging' associated with topicalisation.[5] Also, although topicalisation is applied predominantly into the chosen nostril, a small amount should be applied to the other nostril since there is often some cross-innervation of the nasal septum.

Other alternative methods include:

- 4% cocaine soaked cotton swabs

- nebulised 4% lidocaine (4-6 mls)

- 'Moffets' solution which is 1ml 1:1000 epinephrine, 2ml 1% sodium bicarbonate and 2ml 10% cocaine.

Anaesthetising the oropharynx

The pharynx and posterior third of the tongue are innervated by the glossopharyngeal nerve.

- Mucosal atomiser devices (MAD) are useful to assist in depositing the local anaesthetic as fine droplets. There are several different types of this device available commercially. However a similar effect can be achieved by attaching a 20G cannula to some green oxygen tubing via a three-way tap. The local anaesthetic can then be injected via the cannula port, and an oxygen flow rate of 4-8l.min^{-1} produces good atomisation (Figure 9). Reassure the patient that coughing may occur during this time.
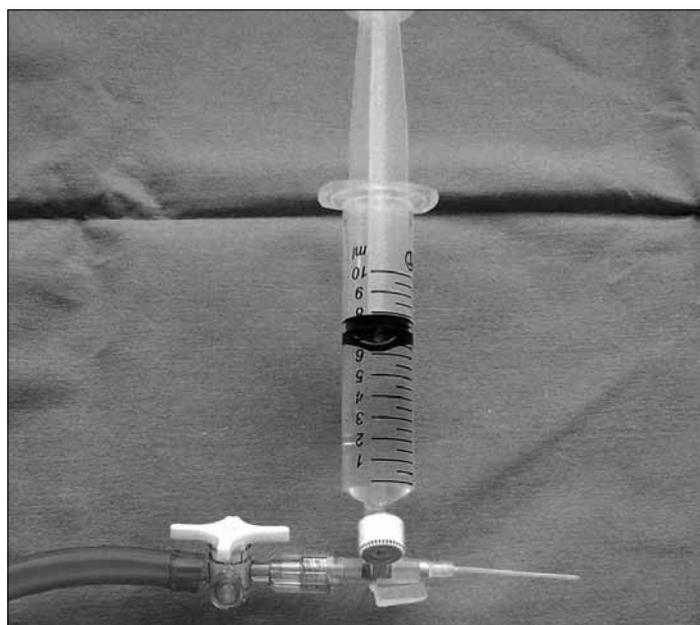
Figure 9. *Improvised Mucosal Atomiser Device (MAD)*

- A benzocaine lozenge may be used to start the process of anaesthesia.
- Instillagel can be gargled orally to anaesthetise the pharynx, followed by 1% and 4% lidocaine spray.

Anaesthetising the larynx

The final nerve to be anaesthetised is the vagus. This nerve supplies sensory branches both above and below the vocal cords via two main branches. The superior laryngeal nerve supplies the arytenoids, epiglottis and sensation above the cords. Below the cords, the sensory innervation is supplied via the recurrent laryngeal nerve.

The commonest method to anaesthetise the larynx is to spray lignocaine directly down the fibrescope side port (spray-as-you-go technique).

'Spray-as-you-go' technique

This is a technique where the larynx is identified using the fibrescope and anaesthetised as visualised.[6] A simple method is to inject the local anaesthetic directly down the side port.

However for a more accurate administration of local anaesthetic onto and below the cords an epidural catheter is useful. The epidural catheter is threaded out of the end of the scope and 2ml 4% lidocaine is injected onto the cords (Figure 10). This can either be 'trickled' onto the cords, or a more forceful 'jet' can be achieved by the addition of air into the injecting syringe (with the syringe held vertically pointing downwards). Both techniques will cause the patient to cough and the view of the cords may be temporarily lost, so it is important to remain patient and keep the fibrescope in the same position until the view clears. Make sure that the epidural catheter is retracted after injecting, to avoid airway irritation or scratching by the tip.

Figure 10. *Transendoscopic local anaesthetic administration through an epidural catheter*

The fibrescope can be advanced closer to the cords and the epidural catheter can often be placed through the cords allowing a further dose of 2ml 4% lidocaine to be injected below the cords. Again coughing is to be expected and the epidural catheter should be withdrawn until the patient settles.

A recent randomised, double-blind comparison of 2% and 4% lidocaine for topical spray-as-you-go anaesthesia demonstrated that there were no significant differences in systolic blood pressure or pulse at various stages of airway manipulation.[7] Both produced clinically acceptable intubating conditions for awake fibreoptic intubation. However the total doses and subsequent plasma concentrations were less in the patients who received the 2% dose. This has useful implications for clinical practice from a safety aspect, and in countries where there is no access to 4% lidocaine it is useful to know that lower concentrations can work equally well.

Other techniques include:

Regional nerve blocks

Although regional nerve blocks are frequently described, they are complicated and invasive to perform, and therefore rarely done and will not be discussed further.

Nebulisation of lignocaine

Nebulised 4% lignocaine can also be used as the initial anaesthetic for the airway. One suggested regimen is 5ml over 10-15 minutes. This technique is efficient but may be more time-consuming.

Translaryngeal block

Also known as cricothyroid puncture, this is another method for anaesthetising the larynx. A 20G cannula is inserted through the cricothyroid membrane and after air has been aspirated, 2-3ml 2% or 4% lidocaine is injected, asking the patient to breathe out fully prior to injection. The subsequent inspiration and coughing will disperse the local anaesthetic efficiently. The benefit of using a cannula compared to a needle is that there is reduced risk of trauma during the procedure. Transtracheal injection is a very useful way of topicalising the larynx and trachea if you do not have a fibrescope to direct the local anaesthetic and can produce excellent conditions. It is also very useful if there is an obstructed view of the larynx from above (e.g. by glottic or supraglottic tumour).

Patients who have undergone any of these procedures for airway anaesthesia remain at risk of aspiration into the airway for several hours after the procedure.

BRONCHOSCOPY AND INTUBATION

The operator passes the scope under direct vision through the nose or mouth and into the pharynx. At all times the scope should be held taught and straight. Small movements of the tip of the scope tend to allow the most successful manoeuvring through the airway.

Difficulty may sometimes be caused when patients have a small pharyngeal cavity, due to normal variation in anatomy, receding mandible, or disease causing swelling or oedema. Asking the patient to sniff can enlarge the nasopharyngeal cavity. Asking the patient to 'stick out their tongue or jaw' can improve the view in the lower pharyngeal space. Secretions and misting of the fibreoptic lens may also obscure the view on the end of the scope. Carefully brushing the adjacent mucous membranes with the tip can often clear the view or asking the patient to swallow.

If you get 'lost' or lose the airspace, i.e. your scope is sitting in secretions ('white-out'), or lying against a mucosal surface ('pink-out'), then withdraw slightly until your view is re-established.

Once the epiglottis and cords are visualised (Figure 11) the spray-as-you-go technique can be instigated if this is your technique of choice. The effect of the topical anaesthesia on the cords can be assessed by observing the reactivity of the larynx to the lidocaine spray. An absent or markedly subdued cough usually indicates an adequately anaesthetised larynx.

Asking the patient to take a deep breath often facilitates entry of the scope through the vocal cords. Once through the cords, carefully advance the tip of the scope a reasonable distance beyond the cords, before railroading the ETT over the fibrescope. A small amount of saline administered into the ETT at this point can reduce friction between the scope and the tube. Lubrication (i.e. KY Jelly) should also be applied to the nares and/or the cuff of the ETT, before it is inserted into the nostril (or mouth) and railroaded over the scope. Passing the endotracheal tube through the nostril is one of the potentially more stimulating parts of the procedure for the patient and some reassurance is often required at this point.

Loosen the endotracheal tube connector from the fibrescope handle. A gentle twisting motion should allow the tube to pass without too much force. If resistance is met, it is likely that the tube tip has caught on the arytenoids. A 360° continual rotation or 'drilling' of the tube should overcome any hold-up when using a reinforced tube. With the blue Portex pre-formed tube, a 90-180° anticlockwise rotation (of both the tube and the scope and advancing both together) can usually overcome the hold-up and allow the tube to advance past the arytenoids and through the cords.

Figure 11. *View of the larynx*

Advance the endotracheal tube into the trachea over the scope until the tip of the tube is correctly positioned above the carina. Withdraw the fibrescope and attach the circuit to the endotracheal tube. Capnography will also confirm correct placement and general anaesthesia can now be induced. This can be done intravenously or as an inhalational induction. The endotracheal tube cuff should not be inflated until after induction of anaesthesia.

COMPLICATIONS

Operator skill and practice will help to ensure a straightforward and successful intubation. Bleeding from minor trauma can make a potentially difficult airway unnecessarily more complicated. A patient who is coughing may end up with more upper airway bruising than one whose airway reflexes are quiescent. If protracted

coughing occurs it may indicate inadequate anaesthesia or sedation. Both can be adjusted accordingly. Technical failure can be minimised by ensuring all equipment is checked prior to proceeding and the anaesthetist should always be vigilant to the possibility of airway obstruction that may be exacerbated by sedation. Equally a degree of obstruction may occur once the scope enters the larynx or trachea. Remember that an awake tracheostomy may be the most appropriate line of management in patients with extremely critical airways.

Awake fibreoptic intubation is a procedure in which fairly liberal amounts of local anaesthetic may be used (especially if sedation is contraindicated) and this is not without risk. The anaesthetist should be vigilant in monitoring for signs of toxicity and overdose, remembering that peak absorption of topical anaesthesia can occur 15-60 minutes following administration.

Table 7. *Complications of awake fibreoptic intubation*

Equipment failure	Poor view/fogging
Bleeding/haematoma	Coughing
Complete airway obstruction	Oesophageal intubation
Local anaesthetic toxicity	Failure to pass ETT (intubate)

SUMMARY

Awake fibreoptic intubation performed by a skilled operator allows the airway to be secured safely in situations where conventional laryngoscopy may prove challenging. It is a straightforward technique that, once mastered, is an extremely valuable skill. The key to its success is thorough preparation of the equipment and the patient. Since there is a variety of ways to provide sedation and airway anaesthesia, each individual anaesthetist will adopt a practice with which they feel confident and tailor it to each patient's requirements. Although it is imperative to have an understanding of the principles underlying awake fibreoptic intubation, nothing can replace the experience gained by directly observing and practising the technique.

REFERENCES

1. Ovassapian A, Krejcies TC, Yelich J, et al. Awake fibreoptic intubation in the patient at high risk of aspiration. *Br J Anaesth* 1989; **62**: 13-16.

2. Popat MT. Practical Fibreoptic Intubation. Butterworth-Heinemann. Published 2001.

3. Rai MR, Parry TM, Dombrovskis A et al. Remifentanil target-controlled infusion vs. propofol target-controlled infusion for conscious sedation for awake fibreoptic intubation: a double-blinded randomized controlled trial. *Br J Anaesth* 2008; **100**: 125-30.

4. Marsland CP, Martin KM, Larsen PD, Segal R; Lidocaine toxicity in volunteer subjects undergoing awake fibreoptic intubation. *Anesth Analg* 2005; **101**: 607.

5. Bell RW & Butt ZA; Warming lignocaine reduces the pain of injection during peribulbar local anaesthesia for cataract surgery. *Br J Ophthalmol* 1995; **79**: 1015-7.

6. Williams KA, Barker GL, Harwood RJ et al. Combined nebulisation and spray-as-you-go topical local anaesthesia of the airway. *Br J Anaesth* 2005; **95**: 549-53.

7. Xue F, Liu H, He N, et al. Spray-as-you-go airway topical anaesthesia in patients with a difficult airway: a randomised, double-blind comparison of 2% and 4% lidocaine. *Anesth Analg* 2009; **108**: 536-43.

Acute pain management for opioid tolerant patients

Simon Marshall and Mark Jackson*
*Correspondence email: mark.jackson@rdeft.nhs.uk

INTRODUCTION

Opioid tolerance is usually encountered in specific patients groups:

- Patients who are prescribed long-term opioids f or the treatment of either chronic non-cancer pain or for the treatment of cancer pain.

- Patients with a substance abuse disorder with continuing illicit use of opioids, particularly intravenous drug users, or patients who are currently on a maintenance treatment program of either methadone or sublingual buprenorhpnine.

- There is also emerging evidence that acute opioid tolerance can occur over surprisingly short periods of time in response to intravenous administration of high potency opioids, particularly remifentanil.

DEFINITIONS

It is essential to have uniform definitions to prevent misconceptions and mislabeling of these groups of patients. It is important that healthcare providers are able to differentiate between the term *addiction* and the normal physiological consequences of remaining on long-term opioids, such as *tolerance* and *physical dependence* (Table 1).

CLASSIFICATION OF OPIOID TOLERANT PATIENTS

Patients with persistent non cancer pain

Epidemiological studies indicate that as many as 11 to 60% of the adult population suffer with chronic pain. The estimates of the prevalence of chronic pain vary widely due to a lack of standardization in the definitions of pain and pain assessment tools. However persistent non-cancer pain is a significant worldwide problem and the use of long-term opioid medication to treat this type of pain is increasing. Patients of this type will be seen in increasing numbers after elective or emergency surgery.

Patients with persistent cancer pain

Opioids are currently the most effective and appropriate treatment for moderate to severe cancer induced pain and remain the mainstay of treatment. Pain is the first symptom of cancer in 25-50% of all cancer patients and up to 75-95% of advanced cancer patients must cope with persistent pain. Cancer pain may be related to disease progression, either local invasion or metastases, or as a consequence of treatments such as surgery, chemotherapy and localized radiotherapy.

Summary

Diagnosis and management of acute pain in opioid tolerant patients is challenging and is often poorly managed in the hospital setting. The evidence base for this group of patients is limited and guidelines are largely based on evidence from case studies, case reports and expert consensus. This article is a review of the current recommendations relating to this group of patients and outlines the approach to management of acute pain in the opioid tolerant patient by anaesthetists in the hospital setting.

Table 1. *Definitions related to chronic use of opioids (American Academy of Pain Medicine)*

Tolerance	A predictable physiological decrease in the effect of a drug over time so that a progressive increase in the amount of that drug is required over time.
Physical dependence	A physiological adaptation to a drug whereby abrupt discontinuation or dependence reversal of that drug, or a sudden reduction in its dose, leads to a withdrawal syndrome.
Addiction	A disease that is characterised by aberrant drug seeking behaviour and maladaptive drug taking behaviour that may include cravings, compulsive drug use and loss of control over drug use, despite the risk of physical, social and psychological harm. Unlike tolerance and physical dependence, addiction is not a predictable effect of a drug.
Pseudoaddiction	Behaviour that may seem inappropriately drug seeking but are the result of under treatment and resolve when pain relief is adequate.

Simon Marshall
Specialist Trainee
Department of Anaesthesia
Musgrove Park Hospital
Taunton TA1 5DA
UK

Mark Jackson
Consultant in Anaesthesia and
Pain Management
Department of Anaesthesia
Royal Devon and Exeter
Hospital
Exeter EX2 5DU
UK

Patients with a substance abuse disorder

These patients fall into 3 distinct subgroups:

Active

These are patients who are currently abusing prescribed or non-prescribed opioid medication. The prevalence of heroin use in the UK is 1%. Similar prevalence levels for heroin use have been documented in both the USA and Australia. Intravenous drug abusers are more likely to present with certain types of acute pain, including traumatic injury, limb ischaemia due to inadvertent intra-arterial injection and infections (epidural abscess and infections around injection sites).

The data on the prevalence of addiction in patients taking prescribed opioids for chronic non-cancer pain is limited, suggesting a ranging between 0-50%. Results from these studies should be interpreted with caution as study populations are not consistent with respect to diagnosis and previous history. Prevalence rates also vary depending on the criteria used to define addiction.

Replacement therapy

Opioid maintenance therapy is increasingly recognized to be an effective management strategy for opioid addiction, with oral methadone the most commonly used drug. The methadone maintenance program is effective in reducing injecting behaviour, illicit drug use, criminal activity and the cost to society.

High dose sublingual buprenorphine is increasingly used as a maintenance therapy in opioid addiction, as it is perceived to have less adverse effects and less social stigma than methadone. Buprenorphine is a partial opioid agonist and thus antagonises the effects of additional illicit or therapeutic opioids that are taken. It has a high opioid receptor affinity and supplemental opioids when given in standard doses do not displace it from the opioid receptors, making it ideal for use as a maintenance therapy. However when administered in high doses as part of the maintenance program it can make acute pain management of patients with conventional doses of opioids very difficult. Management of this group of patients will be discussed in detail later.

Recovery

Patients who are now opioid free and in recovery are often concerned that if they are prescribed opioids to manage their acute pain they will run the risk of relapsing back into their previous opioid abuse disorder. Patients should be reassured that the risk of reverting to an active addiction disorder is small and paradoxically ineffective analgesia in this group of patients is more likely to lead to a relapse.

Patients with acute opioid tolerance

There is emerging evidence that acute opioid tolerance or opioid induced hyperalgesia (OIH) could potentially develop over a very short period of time. OIH is a process that has been shown to occur where the administration of opioids can activate pronociceptive mechanisms in the central nervous system, resulting in an actual increase in pain sensitivity. Paradoxically reducing the dose of opioids can help to improve pain management. This process has been demonstrated to occur with patients on long-term opioids particularly patients on a methadone maintenance program. Opioid tolerance and OIH have also been associated with the short term use of high potency opioids, for example remifentanil, used intraoperatively or as part of the sedation regime in the intensive care

unit. However this association has not been fully established as the studies on this issue have conflicting results.

OPIOID TOLERANT PATIENTS IN THE ACUTE SETTING

Increased workload

Compared with matched opioid naive patients these patients create a greater workload for healthcare professionals and the acute pain team. They require more frequent reviews, more frequent changes to their prescription chart. Patient controlled analgesic (PCA) regimes may require more attention, with increased bolus dose and background infusion rates.

Increased opioid consumption

For a given procedure, postoperative PCA opioid use has been shown to be 2-3 times higher in opioid tolerant patients compared with opioid naive controls.

Increased pain scores

This group of patients consistently report higher pain scores and this can make assessment challenging. It is useful to assess the patients in terms of what they are able to do functionally - their ability to cough, deep breathe, mobilize and complete physiotherapy exercises, as these are likely to be more useful than relying on pain scores.

Consequently, these factors can have a negative impact on the care opioid tolerant patients receive by invoking strong feelings in hospital staff, with patients perceived as 'manipulative' and 'non-cooperative'. Staff who are unfamiliar with such patients may also show apprehension about prescribing large doses of opioid medication that they are unfamiliar with, for fear of causing harm or exacerbating addiction. This may lead to under treatment of pain, an increased level of opioid seeking behaviour by the patient and may ultimately perpetuate an increasing spiral of mistrust in the patient-clinician interaction.

AIMS OF ACUTE PAIN MANAGEMENT

It is important to adhere to a clear and well documented acute pain management plan that both the healthcare staff and patient are aware of. The aims of pain management are categorised as follows:

The provision of effective analgesia

A multimodal approach is always recommended. The provision of effective analgesia needs to incorporate a plan to manage the patient's opioids so that their usual background opioid dose is continued to prevent a withdrawal syndrome, with additional short-acting opioids given for the acute pain treatment (discussed in detail next section). It is also important to use opioid sparing techniques such as:

- Paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs) or COX-2 inhibitors should be prescribed regularly unless contraindicated.

- Local anaesthetic techniques should be employed were possible. Catheter based techniques allow the continuous infusion of local anaesthetic in the postoperative period, decreasing the requirement for additional short-acting opioids.

- Ketamine in low (sub-anaesthetic) doses acts primarily as a non-competitive antagonist of NMDA receptors. Postoperative administration of ketamine in opioid tolerant patients can lead

to improved pain scores and decreased opioid consumption. Often this is administered postoperatively as a continuous low dose IV or SC infusion.

> **A regime for low-dose intravenous ketamine**
>
> Make up 200mg ketamine and 5mg midazolam to 50ml in 0.9% saline and infuse at 2ml.h^{-1}

- Gabapentinoids (gabapentin and pregabalin) are calcium channel modulators that have an established role in the treatment of neuropathic pain. A number of meta-analyses on non-opioid tolerant patients have shown that perioperative gabapentinoids lead to improved analgesia and reduced postoperative opioid consumption, but can also lead to increased sedation scores when compared to placebo. There may be a useful role for these drugs in opioid tolerant patients.

Prevention of withdrawal

All opioid tolerant patients run the risk of developing withdrawal symptoms (Table 2) if their normal dose of opioid is stopped, the dose reduced too quickly or the effect of the opioid is reversed by use of an antagonist such as naloxone. This is not a sign that they are addicted to opioids but is a normal and expected physiological response to physical dependence, which occurs in all patients on long term opioids.

Each patient's usual opioid requirements must be considered, and continued to prevent withdrawal, whilst the additional short-acting opioids are used to manage the acute pain.

Table 2. *Symptoms and signs of opioid withdrawal*

Sweating
Feeling hot and cold
Dilated pupils
Anorexia
Abdominal cramps
Nausea and vomiting
Diarrhoea
Insomnia
Tachycardia and hypertension
Muscular aches and pains

Continuing dose of usual opioid to prevent withdrawal

It is important to continue a patient's usual dose of opioid perioperatively. If the patient normally takes oral medication but is now nil by mouth, then an equivalent parenteral replacement will be needed (see Example 1).

If the patient's normal opioid requirements are via transdermal patches (fentanyl or buprenorphine), we recommended that these patches be continued.

Buprenorphine is a partial agonist and there is a theoretical risk that it might antagonise full opioid agonists, making acute pain management more difficult. However use of buprenorphine transdermal patches

up to 70mcg.h^{-1} is unlikely to interfere with the use of full-agonist opioids for acute pain.

Additional opioid for acute pain

For minor procedures short-acting opioids can be administered as required. A starting dose of one sixth of the patient's usual total 24 hour opioid dose, given up to 4 hourly, is recommended.

The use of intravenous PCA is widely recommended as the treatment of choice for administering short-acting opioids for acute pain management as it allows individual dose titration and reduces workload for staff. Often patients require increased bolus doses and may require a background infusion of opioid if unable to take their usual oral opioid. It can be difficult to know the optimal starting dose. One method is to base the size of the bolus on the patient's normal 24 hour opioid requirement (Example 1).

> **Example 1**
>
> An opioid tolerant patient, who normally takes 150mg sustained release morphine twice a day was admitted requiring an emergency laparotomy and will be nil by mouth postoperatively.
>
> - To prevent withdrawal the usual oral 24 hour opioid dose needs to me maintained, i.e. 300mg morphine.
>
> - As he is nil by mouth this needs to be converted to an IV dose.
>
> - Conversion ratio for oral morphine:IV morphine is 3:1 (see Table 3).
>
> - Total IV dose over 24hrs =100mg, i.e a background infusion of 4mg.h^{-1}.
>
> - The bolus dose should be started at 50% of the dose of the background infusion (2mg), with a standard lock-out time of 5mins.

Note that this PCA dose strategy is a guideline and may not be suitable for all patients in all situations. Opioid tolerant patients require more frequent assessments on the ward and it is likely that the initial PCA prescription will need to be altered depending on the patient's response.

Opioid rotation

This technique, where a patient is changed from one opioid to another, is often used in the treatment of both chronic non-cancer pain and cancer pain. This technique is used when patients are gaining tolerance to the analgesic effect of the initial opioid and, the effective dose required is increasing. However we know that patients gain tolerance to both the beneficial effects of opioids (e.g. analgesia) and also to side effects (e.g. constipation and sedation), but the rates at which tolerance develops is not uniform. So if a patient develops tolerance to the analgesic effects of the opioids at a greater rate than they develop tolerance to undesired effect, they are often unable to tolerate the increased dose needed for analgesia due to excessive side effects.

In this scenario rotating to a different opioid can lead to reduced side effects and improvement in pain relief. The concept is based on the rationale that different opioids do not act to the same degree on the various opioid receptors, they are often metabolized differently and there is incomplete cross-tolerance between different types of opioids.

When conducting an opioid rotation, it is recommended to calculate opioid consumption in the previous 24 hours in morphine equivalents and then reduce this dose by 30-50% to allow for incomplete cross-tolerance among the different opioids (Example 2).

Example 2

A patient on a methadone maintenance program taking 100mg daily, requires a major surgical intervention for which he will be nil by mouth postoperatively.

He is unable to take oral methadone, so we need to convert his dose of methadone to a suitable dose of IV opioid to prevent withdrawal.

- Need to convert his last 24hrs dose of methadone to oral morphine equivalents:
    - Oral methadone:oral morphine is 1:2 or 1:3 (see Table 3)
- Using 1:3 ratio 100mg oral methadone is equivalent to 300mg of oral morphine.
- 300mg oral morphine is equivalent to 100mg IV morphine
- As there is incomplete cross tolerance between the different types of opioids we reduce the equianalgesic dose of oral morphine by 50%.
- Dose of IV morphine required over 24hours to prevent withdrawal is 50mg
- So PCA should have morphine at 2mg.h^{-1} background infusion and starting bolus dose at 50% of the background infusion - 1mg bolus.

Multidisciplinary team approach

It is beneficial to have a collaborative approach with other hospital specialities, such as drug and alcohol services, palliative care and psychology. Regular review by the different specialities within the team provides a more holistic service and helps to identify and deliver the pain management requirements of the patient throughout their in-patient stay. Close liaison with the patient's general practitioner is also necessary to continue the management in the community setting.

Step-down analgesia plan

It is important to have a plan on how to convert the patient back from IV opioids to oral. It is recommended to calculate the patient's last 24 hour consumption of IV opioids and convert this back to the oral equivalent. Then administer 50% of this dose in a sustained release oral preparation and have immediate release opioids prescribed on as required basis. The dose of the immediate release opioids should be 1/6th of the calculated total 24 hour oral equivalent (Example 3).

Example 3

A patient recovering from major surgery is now able to eat and drink and the plan is to convert him from his IV PCA morphine to oral morphine. He has used 60mg IV morphine in the last 24hrs.

- Need to covert IV morphine dose to oral morphine equivalents:
    - 60mg IV morphine is equivalent to 180mg oral morphine.

- 50% of the calculated oral equivalent dose is given in a sustained release form e.g. 45mg of morphine sulphate sustained release twice daily.

    1/6 of the calculated oral equivalent dose is given in the immediate release form on an as required basis e.g. oramorph 30mg up to 4hrly.

It is vital that the patient's general practitioner is made aware of doses of opioids that the patient will be discharged home on and how they should be tapered down.

Management of patients on high dose sublingual buprenorphine

High dose sublingual buprenorphine is being increasingly used as a maintenance therapy in opioid addiction, as it is percieved to have less adverse effects and social stigma. It is typically used in doses ranging from 8-32mg every 2 to 3 days.

Buprenorphine is a partial opioid agonist and its maximum effect at the μ-opioid receptor is less than that of a full agonist producing a ceiling effect for respiratory depression and analgesia. It also has a very high opioid receptor affinity and its binding to opioid receptors is not easily reversed by other opioids. These pharmacological properties make it ideal for use as a maintenance therapy, However

Table 3. *Estimated equianalgesic doses of opioids (Journal of Pain and Symptom Management, 2001)*

Drug	IV dose (mg)	Oral dose (mg)
Morphine	10	30
Oxycodone	10	15 – 20
Fentanyl	0.15 – 0.2	n/a
Methadone	10	10 – 15
Buprenorphine	0.3	0.8 (sublingual)

Table 4. *Comparison of oral morphine and transdermal patch dosage (The British Pain Society, 2007)*

Oral morphine (mg.24h^{-1})	Buprenorphine patch (mcg.h^{-1})	Fentanyl patch (mcg.h^{-1})
10	5	
15	10	
30	20	
45		12
60	35	
90	52.5	25
120	70	
180		50
270		75
360		100

Table 5. *Perioperative pain management strategies for patients stabilized on high dose buprenorphine[4]*

Minor procedures

- Continue the current buprenorphine regimen (and consider an increase of 25%)

- Maximize non-opioid treatments.

Major procedures

- Continue the usual dose of buprenorphine + 25%

- Maximize non-opioid analgesia

- Consider titration of high dose intravenous opioids such as fentanyl or morphine. Patients should be closely observed for adverse effects of sedation or respiratory depression - HDU care is appropriate where available.

Or

- Cease buprenorphine 72 hours preoperatively and commence a full opioid agonist (methadone or sustained release morphine) 24 hours later, or earlier if opioid withdrawal is noted.

- Additional doses of a full agonist can then be titrated to withdrawal symptoms preoperatively and analgesic requirements postoperatively.

Where:

- buprenorphine <4mg per dose - commence methadone 20mg.day^{-1} or morphine 60mg.day^{-1}

- buprenorphine >4 mg per dose - commence methadone 40mg.day^{-1} or morphine 80mg.day^{-1}

they can also make the treatment of acute pain by conventional opioids difficult. Table 5 outlines possible treatment stratergies for this group of patients

CONCLUSION

The acute pain management of opioid tolerant patients is often challenging and it is important to use a multimodal approach to analgesia. Appropriate doses of opioid are needed to prevent withdrawal and provide effective analgesia. Be aware of the potential acute pain management problems of high dose sublingual buprenorphine. Note that the dose regimens outlined in this article are suggestions only and may not be suitable for all patients or in all situations.

REFERENCES

1. Roberts L, chapter 30: the opioid tolerant patient, including those with a substance abuse disorder. In Macintyre, Walker and Rowbotham [eds]. Clinical Pain Management , Acute pain [2nd edition] Hodder Arnold 2008 pages 539 -56.

2. The opioid tolerant patient, ANZCA Acute pain management: Scientific evidence 3rd edition 2010 chapter 11.7 pages 426-31.

3. The opioid tolerant patient, ANZCA Acute pain management: Scientific evidence 3rd edition 2010 chapter 11.8 pages 433-437.

4. Roberts DM, Meyer-Witting M. High dose Buprenorphine: Perioperative precautions and management stratergies. *Anesth Intensive Care* 2005; **33**: 17-25.

5. Mehta V, Langford RM. Acute pain management of opioid dependent patients. *Anaesthesia* 2006; **61**: 269-76.

BRIEF COMMUNICATION

Paediatric anaesthesia at a tertiary hospital in Nigeria

Ilori IU,* Beshel-Akpeke RA, Usang UE
*Correspondence email: iniabasi25@yahoo.com

INTRODUCTION

Many hospitals in sub-Saharan Africa lack the basic facilities for the administration of safe anaesthesia for adult and paediatric patients.[1] Despite these deficiencies, anaesthetic services in our institution have not been audited and so we have no true picture of our anaesthesia service and its effect on anaesthetic outcome. This audit is a retrospective analysis of the paediatric anaesthesia service provided in a tertiary hospital in a resource poor environment, looking specifically at intraoperative adverse events.

METHODS

University of Calabar Teaching Hospital, Calabar, Nigeria, has 3 theatre sites: the main theatre for all surgical specialties, the obstetric and gynaecology complex and a separate ophthalmology site. One of the five consultant anaesthetists is a specialist in paediatric anaesthesia and seven of the eighteen trainees are senior registrars, regularly anaesthetizing children under 5 years.

The data of paediatric patients, aged 0 to 18 years, between August 2007 and September 2009 were extracted retrospectively from the anaesthetic records at the main theatre complex. The patients were grouped into 0 to 5 years and above 5 years. The parameters collected were age, sex, weight, ASA status, haematocrit level, surgical diagnosis, anaesthetic technique and intraoperative adverse events. The data was analyzed using a Microsoft Excel spreadsheet.

RESULTS

We extracted data for 623 paediatric patients during this 2-year period, accounting for 29% of 2178 surgical procedures performed in the main theatre complex. The male to female ratio was 2.3:1, with 311 patients aged 0 to 5 years and 312 over 5 years. The surgeries were mainly elective (527 procedures, 85%). The American Society of Anesthesiologists (ASA) class I patients were 61% and ASA IV were only 2%.

The anaesthetic techniques used for the different age groups and are shown in Table 1.

There were 63 adverse events recorded in 57 (9%) patients. Table 2 shows the age distribution of the adverse events. Forty (63%) of the events occur in the 0 to 5 years group. Respiratory events were the most frequent accounting for 48% of all adverse events, with 74% occuring in the younger age group. Laryngeal spasm accounted for 48% of the respiratory events (15 events). There was one case of masseter muscle spasm in a 7-year-old female child. There was no mortality recorded among the patients. Most of the events occured in ASA 1 and 2 patients (Table 3). The pattern of surgical disease is shown in Table 4. Ear, nose and throat (ENT) pathologies were the commonest, numbering 156 (26%).

DISCUSSION

This audit describes paediatric anaesthesia data that was retrospectively extracted from the anaesthetic

IU Ilori
Department of Anaesthesiology

RA Beshel-Akpeke
Department of Anaesthesiology

UE Usang
Department of Surgery
University of Calabar
Teaching Hospital
PMB 1278
Calabar 540001
Nigeria

Table 1. *Anaesthetic techniques by age group (GA – general anaesthesia)*

Anaesthetic technique	0 – 5 years	>5 years	Total (%)
GA with intubation	191	127	318 (51%)
GA with no intubation	78	72	150 (24%)
Total intravenous anaesthesia with ketamine	11	15	26 (4%)
Regional	12	69	81 (13%)
Combined regional and GA	20	28	48 (8%)

Table 2. *Intraoperative adverse events by age group*

Adverse events	0 - 5 years	>5 years	Total (%)
Respiratory	23	8	31 (48%)
Cardiovascular	4	2	6 (10%)
Delayed awakening	5	4	9 (14%)
Equipment malfunction	4	4	8 (13%)
Postoperative nausea and vomiting	1	2	3 (5%)
Failed spinal	1	2	3 (5%)
Medication error	2	0	2 (3%)
Masseter muscle spasm	0	1	1 (2%)
Total	**40 (63%)**	**23 (37%)**	**63 (100%)**

records in a tertiary hospital where there are skilled anaesthetic and surgical staff. Children constituted 29% of the total 2178 patients in this audit. This is high compared to 9.6% of all operative procedures reported by Ameh et al at rural teaching hospital in northern Nigeria in 2001.[2] In French speaking sub-Saharan Africa, Maman et al reported that 10% of patients were under 10 years of age in Yaounde, Cameroon and 12% under 16 years in Togo.[3] The increase in the percentage of paediatric surgical patients in our sub-region may reflect the relatively urban setting of the hospital or may indicate an improvement in health facilities utilisation. It also suggests that paediatric surgical diseases represent a significant burden of surgical health problems, which should therefore be considered an essential component of our government's child health programme.

An experienced surgical and anaesthesia team considerably decreases operative morbidity and mortality, especially in young children.[4] In the USA, there was a significant reduction in anaesthetic related adverse events from 16 to 2% between 1978 and 1988, as the number of physician anaesthetists increased. This reduction in adverse events was achieved before the introduction of pulse oximetry and other monitors.[4] The 63 adverse events (9%) reported in this audit were specifically intraoperative adverse events. This is comparable to the rate of 9.3% reported by Edonmonyi et al at University of Benin Teaching Hospital, Benin City, Nigeria where there are also trained anaesthetic manpower.[5] All the adverse events were associated with general anaesthesia except for three failed spinal blocks (5% of all events).

Respiratory events were the most frequent perioperative incident, in line with published series in paediatric anaesthesia.[6,7] Laryngeal spasm accounted for 48% of the respiratory events (15 events). Adverse incidents such as these should not result in adverse outcomes when managed by experienced specialists,[4] and there were no recorded intraoperative deaths during the 2-year period of this audit. We would largely attribute this to the presence of staff trained in paediatric anaesthesia. In developing countries there is a need to encourage more physician anaesthetists to develop an interest in paediatric anaesthesia as paediatric patients make up a sizeable number of surgical diseases (29% in this audit). Paediatric

Table 3. *ASA status and adverse events*

ASA class	No of patients	No of adverse events (%)
1	385	23 (44%)
2	174	28 (37%)
3	54	10 (16%)
4	10	2 (3%)

Table 4. *Pattern of surgical disease*

Disease type	Percentage of patients
Ear, nose and throat surgery	26
Hernia and hydrocoele	19
Congenital abnormalities	12
Tumours and cysts	11
Trauma	11
Gastrointestinal	10
Infections	6
Urology	5

surgical patients are distributed across different surgical specialties and are handled by the respective specialist and not necessarily by dedicated paediatric anaesthetists and surgeons. The Federation of Associations of Paediatric Anaesthesia (FEAPA) recommends that paediatric anaesthesia should not be undertaken by an occasional anaesthetist.[8] Unfortunately this recommendation is not feasible in many developing countries where there is a lack of physician anaesthetists. Anaesthesia as a specialty is relatively unattractive to young medical graduates as it is viewed as not being lucrative.[9] Poor working conditions, lack of job satisfaction and poor remuneration has contributed greatly to emigration of trained manpower to developed world.

Although the majority of adverse events were associated with general anaesthesia it is not clear whether there is scope in our practice to increase the use of regional anaesthesia. General anaesthesia was administered in 79% of the patients which is similar to previous reports,[2] with regional anaesthesia employed in only 13%. This may reflect a lack of equipment, lack of expertise in paediatric regional techniques or simply that many of the procedures are not suitable for regional techniques in these age groups.

The adverse events involving equipment malfunction did not show any age inclination (Table 2). The 13% of adverse events involving equipment may be underestimate of the true figure, since under-reporting of equipment failure due to unwillingness to complete paperwork is recognised.[6] Given that 70% of the children did not have their weight documented, under-reporting due to the disinclination of the anaesthetists may be a factor in this audit. Technicians do not usually have formal training in the maintenance of the anaesthetic equipment and spare parts are rarely available. The purchase of anaesthetic equipment should include a training package for maintenance as well as reasonable quantity of spare parts for replaceable components.

There is generally paucity of information on the actual prevailing conditions in which anaesthesia is administered in most developing countries.[6] Poor documentation and under-reporting of adverse perioperative events may have contributed to lack of improvement in the available facilities for safe administration of anaesthesia in our environment. There is a need for proper documentation and report of all perioperative adverse events however minor so that healthcare providers can learn from it and improve on service delivery. It could also act as guide in setting guidelines for safe anaesthetic practice in resource poor environments. A governance system for formal reporting of adverse events involving non-availability or malfunctioning of equipment would make healthcare planners aware of the risks to which anaesthetised patients are exposed.

CONCLUSION

Anaesthesia for children in a resource poor environment can be safe with appropriately trained and skilled manpower. However there still much to be done in relation to equipment maintenance. In recent times the Nigerian government has striven to equip most of its tertiary health facilities with necessary equipment for efficient and safe delivery of health services to its citizen. With no concerted effort to maintain this equipment, the improvement in facilities will be short-lived. Anaesthetic care providers should document and report all adverse events however minor or easily managed. This may assist in assessing our quality of service and identify areas for improvement. The availability of paediatric monitoring facilities would help in decreasing morbidity and mortality in the very young.

REFERENCES

1. Hodges SC, Mijumbi C, Okello M et al. Anaesthesia in developing countries: defining the problems. *Anaesthesia* 2007; **62**: 4–11.

2. Ameh EA, Chirdan LB. Paediatric surgery in the rural setting: prospect and feasibility. *West African Journal of Medicine* 2001; **20**: 52-5.

3. Ouro-Bang'na Maman AF, Kabore RAF, Zoumenou E et al. Anesthesia for children in Sub-Saharan Africa – a description of settings, common presenting conditions, techniques and outcomes. *Pediatric Anesthesia* 2009; **19**: 5–11.

4. Jacob R. Pro: Anesthesia for children in the developing world should be delivered by medical anesthetists. *Pediatr Anesth* 2009; **19**: 35–8.

5. Edomwonyi NP, Ekwere IT, Egbekun R, Eluwa B. Anaesthesia-related complications in children. *Middle East J Anesthesiol* 2006; **18**: 915-27.

6. Fisher QA, Nichols D, Stewart FC et al. Assessing pediatric anesthesia practices for volunteer medical services abroad. *Anesthesiology* 2001; **95**: 1315–22.

7. Jimenez N. Trends in Pediatric Anesthesia Malpractice Claims Over the Last Three Decades. *ASA Newsletter* 2005; **69**: 8-12.

8. Federation of Associations of Paediatric Anaesthesia (FEAPA). Recommendations For Paediatric Anaesthesia Services In Europe. Available at: http://www.sarnepi.it/wp-content/uploads/2009/12/FEAPA_RECOMMENDATIONS-FOR-PAEDIATRIC-ANAESTHESIA-SERVICES-IN-EUROPE.pdf

9. Ilori IU, Akpan SG, Eshiet AI. The Influence of Image on the Dearth of Anaesthetists (a clinical student perception). *African Journal of Anaesthesia and Intensive Care* 2003; **4**: 7-10.

BRIEF COMMUNICATION

Medical outreach for correction of orofacial clefts palate in a rural community in Nigeria

AD Nwosu* and HA Ezike
*Correspondence email: adnwosu@yahoo.com

INTRODUCTION

Cleft lip (cheiloschisis) and palate (palatoschisis) are the most common craniofacial abnormalities with an worldwide incidence of 1:700-800 live births.[1] About 500 children with cleft lip and palate are born in Nigeria annually with a Nigerian study reporting an incidence of 1 in 2703 live births.[2] The child with orofacial clefts often has to contend with psychosocial, speech, feeding, hearing and dental problems.[3] Corrective surgery restores appearance and function, making it possible for patients to live normal productive and social lives. Holistic care for the child with orofacial cleft involves several healthcare specialists (plastic and reconstructive surgeon, maxillofacial surgeon, anaesthetist, speech therapist, orthodontist, otorrhinolaryngologist, audiologist, psychologist, psycho-therapist, nurse and social worker), beginning shortly after birth and continuing into adolescent life.

Other congenital abnormalities, commonly involving the heart and kidneys, may co-exist with cleft lip and palate, especially in association with isolated cleft palate. Associated syndromes such as the Pierre-Robin, Treacher-Collins and Downs may predispose to airway problems during anaesthesia. Otherwise difficult laryngoscopy is usually limited to children with bilateral clefts, retrognathia (receding jaw) and young infants.[4,5]

The cost of medical care for a child with cleft lip/palate in Nigeria is usually in excess of one hundred thousand naira (640 US$, 400 GB£) and can reach five hundred thousand naira.

MEDICAL MISSIONS AND OUTREACH

The huge financial burden of cleft lip and palate is currently borne in large part by charitable organisations and specialist volunteers through sponsored International Health Missions, local outreaches and free healthcare at designated centres. Replacing the traditional international medical missions with local outreach services has been deemed to be more efficient and cost-effective.

Despite the environmental and logistical limitations of many host rural health facilities, an outreach service provided by volunteers was felt to be viable. Volunteers from the National Orthopaedic Hospital in Enugu embarked on a two-day free surgical outreach mission for correction of orofacial clefts in Nsukka, Eastern Nigeria.

METHODOLOGY

Publicity

Several weeks prior to the arrival of the medical mission, the mass media was freely employed to create awareness through television, radio and announcements, targeted at the local councils within the vicinity of the medial mission base health facility. Religious organisations, women's groups and traditional rulers were actively involved in the publicity exercise and mobilization of the local populace. Handbills and posters depicting patents with orofacial clefts, before and after repair, were distributed and displayed at strategic places, with information on the venue and time of the outreach programme.

Assessment of the base health facility

A week prior to the start of the programme, a representative from each of the anaesthetic, plastic surgery and perioperative nursing teams visited the rural hospital to assess its facilities for safe provision of anaesthesia and surgery. We found a spacious patient waiting room and small number of postoperative recovery beds, in a vast compound that was generally clean. The operating room was quite large with a clearly demarcated utility section, scrub-up section, a good operating table and a single electrical socket point. A patient examination couch was available to use as a second operating table.

There was no theatre operating light or recovery room and no stools, fans or air-conditioner. There was no sterilizing equipment, save for a kerosene stove, and no sterile supplies or surgical instruments. There was no oxygen source, patient monitoring, suction

Summary

Cleft lip and palate is a common congenital malformation which can have a profound psychosocial and functional impact on a child. International charities provide multidisciplinary care for this condition that would otherwise be beyond the reach of the patients, particularly in resource-poor communities. We piloted an outreach service for cleft lip and palate surgery from within our own country. Thirteen patients underwent corrective procedures in the rural base facility, with one minor intraoperative airway incident recorded.

Dr AD Nwosu
Consultant Anaesthetist
Department of Anaesthesia
National Orthopaedic Hospital
Enugu, Nigeria

Dr HA Ezike
Consultant Anaesthetist
Department of Anaesthesia
University of Nigeria Teaching
Hosital
Enugu, Nigeria

apparatus, Ambu-bag, anaesthetic machine, laryngoscope or other anaesthetic accessories and supplies.

The medical mission

The medical outreach team consisted of a consultant anaesthetist assisted by two nurse anaesthetists, four plastic surgeons, four perioperative nurses, two pharmacists, with a full compliment of anaesthetic equipment and accessories, surgical instruments, sterile materials and supplies.

Eighteen patients presented for the corrective surgery. Screening took place in the open patient waiting hall and included an anaesthetic assessment. Infants and patients requiring palate repair were excluded, since the available equipment and personnel in the rural hospital could not safely cater for the patients after the medical mission had departed. Provision was made for all the excluded patients to assemble at the rural hospital at a later date for free transportation to the National Orthopaedic Hospital, Enugu where surgery was offered free of charge.

Four of the thirteen patients did not observe pre-operative fasting and their surgery was delayed accordingly. Standard anaesthetic procedures were observed in all cases and monitoring included ECG, non-invasive blood pressure and pulse oximetry. Each patient was weighed and intravenous access was secured before the commencement of anaesthesia. Propofol or ketamine was used for induction and maintenance of general anaesthesia, while pancuronium bromide was used to facilitate controlled ventilation with oxygen-enriched air following endotracheal intubation. Lidocaine (1%) with adrenaline (1:50,000) was used for local infiltration in all the patients. Intravenous paracetamol and tramadol were administered to all patients towards the end of surgery.

RESULTS

Thirteen ASA 1 patients between the ages of 2 and 32 years underwent repair of orofacial clefts; six (46%) were done under general anaesthesia while seven (54%) were done under local anaesthesia. There were ten males (77%) and three females (23%). Five of the patients (38%) were below 14 years. Table 1, shows the details of the surgeries performed during the outreach mission.

Table 1. *Details of surgical procedures performed*

Type of Surgery	No. of patients
Unilateral complete cleft lip repair	4
Unilateral incomplete cleft lip repair	5
Lower lip cleft repair	1
Bilateral incomplete cleft lip repair	1
Revision of bilateral cleft lip	1
Revision of Unilateral cleft lip	1
Total	**13**

One patient who received local anaesthesia and sedation suffered a desaturation due to blood and secretions causing larynospasm. She was quickly intubated with a cuffed endotracheal tube and subsequently had controlled ventilation. All the other patients had SaO_2 greater than 96% throughout the surgery. In the recovery room, one patient had significant operation site bleeding which was controlled with firm pressure. All patients went home after recovery on the same day of surgery.

DISCUSSION

A major challenge in a medical outreach missions such as this is the fact that the patient has their first contact with the surgeon and anaesthetist on the day of surgery, allowing no time for detailed history taking, examination or investigation. Among the five patients excluded, were four cleft palate patients - one had Pierre Robin syndrome and one had Treacher Collins syndrome.

Environmental and safety considerations partly dictated the anaesthetic technique used. The lack of an anaesthetic machine made total intravenous anaesthesia (TIVA) and local anaesthesia the preferred anaesthetic options. Direct access to our dedicated pharmacy unit provided a reliable supply of propofol, suxamethonium and pancuronium. Eight patients (62%) were above 14 years of age, which contrasts with the younger population seen at our base teaching hospital, where there were only 3 adults in a series of 107 cleft patients (0.03%).[6] This may reflect the stigma associated with cleft lip and palate which makes sufferers withdraw from society and hide away in the villages, refusing even to attend the base hospital to access free surgical care.

The majority of the older patients underwent local anaesthesia. In an audit of a similar medical mission by an international charity, only 12.9% of the cases were done under local anaesthesia, the remainder undergoing general anaesthesia.[7] Their series reflected a younger patient population with 83% 14 years or below. Our outreach recorded a minor airway incident in theatre and an insignificant surgical site bleed during recovery. The reported incidence of death or severe complications is low in medical missions for cleft palate surgery; out of 6,037 patients who were operated upon in different locations around the globe by one medical mission, there was one death and seven admissions to the intensive care unit, while fifty-four patients had to be re-anaesthesized to manage complications, predominantly surgical haemorrhage and airway problems.

Factors that may influence morbidity in outreach programmes include the advanced stage of the surgical condition, rapid case turnover, fatigue amongst volunteers, team communication problems, suboptimal recovery care, non-availability of an anaesthetic machine and limited monitoring capacity. In our outreach mission discontent over volunteers' welfare was evident, resulting in one of the team members opting out after day 1. Volunteer fatigue and team communication problems were further evident on day 2 and it was felt that a third day could have left the team understaffed. Fisher et al have cited good communication, volunteers' welfare and efficient conflict resolution as critical in such missions.[7]

CONCLUSION

Free medical outreach missions are exciting but challenging. Volunteers must contend with the realities inherent in providing healthcare in rural communities of developing countries. Adequate preparation should include a survey/assessment of the base health facility and a rigorous system for patient selection. Preoperative anaesthetic assessment of individual patients is necessary for safe anaesthesia and surgery.

REFERENCES

1. Olasoji HO, Ukiri OE, Yahaya A. Incidence and aetiology of oral clefts: a review. *Afr J Med Sci* 2005; **34**: 1-7.

2. Iregbulem LM. The incidence of cleft lip and palate in Nigeria. *Cleft Palate J* 1982; **19**: 201-5.

3. Endriga MC, Kapp-Simon KA. Psychological issues in craniofacial care: State of the Art. *Cleft Palate Craniofac J.* 1999; **36**: 3–11.

4. Hatch DJ. Airway management in cleft lip and palate surgery. *Br J Anaesth* 1996; **76**: 755-6.

5. Gunawardana RH. Difficult laryngoscopy in cleft lip and palate surgery. *Br J Anaesth* 1996; **76**: 757-9.

6. Orkar KS, Ugwu BT, Momoh J.T. Cleft lip and palate: the Jos experience. *East Afr Med J* 2002; **79**: 509.

7. Fisher QA, Nichols D, Stewart FC, Finley GA, Magee WP Jr, Nelson K. Assessing Pediatric Anesthesia Practices For Volunteer Medical Services Abroad. *Anesthesiology* 2001; **95**: 1315-22.

Update Short Reports

CASE REPORT

Titrated spinal anaesthesia in high-risk patients undergoing lower limb surgery

Sue Chew and Tony Chow*
*Correspondence email: tchow@bhhdoa.org.au

INTRODUCTION

This brief communication revisits an under-utilised anaesthetic technique that dates back over two decades and updates the technique using modern equipment. Continuous spinal anaesthesia has been validated as a safe, reliable and reproducible technique for surgery involving the lower limb.[1] The technique became popular for its provision of long-lasting spinal blockade, thereby facilitating anaesthesia for surgery that would otherwise exceed the duration conferred by a single dose spinal anaesthetic.

The technique lost popularity following a number of case reports of cauda equina syndrome associated with continuous spinal anaesthesia and the use of microcatheters.[2] An FDA investigation in 1992 lead to withdrawal of approval of microcatheters smaller than 24G for intrathecal. Proposed mechanisms of nerve injury included maldistribution of local anaesthetic as microcatheters have a limited flow rate. As the technique of continuous spinal anaesthesia lends itself to repeat dosing, pooling of local anesthetic in the caudal region is a potential risk.[3] We describe a technique using a 20G catheter.

CASE REPORTS

The clinical features of the six patients in this series are outlined in Table 1.

All six patients received a spinal catheter as described in Table 2. No sedation was administered. The titration process, three 0.5 boluses of 0.5% hyperbaric bupivacaine 15 minutes apart, meant that the induction of anesthesia took around an hour. Upon successful demonstration of anaesthesia of the operative region surgery was commenced without the

Summary

We present a series of six critically ill patients (ASA 4E) undergoing major lower limb vascular and orthopaedic surgery using a carefully titrated spinal anaesthetic technique via a spinal catheter. All six patients received three boluses of 0.5ml of 0.5% hyperbaric bupivacaine 15 minutes apart for induction and anaesthesia and surgery proceded uneventfully.

Sue C Chew
Anaesthetist
Department of Anaesthesia
St. Vincent's Hospital,
Melbourne
Victoria, Australia 3065

Tony KF Chow
Senior Staff Anaesthestist and
Adjunct Senior Lecturer
Department of Anaesthesia &
Peri-Operative Medicine
Box Hill Hospital
Victoria, Australia 3128

Table 1. *Six patients undergoing major lower limb surgery with significant co-morbidities*

Patient	Age (years)	Surgery	Comorbidities
1	60 female	Femoral-popliteal bypass	Asystolic arrest on GA induction Recent GI bleeds Recent quadruple coronary bypass surgery Recent acute renal failure requiring dialysis
2	72 male	Femoral embolectomy from artery graft	Severe emphysema and pulmonary hypertension (pulmonary arterial pressure 39mmHg)
3	78 female	Dynamic hip screw for fractured neck of femur	Aortic stenosis (peak gradients 44mmHg) Recent haemorrhagic cerebral infarct Ischaemic heart disease (IHD), diabetes, atrial fibrillation, congestive cardiac failure
4	91 female	Dynamic hip screw for fractured neck of femur	Aortic stenosis (peak gradient 70mmHg) IHD
5	76 female	Insertion of femoral intramedullary nail Cerebrovascular disease	VT arrest on induction of GA Unstable angina
6	86 male	Above knee amputation	COPD with current infective exacerbation Cardiac failure (Left ventricular ejection fraction 20-25%) Recent acute coronary syndrome

Table 2. *Description of titrated spinal anaesthetic technique (Adapted from Professor Colin Goodchild, Monash University Department of Anaesthesia)*

Position of patient	In lateral position, with the operative leg down.
Equipment	A standard 18G Tuohy epidural set with a 20G Portex epidural catheter.
Technique	Following strict sterile preparation, the Tuohy needle is inserted at the lumbar 4/5 vertebral space in the midline to identify the epidural space using loss of resistance with saline.
	The syringe is then disconnected and the remaining saline discarded. The syringe is reattached and the plunger gently withdrawn. This has the effect of creating slight negative pressure to facilitate apposition of the dura to the tip of the needle. (Technique from reference 1, adapted by Prof Colin Goodchild).
	The needle is then advanced a further 0.5cm to puncture the dura. The syringe is then disconnected and the Portex catheter is fed through the needle. The correct placement of the catheter can be confirmed by flow of cerebrospinal fluid within the catheter.
	The catheter is secured with 3 to 5cm of the catheter left within the subarachnoid space, in the same manner as an epidural.
	Clear labeling of the catheter is essential to avoid confusion with an epidural catheter.
Medication	We used hyperbaric 0.5% bupivacaine aiming for a unilateral block. 0.5ml aliquots were titrated at 10 to 15 minute intervals to achieve the desired block.
	We do not use the catheters on our surgical wards, removing the catheter before transfer to the ward. However we do run infusions for patients admitted to the ICU postoperatively (preservative-free morphine at 10mcg.h^{-1}).

aid of any sedatives. Patients 1 and 5 received an additional bolus due to the long duration of surgery. All operations were successfully completed with minimal vasopressor support (three doses of 0.5mg metaraminol or less) and all patients were cardiovascularly stable intraoperatively and in the immediate postoperative period. There were no intraoperative adverse events. All six patients were managed in a post-anaesthesia care unit (PACU) and no adverse events (hypotension, sedation, respiratory depression, nausea or vomiting) were observed.

Four of the six patients were discharged from hospital. Two patients died in the postoperative period; patient 6 died from fulminant acute pulmonary edema 3 days postoperatively, and patient 2 died following a respiratory arrest 2 days postoperatively. Post mortem concluded that both died of their underlying conditions.

DISCUSSION

Titrated spinal anesthesia remains a clinically underutilised technique. It continues to have a role as an alternative to general anaesthesia where single-dose spinal techniques are undesirable or inappropriate. There are case reports of successful use of titrated spinal anaesthesia in the parturient with congenital heart disease,[4] the role of titrated spinal anaesthesia in the peripartum management of a parturient with severe aortic stenosis[5] and also where severe aortic stenosis would normally preclude the technique of single-dose spinal for lower limb surgery.[6]

The key benefit conferred by this technique is greater haemodynamic stability achieved in patients with limited cardiac reserve and major co-morbid disease, who face significant cardiovascular challenges when undergoing lower limb vascular and orthopaedic surgery.

This has been demonstrated in a number of elective randomised controlled trials involving similar patient groups, whom were optimised but not critically ill.[7,8]

Spinal anaesthesia is associated with a risk of profound and prolonged hypotension related to rapid sympathetic block. However careful titration of the spinal dose allows more gradual extension of the block which can be manipulated and titrated to achieve the desired clinical effect, whilst minimizing the haemodynamic consequences.

This series of patients demonstrates the use of titrated spinal anaesthesia in patients where conventional single-dose spinal anaesthesia would usually be contraindicated and in whom general anaesthesia would be considered very high-risk or had already proven to be inappropriate.

REFERENCES

1. Schnider TW, Mueller-Duysing S, Johr M, Gerber H. Incremental dosing versus single-dose spinal anesthesia and hemodynamic stability. *Anesth Analg* 1993; **77**: 1174-8.

2. Rigler ML, Drasner K et al. Cauda equina syndrome after continuous spinal anesthesia. *Anesth Analg* 1991; **72**: 274-81.

3. Mollmann M, Holst D, Lubbesmeyer H, Lawin P. Continuous spinal anesthesia: mechanical and technical problems of catheter placement. *Reg Anesth* 1993; **18** (Suppl): 469-72.

4. Chohan U, Afshan G, Mone A. Anaesthesia for caesarean section in patients with cardiac disease. *J Pak Med Assoc* 2006; **56**: 32-8.

5. Pittard A, Vucevic M. Regional anaesthesia with a subarachnoid microcatheter for caesarean section in a parturient with aortic stenosis. *Anaesthesia* 1998; **53**: 169-73.

6. Collard CD, Eappen S, Lynch EP, Concepcion M. Continuous spinal anesthesia with invasive hemodynamic monitoring for surgical repair of the hip in two patients with severe aortic stenosis. *Anesth Analg* 1995; **81**: 195-8.

7. Favarel-Garrigues JF, Sztark F et al. Hemodynamic effects of spinal anesthesia in the elderly: single dose versus titration through a catheter. *Anesth Analg* 1996; **82**: 312-6.

8. Minville V, Fourcade O et al. Spinal anaesthesia using single injection small-dose bupivacaine versus continuous catheter injection techniques for surgical repair of hip fracture in elderly patients. *Anesth Analg* 2006; **102**: 1559-63.

Update Short Reports

CASE REPORT

Report of an effective awake thoracic epidural anaesthetic for major abdominal surgery in two high risk patients with severe pulmonary disease

E Abd Elrazek*, M Thornton, A Lannigan
*Correspondence email: Prof.essamrazek@hotmail.com

Summary

Awake thoracic epidural anaesthesia as the sole anaesthetic technique was successfully employed for two high-risk surgical patients with chronic obstructive pulmonary disease, undergoing abdominal surgery. The procedure was tolerated well and the anaesthetic technique, which has been shown to reduce intraoperative and postoperative cardiac, respiratory and gastrointestinal complications, may have significantly contributed to the prompt, complication free recovery experienced by both patients.

Essam Abd Elrazek
Consultant Anaesthetist

M Thornton
Consultant Surgeon

A Lannigan
Consultant Surgeon
Wishaw General Hospital
Wishaw
UK

INTRODUCTION

We report two cases of awake major abdominal surgery in two high risk surgical patients with severe pulmonary disease, performed under thoracic epidural anaesthesia as a sole technique. The first case was an elective open sigmoid colectomy in a 61-year-old patient with chronic obstructive pulmonary disease (COPD) and recent thoracotomy for a wedge resection of a bronchial adenocarcinoma. The second case was an emergency open cholecystectomy in a 66-year-old patient with end-stage COPD. Reviewing the literature, no similar cases were reported recently.

CASE ONE

A 61-year-old male patient known to have end-stage COPD was diagnosed with a sigmoid adenocarcinoma in January 2008. Preoperative staging identified a spiculated mass lesion in his right lung. A PET scan suggested that these were two independent primaries. In March 2008 he underwent a right thoracotomy under a combined anaesthetic technique of general anaesthesia in conjunction with a thoracic epidural. During surgery, it was difficult to ventilate him due to secretions in his dependent lung and a decision was taken to limit the operative procedure to a wedge resection rather than a lobectomy. The first 10 postoperative days were complicated by atelectasis, reduced oxygen saturation and rapid atrial fibrillation, which converted to sinus rhythm with amiodarone.

At anaesthetic assessment prior to colonic resection, the patient was noted to have a BMI of 32 and he was still smoking 4-5 cigarettes per day (previous history of 50 pack years). He had chronic productive cough and was on four regular inhalers; terbualine (Bricanyl), tiotropium bromide (Spiriva) and budesonide/formoterol (Symbicort) with salbutamol (Ventolin) as required. On examination he sounded generally wheezy, with reduced air entry bilaterally. His preoperative chest Xray showed generalised emphysematous changes with hyperinflation, but was clear of focal disease.

The patient's peak expiratory flow rate (PEFR) was 250L.min^{-1}. Pulmonary function tests showed that his FEV_1 was 1.5L (54% of predicted) with an FEV_1/FVC ratio of 45%, and not improved after a bronchodilator. The six-minute walk test (6MWT) detected an overall low level at 223 meters (predicted distance in healthy elderly = 631 ± 93 meters),[1] and he was diagnosed to have moderately severe irreversible COPD.

Surgical and anaesthetic options were discussed and we decided to proceed to open surgery using awake thoracic epidural anaesthesia to minimise potential chest complications.

The patient received an awake thoracic epidural anaesthetic (T7-8). The technique was performed in a lateral position under complete asepsis and continuous monitoring of heart rate (HR), non-invasive blood pressure (NIBP) and pulse oximetry (SpO$_2$). Light sedation using 4mg midazolam was given and lignocaine 1% (5ml) was used to infiltrate the skin. The block was induced with lignocaine 2% with adrenaline 1:200 000 (total 20ml), clonidine 150mcg and diamorphine 3mg. Loss of sensation up to T4 was obtained bilaterally five minutes after injection of the local anaesthetic bolus. This was confirmed testing cold sensation with ice. A bolus of 10ml levo-bupivacaine 0.5% was given followed by an infusion of 0.1% levo-bupivacaine with fentanyl 2mcg.ml^{-1} (10–15ml.h^{-1}) to maintain the block throughout the operation. Analgesia and abdominal muscle relaxation were optimum and excellent operating conditions were obtained.

The patient was conversing with the operative team during surgery, while remaining very comfortable, breathing 4-6L.min^{-1} oxygen via Hudson facemask. No further sedation was required. The patient was stable from a haemodynamic and respiratory standpoint throughout the operation. The operation time was two hours and invasive monitoring was not used.

The patient was transferred to the recovery room postoperatively, and then to the high dependency unit (HDU) for postoperative observation and monitoring. Continuous epidural analgesia was very effective and no further analgesia was required. The upper level of the epidural block was consistent with the epidural scoring scale for arm movements (ESSAM) of zero (able to perform a hand grip),[2] the patient was breathing comfortably and no respiratory support was needed. The patient made a remarkable recovery and was discharged home 6 days post-operatively in good general condition. On review at 4 and 8 weeks after discharge, the patient was well and had returned to preoperative activity levels.

CASE TWO

A 66-year-old male ex-smoker was admitted to the emergency department of Wishaw General Hospital suffering from sudden onset epigastric and right upper quadrant pain. He had tenderness and guarding in the right upper quadrant with an obviously palpable gall bladder consistent with acute cholecystitis. He had progressive shortness of breath, generalized expiratory wheeze with bilateral basal crepitations consistent with COPD, for which he used three different inhalers regularly; salbutamol (Ventolin), fluticasone/salmeterol (Seretide), and tiotropium bromide (Spiriva). He could manage only 50 meters on the flat and one flight of stairs, with a PEFR of 250L.min^{-1}. His most recent pulmonary function tests showed that he had FEV_1 of 1.14L (45% of predicted value) and FEV_1/FVC ratio of 41%. His chest Xray showed COPD with bilateral basal consolidation. He was also taking amlodipine for a history of hypertension and co-dydramol for osteoarthritis.

On admission, his white cell count was raised with the C-reactive protein over 300, which fell after administration of intravenous antibiotics. An ultrasound confirmed gallstones with acute inflammatory changes in the gallbladder. Imaging and clinical impression suggested he was developing a gallbladder empyema and concerns were raised about the viability of the gallbladder, suggesting open cholycystectomy was necessary.

The anaesthetic technique was very similar to the first case. After patient consent, the patient was placed in the lateral position and a thoracic epidural was inserted into space T6-7. Light sedation was used, and the same combination of anaesthetic and analgesic medication was used. The surgery was completed in one hour and there were no complications. The patient was stable and was able to converse with the operating team throughout.

The patient was again managed in the HDU postoperatively and did not require any analgesia in addition to the continuous epidural infusion, nor respiratory support. The ESSAM score was again zero. The patient stayed in hospital for 12 days post-operatively to optimise his chest condition with nebulisers, antibiotics and physiotherapy. The postoperative histopathologic examination confirmed the diagnosis of acute diffuse suppurative cholecystitis with numerous suppurative foci within the necrotic gallbladder wall.

DISCUSSION

General anaesthesia in high risk surgical patients with significant pulmonary disease can trigger adverse effects such as pneumonia, impaired cardiac performance, neuromuscular problems, biotrauma and barotrauma and intra- and postoperative hypoxemia. Avoiding tracheal intubation decreases the risk of postoperative laryngospasm and bronchospasm, especially in elderly COPD patients who have irritable upper and lower airway tracts. Awake thoracic epidural anaesthesia has been reported to be a safe technique in patients with end-stage COPD.[3] Our two patients had end-stage COPD as a significant co-morbidity and we feel that the use of epidural anaesthesia may have made a vital contribution to their recovery.

The pathophysiological response to surgical trauma includes pain, nausea, vomiting and ileus, stress-induced catabolism, impaired pulmonary function, increased cardiac demands, and risk of thromboembolism. Surgical and medical complications, delayed recovery and discharge from hospital may result. The development of safe anaesthetic and analgesic techniques including regional anaesthesia, provide excellent operative conditions and enhanced recovery. The anaesthetist has a pivotal role in facilitating early postoperative recovery by providing minimally invasive anaesthesia and analgesia and tailoring the anaesthetic strategy to suit the patient's general condition and the surgical demands.[4]

Thoracic epidural anaesthesia improves tissue oxygenation by reducing the fall in subcutaneous tissue oxygen tension caused by surgical stress and adrenergic vasoconstriction during major abdominal surgery, improves cardiac, respiratory and gastrointestinal function and may decrease the incidence of surgical wound infection.[5] Splanchnic sympathetic nervous blockade induced by epidural anaesthesia results in reduced inhibitory gastrointestinal tone and increased intestinal blood flow, positive factors where a colonic anastomosis is to be performed.[6]

Postoperative myocardial infarction is reported to be significantly lower in patients receiving continuous thoracic epidural analgesia. Two systemic reviews have found that epidural anaesthesia with or without postoperative epidural analgesia reduces postoperative pulmonary infections compared with general anaesthesia with or without postoperative systemic analgesia.[7,8] Ballantyne et al confirmed that postoperative epidural pain control can significantly decrease the incidence of pulmonary morbidity.[9] Furthermore, a comparative study of major abdominal surgery in the elderly reported that postoperative epidural analgesia provides better pain relief, improved mental status and faster return of bowel activity.[10]

Awake epidural anaesthesia was reported to be an effective and safe technique in the high-risk colectomy patient in 1994.[11] Since then, there has been a paucity of data in the literature to describe the procedure performed under regional, especially awake, epidural anaesthesia in patients with co-existing pulmonary diseases. Awake laparoscopic cholecystectomy has been reported under thoracic epidural anaesthesia in COPD patients.[12] However, this anaesthetic technique is still unrecorded for open cholecystectomy, despite the fact that open surgery is known to adversely affect postoperative pulmonary function more than the laparoscopic procedure.[13]

In this article, the two reported patients had significant respiratory co-morbidity and prompted the team to consider all surgical and

anaesthetic options. Thoracic epidural was preferred to combined spinal epidural (CSE) anaesthesia because it is simple, less invasive and more reliable. In a CSE technique, the clinician has no chance to test the effectiveness of his epidural until the effect of the spinal wears off and it would be too late if it is found to be ineffective or not working at all and the only available option in this scenario would be to induce general anaesthesia. In our technique, epidural anaesthesia was induced with lignocaine to speed up the onset of the block, but later the longer acting levo-bupivacaine was used. Diamorphine and clonidine were added to improve the quality of the analgesic effect of the epidural. The risk of inadvertent high blockade postoperatively was reduced by monitoring the patient's arm movements using the epidural scoring scale for arm movements (ESSAM), which has been found to be very simple and reliable method for the early detection of the cephalad spread of thoracic epidural analgesia.[2]

We believe that thoracic epidural anaesthesia and analgesia is very useful technique for selected high-risk patients, and avoids the risks associated with general anaesthesia. Development of this technique may help extend the range of surgery offered to the high-risk surgical patient with significant co-morbidity, especially those with severe pulmonary disease. The technique avoids the dangers associated with positive pressure ventilation in high-risk patients, enhances postoperative recovery and avoids the need for postoperative ICU care. Needless to say, the technique requires anaesthetic and surgical experience as well as co-operation, and we recommend that these high-risk patients are observed closely in a high dependency area whilst they are receiving the epidural infusion.

Acknowledgement

REFERENCES

1. Troosters T, Gosselink R, Decramer M. Six minutes walk distance in healthy elderly subjects. *European Respiratory Journal* 1999; **14**: 270-4.

2. Abd Elrazek E, Scott NB, Vohra A. An epidural scoring scale for arm movements (ESSAM) in patients receiving high thoracic epidural analgesia for coronary artery bypass grafting. *Anaesthesia* 1999; **54**: 1097-109.

3. Gruber EM, Tshernko EM et al. The effects of thoracic Epidural Analgesia with Bupivacaine 0.25% on Ventilatory Mechanics in patients with Severe Chronic obstructive Pulmonary Disease. *Anesthesia & Analgesia* 2001; **92**: 1015-9.

4. Koltun WA, McKenna K, Rung G. Awake epidural anaesthesia is effective and safe in the high-risk colectomy patient. *Diseases of the Colon and Rectum* 1994; **37**: 1236–41.

5. Kabon B, Fleischmann E, Treschan T, Tguchi A, Kapral S, Kurz A. Thoracic epidural anesthesia increases tissue oxygenation during major abdominal surgery. *Anesthesia and Analgesia* 2003; **97**: 1812-7.

6. Veering BT, Cousins MJ. Cardiovascular and pulmonary effects of epidural anaesthesia. *Anaesthetic Intensive Care* 2000; **28**: 620–35.

7. Jayr C, Thomas H, Rey A, Farhat F, Lasser P, Bourgain JL. Postoperative pulmonary complication: epidural analgesia using bupivacaine and opioids versus parentral opioids. *Anaesthesiology* 1993; **78**: 666–676.

8. Rodgers A, Walker N, Schug S et al. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomized trials. *British Medical Journal* 2000; **321**: 1493–1497.

9. Ballantyne JC, Carr DB, deFerranti A et al. The comparative effects of postoperative analgesic therapies on pulmonary outcome: cumulative meta-analysis of randomized controlled trials. *Anesthesia and Analgesia* 1998; **86**: 598–612.

10. Mann C, Pouzeratte Y, Boccara G et al. Comparison of Intravenous or epidural patient-controlled analgesia in the elderly after major abdominal surgery. *Anesthsiology* 2000; **92**: 433–441.

11. Kehlet H, Dahl J.B. Anaesthesia, surgery, and challenges in postoperative recovery. *Lancet* 2003; **362**: 1921–1928.

12. Pursnani KG, Bazza Y, Calleja M, Mughal MM. Laparoscopic cholecystectomy under epidural anaesthesia in patients with chronic respiratory disease. *Surgical Endoscopy* 1998; **12**: 1082-1084.

13. Karayiannkis AJ, Makri GG, Mantzioka A, Karousos D, Karatzas G. Postoperative pulmonary function after laparoscopic and open cholecystectomy. *British Journal Anaesthesia* 1996; **77**: 448-452.

CASE REPORT

Intraoral endotracheal tube kinking – a preventable problem

Manpreet Kaur,* Babita Gupta, Ashish Bindra, Ajit Kumar
*Correspondence email: manpreetkaurrajpal@yahoo.com

CASE REPORT

An 18-year-old female sustained large right subdural haematoma. In view of Glasgow coma score (GCS) of 6/15 anaesthesia was induced with propofol 100mg, rocuronium 50mg in the emergency department. She was intubated with an oral cuffed polyvinyl chloride (PVC) 7.5mm internal diameter endotracheal tube (Unomedical, Malaysia). This was secured at 21 cm at the angle of mouth. Satisfactory endotracheal tube (ETT) tube position was confirmed by chest auscultation and sustained capnography. Anaesthesia was maintained with isoflurane 1-2% and 60% nitrous oxide in oxygen. The patient was ventilated with volume control ventilation using an AV-S ventilator using a circle system with gas flows of 2L.min⁻¹ and peak airway pressure of 17cm of water. Decompressive craniotomy was performed in the supine position with the head turned towards the left side.

Towards the end of the surgery the patient developed a tachycardia of 120bpm, and the airway pressure increased from 17 to 34cm of water. Capnography showed normal carbon dioxide levels, but a steep increase in the phase 3 slope suggesting partial airway obstruction.

We suspected obstruction of the ETT or bronchospasm. Pneumothorax and bronchospasm were excluded by chest auscultation and normal blood gas analysis.

There were no kinks or defects seen in the ventilator tubing or its connections. We could not pass a suction catheter through the ETT. The airway pressure improved slightly to 24cm of water when neck flexion was reduced. At the end of the surgery a kink was found in the intraoral section of the ETT, specifically where the pilot tube exits the main body of the ETT (Figure 1).

DISCUSSION

As demonstrated by this case, the most common site of a kink, is the site of exit of the cuff pilot tube,
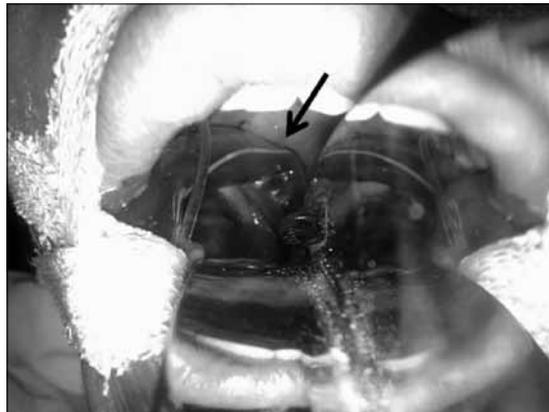
Figure 1. *Laryngoscopy showing the kinked intraoral section of the ETT (arrow)*
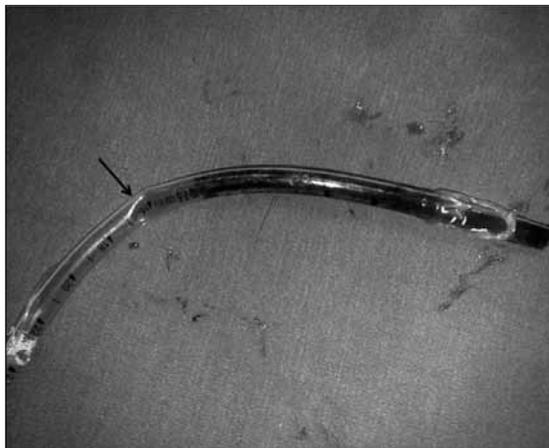
Figure 2. *The ETT after extubation*

usually 16cm from tip of the tube and within the oral portion of the tube. The stability of preformed curved endotracheal tubes is not usually compromised when bent along either inner concave bend or bent in the opposite side. However, if the ETT temperature is increased to 36˚C, the softened tube tends to kink, even at low degrees of curvature.[2]

This problem may be prevented by use of armored or flexometallic ETTs where local manipulation or movement of the head is expected or if the ETT

Summary

Intraoral endotracheal tube kinking is not an uncommon phenomenon especially in the prone position[1] but there are very few reports of intraoral kinking in the supine position. We report a case where unexpected intraoral tube kinking during craniotomy caused an unacceptable increase in airway pressure.

Manpreet Kaur
Senior Resident

Babita Gupta
Assistant Professor

Ajit Kumar
Senior Resident
Department of Anaesthesia
& Critical Care
JPNA Trauma Centre, AIIMS
New Delhi, India

Ashish Bindra
Senior Resident
Department of
Neuroanaesthesia, AIIMS
New Delhi
India

cannot be easily accessed during surgery (e.g. neurosurgery or facio-maxillary surgery) even in supine position. The anaesthetist should be aware of the risk of this complication, particularly if it is difficult or impossible to pass a suction catheter through the ETT. Use of lubricated Berman intubating airway, passed over the ETT, can relieve the intraoral kink during surgery.[3]

We propose that the design of PVC ETTs should be altered such that pilot tube exits the body of the ETT in a section of ETT that lies outside the oral cavity.

REFERENCES

1. B Neerja, Bala I. Kinking of endotracheal tube during posterior fossa surgery. *Indian J Anaes* 2010; **54**:173.

2. Hübler M, Petrasch F: Intraoperative kinking of polyvinyl endotracheal tubes. *Anesth Analg* 2006; **103**: 1601-2.

3. Ogden LL, Bradway JA. Maneuver to relieve kinking of the endotracheal tube in a prone patient. *Anesthesiology* 2008; **109**; 159.

CORRESPONDENCE

Superficial cervical plexus block for central venous cannulation

Ashwini Sharma, Fortis Hospital, Mohali, India

Superficial cervical plexus block has been widely used for providing anaesthesia in procedures involving the neck region, for example carotid endarterectomy. We have experience of using this block to provide local anaesthesia for insertion of jugular central venous cannulae. It is a simple procedure in which expertise can be gained very quickly.

Anaesthetists are commonly asked to insert central catheters or dialysis catheters. These patients often have a history of repeated cannulations and the standard technique for local infiltration often involves several injections to cover the puncture and subsequent suturing. Apart from requiring multiple injections, distortion of local landmarks may also result. We have started performing these cannulations under superficial cervical plexus block and feel that patient satisfaction has improved compared with the conventional infiltration technique. It is a simple, easily-learnt, safe and reliable block with relatively few complications.

Technique

With the patient's head turned away from the site intended for puncture, clean the skin with chlorhexidine in alcohol. The midpoint of the posterior border of sternomastoid is identified and using a 26G needle 10ml 2% lignocaine is injected for 2-3cm in both cranial and caudal directions along the posterior sternomastoid border. This will result in blockade of neural conduction in the ventral rami of the C1-4 nerve roots.[1]

The area of anaesthesia typically spreads along the distribution of the transverse cervical (over the front of neck), greater auricular, lesser occipital (side of neck) and supraclavicular nerves (around the clavicle).

There are very few complications associated with this block as the injection is subcutaneous just like local infiltration. Avoid puncture of the external jugular vein which overlies this area in some patients. Spread to involve the phrenic, vagus, or glossopharyngeal nerve as well as the sympathetic chain is possible, but this is more frequent with a deep cervical plexus block. The same is true about the possibility of intra-arterial, epidural and intrathecal injection complicating this block.[2]

Because of its simplicity, ease and multiple advantages over conventional infiltration, we advocate that this block be used more often during central venous cannulation especially in patients with a history of multiple cannulations and particularly where a wide bore cannula ('vascath' for renal dialysis) is needed.

REFERENCES

1 Waterhouse P, Plastow S. Internal jugular vein cannulation doesn't have to be a pain in the neck. *Anaesthesia* 2008; **56**: 393.

2. Chauhan S, Baronia AK, Maheshwari A, Pant KC, Kaushik S. Superficial cervical plexus block for internal jugular and subclavian venous cannulation in awake patients. *Reg Anesth* 1995; **20**: 459

Cerebral Challenge

Suzanne Coulter* and Louise Finch
*Correspondence email: s-coulter@doctors.org.uk

Case 1

An otherwise fit and well 60-year-old man presents for elective varicose vein surgery. The junior doctor on the ward orders a chest Xray as the patient has recently had a chest infection – he is now asymptomatic.

1. What coincidental abnormality does this chest Xray show?

2. Would this change your preoperative management?

3. How would you alter the anaesthetic you give him?

Figure 1. *Chest Xray of patient 1*

Case 2

You are on a ward assessing patients for surgery when a patient in a nearby cubicle collapses. The emergency team is called but you are first on the scene. The patient is 65-years-old and is awaiting elective surgery. He responds to a painful stimulus, a weak radial pulse is palpable and the nurse has recorded a blood pressure of 70/45mmHg. His ECG is shown below.

1. What abnormality is shown on the ECG?

2. How would you initially manage this patient?

3. How would you manage this patient if they were not compromised by the arrhythmia?

4. How would you decide if this was a ventricular or supraventricular rhythm?

5. Would it change your initial management?
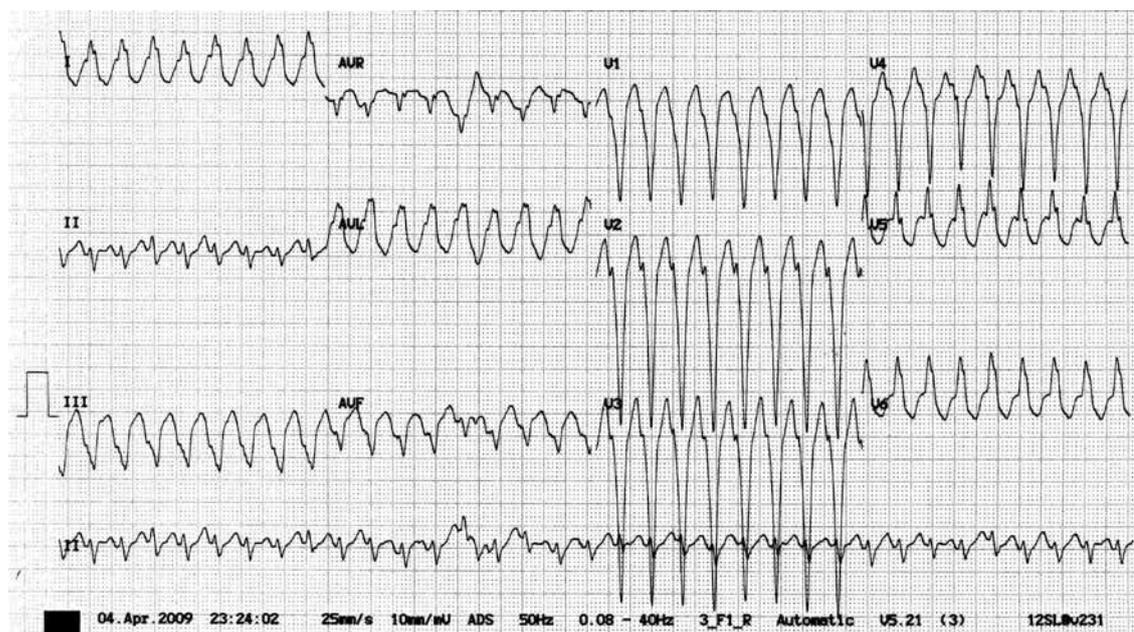
Figure 2. *ECG of patient 2*

Suzanne Coulter
Core Trainee in Anaesthesia

Louise Finch
Core Trainee in Anaesthesia
Department of Anaesthesia
Royal Devon and Exeter
NHS Foundation Trust
Barrack Road
Exeter
Devon
EX2 5DW
UK

Case 3

A previously fit 30-year-old man is brought to the Emergency Department with a Glasgow Coma Score of 3/15 having been knocked off his motorcycle. He is being ventilated using a bag-valve-mask, has a heart rate of 80bpm and a blood pressure of 150/80mmHg. You immobilise his cervical spine, intubate him and take him for an urgent CT head scan (Figure 3). No other significant injuries have been found clinically or radiologically.

1. What does his CT head show?

2. How would you manage this patient?
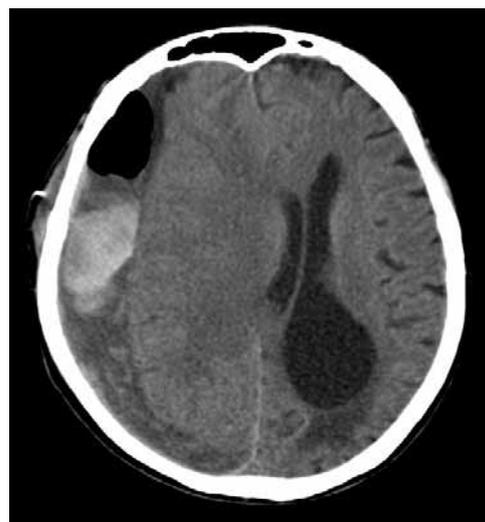
Figure 3. *CT head of patient 3*

DISCUSSION

Case 1

This chest Xray shows a large hiatus hernia. This can be seen behind the heart as a globular structure with a fluid level within it. The Xray film must be adequately penetrated to show structures behind the heart - i.e. you should just be able to see the thoracic vertebral bodies behind the heart. A hiatus hernia arise due to a defect in the diaphragm allowing part or all of the stomach to pass into the thorax. The patient may have symptoms of dyspepsia, belching, chest pain (which can mimic cardiac ischaemia) or frank reflux.

Hiatus herniae are relevant in anaesthesia because of the increased risk of reflux and subsequent aspiration. Pulmonary aspiration of gastric contents carries a significant morbidity and mortality. Injury from aspiration of gastric contents results from chemical pneumonitis, mechanical obstruction from particulate material and bacterial contamination. The morbidity is related to the pH and the particle size of the aspirate. Patients can be at greater risk of reflux due to a variety of factors (Table 1).

In order to minimise the risk of reflux, aspiration and resultant morbidity, anaesthetic practitioners should consider the following:

Preoperative care

- Patients should be appropriately fasted (2 hours for clear fluids, 6 hours for food/milk).

- Patients should be questioned about the presence of symptoms such as heartburn, reflux or previous diagnosis of hiatus hernia.

- Consideration should be given to the use of premedicating agents to reduce the volume and increase the pH of gastric contents (see Table 2).

In the presence of significant symptoms of reflux, the general anaesthesia technique should include intubation, with the tube inserted as part of a rapid sequence induction.

Significant reflux symptoms should be considered as:

- frequent (daily to weekly) reflux – felt as acid in the mouth or burning in the oesophageal area.

- reflux related to position (lying flat or bending over).

Table 1. *Risk factors for gastro-oesophageal reflux*

Increased gastric volume	Delayed gastric emptying	Gastro-oesophageal junction incompetence	Raised intra-abdominal pressure	Miscellaneous
recent solid or	pregnancy	hiatus hernia	obesity	peritonitis
small or large bowel obstruction	head injury	nasogastric tube	late pregnancy	pancreatitis
	opioids	scleroderma	steep head-down position	vagal stimulation
gastric insufflation during mask ventilation	pain, fear and anxiety			magnesium
	diabetic autonomic neuropathy			volatile agents
	renal failure			oesophageal strictures
	shock of any cause			pharyngeal pouch

For some patients, who give a history of infrequent reflux, you may feel that intubation is not necessary. For these patients one or more of the premedicant drugs shown in Table 2 may be used to enhance gastric emptying or reduce the acidity of the stomach contents. This decision will also be influenced by the planned procedure and other factors that may make reflux more likely.

If you are uncertain whether the reflux history is significant, the safest course of action is to intubate using a rapid sequence induction.

Postoperative care
- Muscle relaxant should be adequately reversed and the patient fully awake (able to sustain a head lift for 5 seconds and maintain a firm grip) prior to extubation.
- Extubation should be performed with the patient on their side or sitting up to minimise risk of aspiration at this critical point.
- Make the patient aware of the need to inform future anaesthetic practitioners of their significant aspiration risk.

Table 2. *Summary of premedicant drugs available for patients with reflux oesophageal disease*

	Prokinetic	H$_2$ receptor antagonist	Proton pump inhibitor	Antacid
Drug	metoclopramide 10mg PO/IV	ranitidine 150-300mg PO lanzoprazole 30mg	omeprazole 20-40mg or	30% sodium citrate 30ml
Timing	30-60min prior to anaesthesia (effects last for 2 hours)	2hr prior to anaesthesia and preceding evening if possible.	2-6hr prior to surgery and preceding evening if possible.	immediately prior to induction (short duration)
Mechanism	reduction of volume of gastric contents	alkalinisation of gastric contents	reduction of gastric acid secretions	alkalinisation of gastric contents

Case 2

This ECG shows a broad complex tachycardia (the QRS duration is greater than 0.12s or more than 3 small squares) which should be managed according to the European Resuscitation Council's guidance (Figure 4).

Tachycardia Algorithm (with pulse)
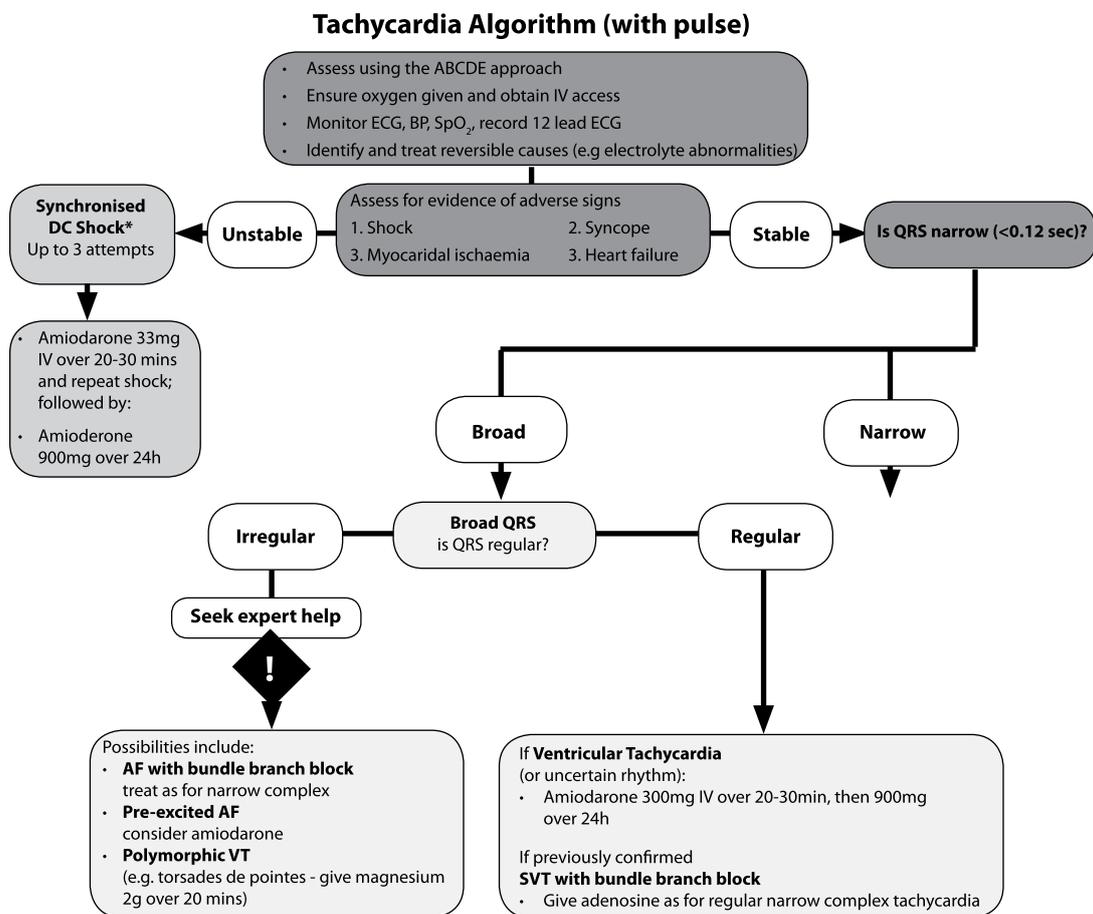
Figure 4. *Broad complex tachycardia algorithm (By kind permission of the European Resuscitation Council) Available at www.cprguidelines.eu/2010/*

As for any acutely unwell patient, management should follow an ABC approach:

- **A**: Airway support if necessary and administer oxygen (15L.min^{-1} as available).

- **B**: Pulse oximetry should be recorded and assessment should be made of his breathing which might be compromised, in this situation by pulmonary oedema.

- **C**: Circulation is compromised here - his blood pressure is 70/45. IV access should be obtained.

The cause of this patient's collapse is his arrhythmia. The management of arrhythmias is determined by two major factors:

1. Whether the patient is stable or unstable (as here).

2. The nature of the arrhythmia.

Presence of any of the adverse signs in the table below indicates that a patient is unstable.

The first step in management is to treat any reversible precipitants such as electrolyte abnormalities (particularly low plasma potassium and low plasma magnesium) or pro-arrhythmic drugs.

Electrical cardioversion is indicated for unstable patients and antiarrhythmic drugs (which are less reliable and have a slower onset) are used for patients with no adverse signs.

Electrical cardioversion would be appropriate in this patient as he has some signs of instability. He is conscious and so some form of sedation should be used. Three cardioversions may be attempted; if these fail to restore sinus rhythm, amiodarone 300mg should be given intravenously over 10-20 minutes, followed by a further attempt at electrical cardioversion.

The shocks must be 'synchronised' and this can be achieved by pressing the *sync* button on the defibrillator. This avoids the theoretical risk of delivering the electrical shock on the T-wave which may precipitate ventricular fibrillation. An energy level of 150J biphasic (or 200J on older monophasic defibrillators) should be used for broad complex tachycardias (BCT).

If the patient is stable, pharmacological treatment may be appropriate and an effort should be made to determine the nature of the arrhythmia. BCTs are usually ventricular in origin (80%) and should be assumed to be so if the patient is unstable. However, less commonly,

they may also represent an SVT with aberrant conduction (usually a bundle branch block, which makes the QRS complex prolonged). This may be the case if the rhythm is irregular (underlying AF), or if the patient is previously known to have a bundle branch block (BBB).

In practice it can be very difficult to differentiate Ventricular Tachycardia (VT), from SVT with a BBB. Features that suggest the diagnosis is VT are described in Table 4.

Table 4. *ECG criteria suggestive of VT*

Evidence of AV dissociation	The presence of atrioventricular dissociation (i.e. evidence that the atria and ventricles are contracting entirely independently from one another). Occasionally in AV dissociation a sinus atrial beat may be conducted and seen as a normal QRS complex (a capture beat) or will be conducted and superimposed on a VT complex (a fusion beat).
Axis	Left axis deviation. Left BBB with right axisdeviation, or right BBB with a normal axis.
QRS duration	QRS duration of >140ms in a right BBB pattern, or >160ms in left BBB pattern.
Concordance	All the chest leads (V1 - V6) are of one polarity (either all positive or all negative.

You should then choose the most appropriate agent, guided by local availability of drugs and what you believe to be the nature of the arrhythmia.

Pharmacological treatments of stable tachycardia include:

- *Adenosine* for supraventricular tachycardia (SVT). This drug is also useful if it is unclear whether the tachycardia is an SVT with a bundle branch block or VT. In SVT adenosine may convert the rhythm to sinus or slow it enough for the underlying rhythm to be established. It has no effect on VT.

- *Amiodarone* for stable VT or SVT.

- *Magnesium sulphate* (2g IV) for torsades de pointe - a type of VT where the axis of depolarisation is continuously rotating.

- Seek expert help for irregular BCTs which may represent atrial flutter with a variable block or atrial fibrillation with rapid conduction due to an accessory conduction pathway.

Table 3. *Signs indicating that the patient is cardiovascularly unstable*

Adverse sign	Shock	Syncope	Heart failure	Myocardial ischaemia
Indicated by	pallor	loss of consciousness (reduced cerebral blood flow)	pulmonary oedema (if the left ventricle fails)	chest pain or ECG changes
	sweating			
	cold and clammy		and/or	
	hypotension (SBP <90mmHg)		raised jugular venous pressure and hepatic engorgement (if the right ventricle fails)	
	reduced conscious level			

Case 3

Traumatic brain injuries can be clinically classified on the basis of the Glasgow Coma Score (GCS):

Glasgow Coma Score	Grading of head injury
3-8	severe
9-12	moderate
13-15	mild

Patients with a GCS less than 9 should be considered to have lost their protective airway reflexes and so should be intubated early. Rapid sequence induction should be used, with consideration given to use of opioids such as alfentanil to minimise the rise in intracranial pressure associated with intubation. Until proven otherwise, such patients should be assumed to have suffered a cervical spine injury, with 3-point immobilisation and in-line stabilisation performed during intubation.

This patient's CT shows a large right subdural haematoma with significant midline shift indicative of a severe head injury.
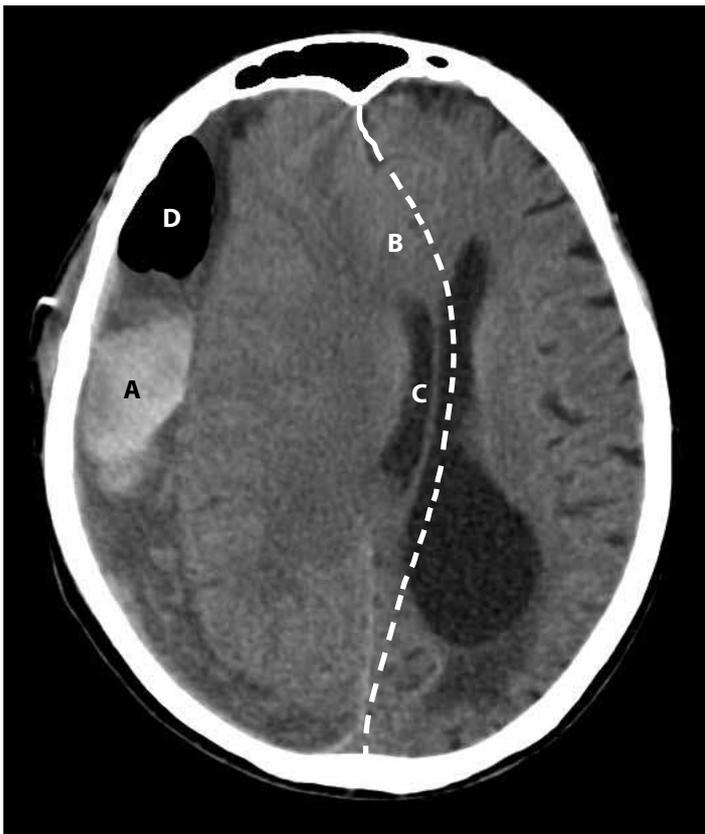
Figure 4. *The CT of patient 2 shows a large subdural haematoma (A) with midline shift (B), effacement of the right lateral ventricle (C) and air within the cranial cavity (D) indicating likely cranial fracture*

Subdural haematomas are located between the dura mater lining the brain and the brain itself, with a convex outer edge and a concave inner border. They are usually venous in origin.

Head injuries can also be classified radiologically by their appearance on a CT scan.

Grade	CT appearance
I	No evidence of any significant brain injury
II	No midline shift or < 5mm. CSF cisterns at the base of the brain are widely patent. No high density or mixed density lesions of > 25ml
III	Midline shift > 4mm compression or absence of basal cisterns. No high or mixed-density lesions > 25ml
IV	Midline shift >5mm, compression or absence of basal cisterns.

This man should be discussed with a neurosurgeon as definitive management should include drainage of the haematoma. This may involve transfer to a tertiary centre with neurosurgical facilities. Whilst awaiting transfer to theatre or another centre, there are several aspects to his care that can be optimised to limit secondary brain injury , by maintaining cerebral perfusion pressure above 70mmHg.

REMEMBER: CPP = MAP – ICP

(CPP = Cerebral perfusion pressure,
MAP = Mean arterial pressure, ICP = Intracranial pressure)

- Normal ICP is 5-12mmHg. In a head injured patient it is reasonable to assume it is 20mmHg and so a mean arterial pressure of 90mmHg is needed to achieve a CPP of 70mmHg.

- Blood pressure should be monitored regularly, and invasively if possible.

- If thoracic and lumbar spine have been cleared then patient should be 30° head up to improve cranial venous drainage.

- Endotracheal tubes should be taped in place rather than tied to prevent ties obstructing venous drainage.

- $PaCO_2$ should be maintained in the low normal range (4.5-5kPa).

- Maintain normoglycaemia.

- Maintain oxygen saturations >95%.

- Any seizures should be controlled (e.g. 18mg.kg^{-1} phenytoin)

A brief period of hyperventilation (to lower the $PaCO_2$) and/or mannitol 0.5g.kg^{-1} IV can be used to control acute surges in ICP. Hyperventilation should not be sustained as cerebral vasoconstriction may lead to further ischaemia.

FURTHER READING

Ali B, Drage S. Management of head injuries. *Anaesthesia Tutorial of the Week* No 46 (March 2007). Available at: http://totw.anaesthesiologists.org/2007/03/12/management-of-head-injuries-46/

Update in
Anaesthesia

Education

From the journals

Pratheeban Nambyiah
Correspondence email: pnambyiah@doctors.net.uk

Push, blow or both: is there a role for compression-only CPR?

Nolan J. *Anaesthesia* 2010; **65**: 771-4

New cardiopulmonary resuscitation guidelines were published in October 2010. One current debate concerns the necessity of ventilation of the lungs during cardiopulmonary resuscitation (CPR). There is a lack of good evidence regarding CPR and most recommendations are drawn from expert opinion and non-randomised studies. The necessity to perform mouth-to-mouth ventilation may deter bystanders from attempting CPR, particularly in areas where the prevalence of blood-borne diseases is high. The bystander CPR rate in England for 2004-2006 was 36%, and on the basis that 'any CPR is better than none', there are calls from some experts for compression-only CPR to be incorporated into international guidelines.

The rationale is that it may increase bystander CPR rates, decrease the 'no-flow' time created when chest compressions are interrupted to give mouth-to-mouth ventilation, and is easier to teach. In support of this, a meta-analysis published after this editorial supports the benefit on outcome with chest-compression-only resuscitation compared to conventional CPR.[1]

However those with asphyxial cardiac arrest, particularly children or drowning victims, are likely to require early ventilation.

Findings from a Japanese observational study of cardiac arrest in children suggest that 71% are from non-cardiac causes, and that within this sub-group conventional CPR produces better neurological outcome.

Given that any teaching would have to cover CPR for this vulnerable group, it would be difficult to advocate that all bystander CPR should be compression-only. This editorial therefore advocates 2-stage teaching for the lay public: a basic compression-only CPR course that could be easily taught to most of the community, followed by more advanced follow-up training in conventional CPR.

Reference

Hüpfl M, Selig HF, Nagele P. Chest-compression-only versus standard cardiopulmonary resuscitation: a meta-analysis. *Lancet* 2010; **376**: 152-7.

Umbilical vein oxytocin for the treatment of retained placenta (Release Study).

Weeks A et al. *The Lancet* 2010; **375**: 141-7

Retained placenta is a major risk factor for post-partum haemorrhage (PPH) and sepsis. It complicates 0.1-2% of deliveries and, in settings where there is restricted availability of surgical and anaesthetic facilities, has a case fatality rate of nearly 10%.

As such a low-cost, effective non-surgical intervention is urgently needed. Recent WHO guidelines on the management of PPH have suggested that umbilical oxytocin 'may be offered'. The theory is that delivery of oxytocin directly to the retroplacental myometrium via the umbilical vein promotes muscular contraction and causes the placenta to shear off. The WHO

recommendation is largely based on a 2001 Cochrane meta-analysis which suggested some benefit, albeit with reservations.

This multicentre randomized controlled trial breaks new ground, both in its quality (577 women were randomly assigned to treatment oxytocin or placebo saline, at three centres in Uganda, Pakistan and the UK, in a double-blind trial, analysed by intention to treat, with no participants lost to follow-up) and for the fact that the oxytocin is delivered via an umbilical vein catheter, rather than as an injection into the umbilical vein, which is thought to increase the

Pratheeban Nambyiah
Specialist Trainee
Anglia School of
Anaesthesia
UK

concentration of oxytocin reaching the placental bed. Unfortunately the study, which was adequately powered to detect a 20% relative reduction in the need for manual removal of retained placenta, failed to detect a difference between the two groups (oxytocin 179/262 [61.3%] vs placebo 177/285 [62.1%] RR 0.98, 95% CI 0.87-1.12, P=0.84). The authors also revisited the Cochrane meta-analysis, and found that when their study is added to the review, there is no

evidence of benefit with oxytocin. There was no evidence of harm, but they argue that "in busy, resource-poor setting, clinicians' time… can be better used elsewhere".

The reason for the lack of efficacy is not clear, but it may be that the oxytocin enters retroplacental lakes from where it drains into the uterine vein without entering the capillaries feeding the myometrium.

Intraoperative risk factors for acute respiratory distress syndrome in critically ill patients.

Hughes C, Weavind L, Banerjee A, Mercaldo N, Schildcrout J, Pandharipande P. *Anesthesia & Analgesia* 2010; **111**: 464-7

Some models for the development of acute respiratory distress syndrome (ARDS) propose a 'two hit' hypothesis, whereby the first insult leads to tissue injury and inflammation, and the second to the clinical features of ARDS. This retrospective cohort study looks at potential intraoperative risk factors that could act as the 'first hit', predisposing patients to developing ARDS in their subsequent clinical course. 89 surgical patients who required postoperative mechanical ventilation were assessed for the development of ARDS (according to ARDSNet diagnostic parameters) in the first seven postoperative days. The authors hypothesized that the intraoperative use of aggressive fluid resuscitation, high tidal volume per ideal body weight (TV/IBW) ventilation, and transfusion of blood products would be independent risk factors for the subsequent development of ARDS.

They found that, for patients given 20ml.kg^{-1} fluid, the unadjusted odds for developing ARDS were 3.1 times that of patients given

<10ml.kg^{-1}. Adjusting for confounders using propensity scoring (including APACHE score and presence of sepsis) strengthens the association (odds ratio 3.8, P=0.04). A lower magnitude of increased risk is seen for patients receiving 10-20ml.kg^{-1} of fluid (OR 2.4) but this was not statistically significant (P=0.14). However, the results did not support their other two hypotheses, namely the importance of high TV/IBW and transfusion of blood products intraoperatively, although these are recognized risk factors for ARDS in other settings.

There are limitations to the study – for example its retrospective design, its focus only on those patients who required mechanical ventilation postoperatively, the lack of differentiation between different types of fluid and blood products, and the absence of information about intraoperative haemodynamic status (for example, what role does intraoperative hypotension play?). However at a minimum this study has focused attention on an area that deserves further prospective analysis.

Hospital–acquired infections due to gram negative bacteria

Peleg A, Hooper D. *New England Journal of Medicine* 2010; **362**: 1804-13

Making generalized comments on microbiology topics is always difficult, as the range of pathology, local microbial flora, and antimicrobial sensitivity profiles vary across the globe. However, this review makes a number of educational points which make it useful reading. Gram negative bacteria have a number of mechanisms facilitating resistance to antimicrobial agents. This has been compounded by the fact that recently there have been few new agents in production, due to a combination of financial and technical difficulties. As a consequence we now have increasing drug resistance in the absence of drug development.

Gram negative infections in hospital lead to three main classes of infection: lower respiratory tract, blood stream and urinary tract. Urinary tract infections are the most common, but the others are the most lethal. The majority of pneumonias in this setting are associated with mechanical ventilation. The organisms most often responsible are *Pseudomonas, Acinetobacter, and Enterobacteria*. Of particular concern in some areas of the world (for example Greece) there is now growing resistance of ICU isolates to carbapenems such as imipenem and meropenem. More recently, the concept of health-

care associated pneumonias has been developed. These affect patients who have extended contact with health-care facilities or treatment in the community; they are more likely to develop gram negative and multi-drug resistant pneumonias, and should not therefore be treated as other community-acquired pneumonias.

Blood stream infections are usually associated with invasive medical devices or surgery. Almost any gram negative organism may be responsible given an adequate portal of entry, but those among the most common include *Klebsiella, E.coli, enterobacter, and Pseudomonas aeruginosa*. Again, extended spectrum β-lactamase producing bacteria (ESBLs) are proving to be resistant to carbapenems (particularly in South America and China), and often also carry fluroquinolone resistance. The authors emphasise that diagnosis and treatment should be based on surveillance of local flora. However strategies should include early empirical treatment with broad-spectrum antibiotics in those most at risk, followed by de-escalation to narrow-spectrum agents based on culture and sensitivity profiles. The use of 'care bundles' is encouraged to reduce ventilator-associated and central venous catheter-related infections.

Anaemia and patient management in hip and knee surgery. A systematic review of the literature.

Issues surrounding transfusion of allogenic blood products have had a high profile recently. This systematic review looks at pre- and postoperative anaemia in orthopaedic surgery, and the effects on clinical outcomes. 49 relevant publications were retrieved from a Medline search, each with a sample size of greater than 100 patients. (A further 65 publications reporting on less than 100 patients were also used to fill possible evidence gaps.)

The major conclusions were as follows:

- Most studies report impaired functional mobility in the early postoperative period in the presence of anaemia, although not all reach statistical significance.

- There is an increased incidence of postoperative urinary tract and respiratory tract infections in patients with preoperative anaemia.

- Several prospective cohort studies show a significantly increased length of hospital stay (LOS) and mortality in the anaemic groups.

- The use of perioperative iron supplementation, recombinant human erythropoietin, and cell salvage reduces the need for allogenic blood transfusion (ABT). Some studies also show reduced postoperative infection rates, LOS, and 30-day mortality although these latter outcomes do not always reach statistical significance.

- Use of conservative transfusion algorithms (e.g. triggered at Hb <7g.dl^{-1} rather than <10g.dl^{-1}) reduces the need for ABT (without increasing LOS in the one study that reported clinical outcomes).

There are some weaknesses acknowledged in this review. The definition of anaemia in the constituent studies varies from a haemoglobin level less than 13 to less than 8g.dl^{-1}, and is sometimes not reported at all. Similarly transfusion triggers varied and were inconsistently reported. Many of the studies are underpowered to detect differences in endpoints such as physical functioning, LOS and mortality.

Importantly, the question arises as to whether it is preoperative anaemia or the parallel increase in perioperative ABT that is responsible for the adverse outcomes. Studies in cardiac and general surgery have found that both are independent risk factors for postoperative mortality, ischaemia, and infections, and there is no reason to suppose that orthopaedic surgery would be any different. This review therefore adds to the growing body of evidence that suggests that although anaemia is a serious problem in this cohort of patients, strategies to minimise ABT are likely to be of patient benefit.

Two other pertinent studies have entered the literature since this review was published. In a large case-control study at the Mayo Clinic, Mantilla et al. looked at the risk of peri-operative myocardial infarction and mortality in patients undergoing hip or knee arthroplasty. The authors concluded that anaemia per se is not independently associated with MI and mortality in these patients; rather that pre-existing comorbidities are. Glance et al. conducted a retrospective analysis of over 10,000 patients, and found that intra-operative transfusion of just 1-2 units of erythrocytes in the setting of elective surgery is associated with higher mortality and morbidity in patients with anaemia, although it is impossible to be certain whether this is due to the transfusion, or to the surgical blood loss. For different reasons then, both these studies suggest we should be more conservative with our transfusion strategies.

The multi-centre FOCUS trial, designed to compare an aggressive transfusion strategy with a conservative one, may provide a more complete answer. Full publication is awaited, but results published in abstract form suggest that there is no difference in mortality or functional outcomes between conservative and liberal transfusion triggers.

Further reading

Mantilla et al. Risk for perioperative myocardial infarction and mortality in patients undergoing hip or knee arthroplasty: the role of anemia. *Transfusion* 2011; **51**: 82-91.

Glance et al. Association between intraoperative blood transfusion and mortality and morbidity in patients undergoing noncardiac surgery. *Anaesthesiology* 2011; **114**: 283-92.

Carson JL, Terrin ML, Magaziner J, Chaitman BR, Apple FS, Heck DA, Sanders D. Transfusion trigger trial for functional outcomes in cardiovascular patients undergoing surgical hip fracture repair (FOCUS). *Transfusion* 2006; **46**: 2192–206.

Recently individual tragedies have focused attention on the role that human factors play in the breakdown of safe practice in anaesthesia.

One such case was that of Elaine Bromiley, who died after a failure to recognise and manage a 'can't intubate, can't ventilate' scenario. Her husband is a pilot, and the record of the aviation industry in placing human factors at the centre of safety management contrasts with our somewhat technically-focused discipline.

This issue of the BJA is dedicated to examining the role of human factors in anaesthesia and critical care.

The anaesthetist's non-technical skills (ANTS) system is reviewed in the above article. This is a tool to aid teaching, appraisal and research. It has four categories: situational awareness, decision-making, task management, and team working. Each category has component elements and examples of good and bad behaviour. For instance, behavioural markers of good practice in team working may include discussing cases with surgical colleagues, whereas markers of poor practice in situational awareness may include easy distractibility and fixation. The increased use of high-fidelity simulators in recent years provides an important opportunity to explore these skill sets.

IMPORTANT NOTICE

Periodically we need to check that *Update in Anaesthesia* is being posted to the correct recipients. If you wish to continue receiving the journal please send the following details to us:

Name

Institution

Postal address

Email address *(if you have one)*

Number of recipients wishing to receive *Update* at this address

Please send this information:

By email to: **worldanaesthesia@mac.com**

or by mail to: Carol Wilson
Pound Cottage
Christow
Exeter
EX6 7LX
United Kingdom

Book Reviews
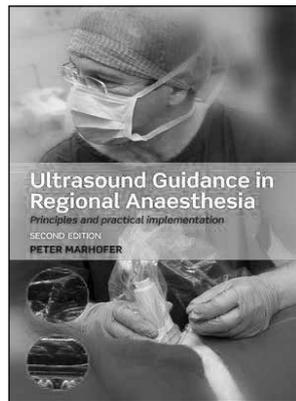
Ultrasound Guidance in Regional Anaesthesia: Principles and Practical Implementation

2nd Edition. Edited by Peter Marhofer

Oxford University Press 2011

ISBN 978-0-19-958735-3

Price: £39.95

This is the second edition of a book first published under the name Ultrasound Guidance for Nerve Blocks in September 2008. The slight amendment to the title is a recognition that the scope of ultrasound use in regional anaesthesia has broadened to include neuraxial blockade and abdominal field blocks. It is the work of Professor Marhofer, one of the pioneers in this imaging modality's application to regional anaesthesia, and represents the teaching of the Austrian Regional Anaesthesia Group based in Vienna.

It is unfortunate that the first two things you notice about this new edition are that it is no longer pocket-sized (opting for A5 size) and the price has increased by over 60%. The increased size has lead to a more aesthetically pleasing format in some chapters, however some would find a pocket-sized book more practical.

The book can be divided into three. The first 7 chapters serve as an introduction to ultrasound guided regional anaesthesia (UGRA) together with the organisational and economic considerations of implementing an UGRA service. The middle section explains in general terms the practical skills that are required, with the third part focusing on the individual block techniques.

Chapter 1 gives a very detailed account of the physics of ultrasound machines. Chapter 2 is new to this edition and highlights the ethical and practical difficulties in scientific research into UGRA. Chapters 3 and 4 start with a quick overview of the history, discuss the possible advantages and limitations of using ultrasound, and ends by proposing a new concept for training. Chapter 5, again a new chapter for this edition, debates whether we have reached the gold standard in regional anaesthesia and goes on to provide targets to make this aspiration a reality. Chapter 6 describes the array of equipment needed and organisational requirements for providing successful, safe UGRA. This section has been updated to include more on the different types of needles

and probes available. A new chapter addresses the particular issues involved in providing UGRA in children.

Chapter 8 gives an account of the sonographic appearance of anatomical structures which now includes neuraxial structures and common artefacts. Chapter 9 and 10 give some useful advice for optimising ultrasound images and needle manipulation, however it is a shame there is no mention of indirect indicators such as tissue movement, tactile feedback & hydrolocation. Chapter 11 is new and serves as a succinct reference for the nerve supply of the major joints.

The rest of the book covers the individual block techniques starting with the neck, upper limb, lower limb and trunk. The book is now all-encompassing with the addition of the transversus abdominis plane block to the truncal blocks chapter, a whole new section on neuraxial anaesthesia, and included in each chapter is a section on paediatric applications. These additions are very welcome and generally covered well, with the exception of epidurals. I feel a mention of prepuncture scanning (ultrasound assisted rather than guided) with the inclusion of the transverse interspinous view would have been of benefit, but this is a minor criticism. Knowledge of anatomy is essential for regional anaesthesia and this book now includes colour cadaveric cross sections to complement the sonograms. Importantly it also discusses the anatomical variability of the course of each nerve.

The book finishes by touching on catheter techniques and future challenges for the subspecialty. Lastly the appendices contain a consensus statement by worldwide experts in UGRA and also the Association of Anaesthetists of Great Britain and Ireland's guidelines on treating local anaesthetic toxicity. I wonder if this last important safety topic may have been better placed in the main body of the book.

David Pappin
Fellow in Regional
Anaesthesia
Exeter
UK

In conclusion this book serves as a well written, comprehensive introduction to all aspects of UGRA. It strives to give a balanced argument to the controversial issues that surround the subject and educate the clinician in delivering the techniques safely.

Contained within this book is a wealth of knowledge which both the trainee and more experienced anaesthetists will undoubtedly find very useful, however I'm not certain that the extra chapters and improved quality of the figures justify the massive increase in cost of this second edition.
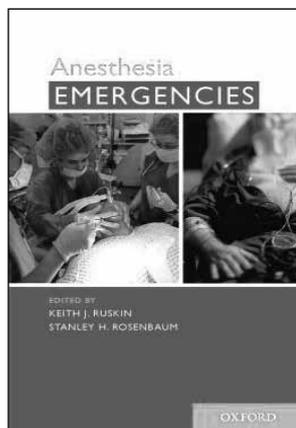
Anesthesia Emergencies

Oxford University Press, USA 2011

Edited by Keith Ruskin and Stanley Rosenbaum

ISBN No: 978-0-19-539671-3

Price: £26.00

Anesthesia Emergencies is a 395-page quick reference handbook published by the Oxford University Press (US). It written by an array of authors from the United States and edited by Dr Keith J. Ruskin and Dr Stanley H. Rosenbaum, both of whom are Professors of Anaesthesiology at Yale Medical School.

It is designed as a paperback pocket book for use in an anaesthetic emergency. The chapters and disorders within each chapter are based on systems and are ordered alphabetically. Each subject is covered in a structured manner dealing with presentation, pathophysiology, differential diagnosis, immediate management, diagnostic studies, subsequent management, risk factors and prevention. The immediate management is displayed in a highlighted box – this is probably the section you would seek out in an emergency.

Following the preface is a three-page introduction entitled 'Lessons learned from aviation'. This is a brief description of the field of 'human factors' in emergency situations and outlines the benefits of good non-technical skills in dealing with a crisis. It would be useful to mention the availability of courses in human factors and simulator training for critical incidents.

The content of the book is comprehensive, with coverage of topics ranging from 'can't intubate, can't ventilate' scenario to occupational exposure to toxic substances. I can't think of an anaesthetic emergency that has been missed.

The presentation of the material leaves a little to be

desired as it is very grey. Reading more than a couple of pages of colourless bullet points becomes rather hard going. There are a few photographs but the details are difficult to interpret due to their dark grey appearance. At times the formatting is also poor with the aforementioned bullet points appearing somewhat at random (page 136).

The structured way in which the book addresses each clinical emergency is a strong positive, however at times they stick too rigidly to it - for example, does 'Operating room Fire' need a differential diagnosis section?

I began reading this book with some concerns about differences between American and UK practice that may make the text less relevant to my own practice in the UK. However, there are only a few subtle differences, for example, in the induction agents used and algorithms for cardiac arrest. Mast cell tryptase estimation is not mentioned in the section dealing with anaphylaxis. For the most part though, the content is relevant and useful to anaesthetists in all settings.

Overall, Anaesthesia Emergencies is a thoroughly comprehensive and well put together book, if a little lacking in presentation and appearance. There is a similar book called '*Emergencies in Anaesthesia*' which is edited by the same specialists responsible for the Oxford Handbook of Anaesthesia. Both books have similar content but 'Emergencies in Anaesthesia' delivers it with a splash of colour and with a more hard wearing cover. It is easier to read and the one I would choose from the two.

Thomas Knight
Trainee in Anaesthesia
Exeter
UK
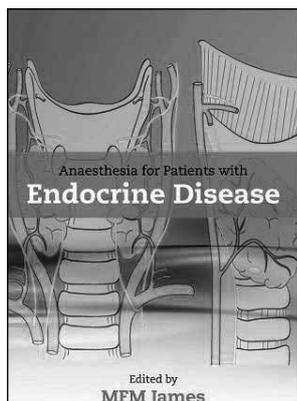
Anaesthesia for Patients with Endocrine Disease

Edited by MFM James

Oxford University Press 2010

ISBN No: 978-0-19-957025-6

Price £75.00

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.

Six of its 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 further 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.

Pete Ford
Consultant Anaesthetist
Exeter
UK
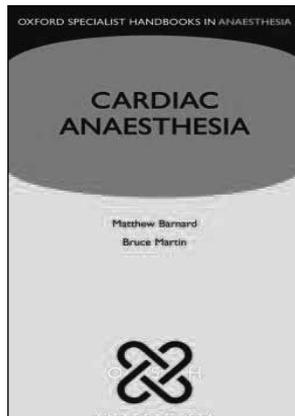
Cardiac Anaesthesia (Oxford Specialist Handbooks in Anaesthesia)

Edited by M Barnard and B Martin

Oxford University Press 2011

ISBN 978-0-19-920910-1

Price: £42.95

Cardiac Anaesthesia joins a growing number of Oxford Specialist Handbooks in Anaesthesia and is presented in the usual 'white coat' pocket size with a durable cover familiar to this range of textbooks. The authors aimed to produce a book which provided all the information an anaesthetic trainee caring for cardiac surgical patients would require and also to provide an 'on-the-spot' practical reference guide. The book certainly fulfils both of these aims and I believe has a wider appeal. The authors are consultant anaesthetists based at The Heart Hospital in London, but 35 other consultants from the UK, North America and New Zealand have contributed to provide a balanced view of developed world practice.

The book is divided into three parts: Part one covers the cardiovascular system, anatomy, physiology, pharmacology (mainly pharmacodynamics) and cardiovascular diseases and treatment. I was surprised at the clarity and detail for such a relatively small book - this level of information is usually only found in larger reference textbooks.

Part two covers the organ system implications of cardiac surgery including the central nervous system, haematology, the inflammatory response, renal, respiratory and infectious complications. Part three deals with the clinical practice of cardiac anaesthesia and is extremely comprehensive including detailed chapters on interventional cardiology, paediatric and adult congenital heart disease, transoesophageal echocardiography, cardiopulmonary bypass, deep hypothermic circulatory arrest and 'off pump' surgery to name a few. Each chapter provides references for further reading at the end. The chapter on paediatric congenital heart disease has a number of line diagrams to aid understanding of the various surgical procedures and there are various transoesophageal echocardiogram images throughout the book.

I would definitely buy this book if I was considering a career in cardiac anaesthesia but I would also encourage trainees to buy it as an adjunctive text to augment their understanding of cardiovascular physiology, pharmacology and anatomy in preparation for postgraduate anaesthetic exams, regardless of their aspirations in the field of cardiac anaesthesia. It also has much to offer staff working on cardiac or general intensive care units caring for patients with acute coronary syndromes or post cardiac surgery. If I were to make one criticism it would be that there is a degree of repetition of certain subjects within the book, pharmacology being an example. The authors acknowledge this and explain that it enables various sections to be used independently and I would agree with this view.

This is a comprehensive, well edited, pocket sized textbook which has appeal beyond its intended target audience.

Richard Eve
Trainee in Anaesthesia
Derriford Hospital
UK

Guide for Contributors

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) and read by 90 people a day from more than 130 countries. *Update* is also distributed in the form of a CD-ROM, produced by the Association of Anaesthetists of Great Britain and Ireland.

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

CLINICAL OVERVIEW ARTICLES
General considerations

- Papers must not have been published in whole or any part in another journal.

- 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_view gid,67 Itemid,49/). Discuss older drugs as well as newer ones; halothane, thiopentone, ketamine and ether are widely used around the world.

- The article should be long enough to cover the topic in reasonable detail. Many readers will not have access to texts or journals to supplement their reading. Include text boxes and teaching points to make the layout interesting. Avoid long numbered lists with complex subdivisions. Check that your text is correct, particularly drug doses, as many readers will not be able to verify them.

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

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

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

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

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

UPDATE SHORT REPORTS

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

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

Legal considerations
- Papers based on clinical investigation on humans should include the consent of patients and a statement of approval from an appropriate Ethics Committee. In those institutions where Institutional Review Board consent is required for the performance of audits, this should be obtained and referred to in the text.

- Avoid use of identifiable names, initials and hospital numbers of patients.

- Human subjects of case reports, research or audits should not be identifiable. Manuscripts should not disclose patients' names, initials, hospital numbers (or other data that might identify the patient(s)).

- Guides for use of tables, figures and illustrations are as described above for Clinical Overview articles.

Brief Communications
- Original investigative articles or audits of patient outcome or clinical techniques.

- Up to 1500 words (approximately 2 pages of *Update in Anaesthesia).*

- Subdivided into:
  - Summary (maximum five sentences) and key words
  - Introduction
  - Patients and methods
  - Results
  - Discussion
  - Acknowledgements
  - References – maximum 15
  - Tables and/or figures - limited to two per article.

Case Reports
- Suitable for presenting descriptive studies (a series of cases), personal experience or individual case reports of particular interest.

- Up to 800 words. Three tables or figures 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@rdeft.nhs.uk

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

Department of Anaesthetics
Royal Devon and Exeter Hospital
Barrack Road
Exeter EX2 5DW
United Kingdom

Update in Anaesthesia

Education for anaesthetists worldwide

Update Contacts