

Anaesthesia and Intensive Care

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The anaesthetist has seen his role steadily expand and it is hard to think of one medical specialty in which anaesthetists are not involved at least to some extent. We present a range of papers which demonstrates the breadth of anaesthesia: from its traditional realm in the operating theatre to critical care and resuscitation onto chronic pain and obstetric analgesia.

Airway Management

Undoubtedly, one of the key skills of the anaesthetist is the ability to secure an airway. The golden standard is still the endotracheal tube, but this requires skill at intubation. For this reason, other means of obtaining an airway without resorting to intubation have been marketed. These include the Guedel airway, the Airway Management Device™, the Laryngeal Tube™, the Combitube™ and the Laryngeal Mask Airway (LMA). These devices can all be inserted blindly and are suitable for use by medical and paramedical staff not skilled at intubation.

The most successful of these appears to be the LMA, of which there are two main versions. The Classic LMA has been in use for more than 10 years, and is basically a tube which is placed just above the glottis and held in place with an inflatable cuff (Figure 1a). Although it permits gas exchange through the trachea, it does not protect the airway from regurgitation, and the cuff only allows a good seal with positive pressures of not more than 20cmH₂O. The ProSeal™ was marketed to overcome these deficiencies. This has a bigger cuff which is more wedge-shaped, allowing a better seal and the ability to ventilate with higher positive pressures.¹ It also incorporates a separate drain tube, situated at the tip of the mask, allowing insertion of a gastric tube and to vent gas or liquid from the upper oesophagus.^{1,2} (Figure 1b)

The ProSeal™ is inserted blindly, and its design does not take into account variations in anatomy. In fact, insertion and correct placement have been proven to be more difficult with the ProSeal™ than with the Classic LMA^{1,3}, but easier than the

Laryngeal Tube™.⁴ Malposition may result in significant leakages from around the cuff or from the drain tube. Even worse, it may occlude the vocal cords, and result in improper ventilation.

Nevertheless the ProSeal™ is having an impact: it has been used with success in caesarean deliveries when intubation was difficult or impossible⁵, and in laparoscopic surgery as an alternative to tracheal intubation, which for years has been the recommended standard.⁶ The ProSeal™ is not a panacea, but it is a useful addition to the armamentarium necessary to obtain a secure airway.

Delivery of anaesthetic using closed-loop systems

Open-loop control systems have been in use in anaesthesia for a number of years. The most popular such system is the target-controlled infusion system for the administration of propofol in total intravenous anaesthesia. This system makes intravenous anaesthesia simpler to perform by using a variety of pharmacokinetic models and equations to produce a predicted blood concentration. It remains up to the anaesthetist to select the appropriate blood concentration (the target) for each patient.

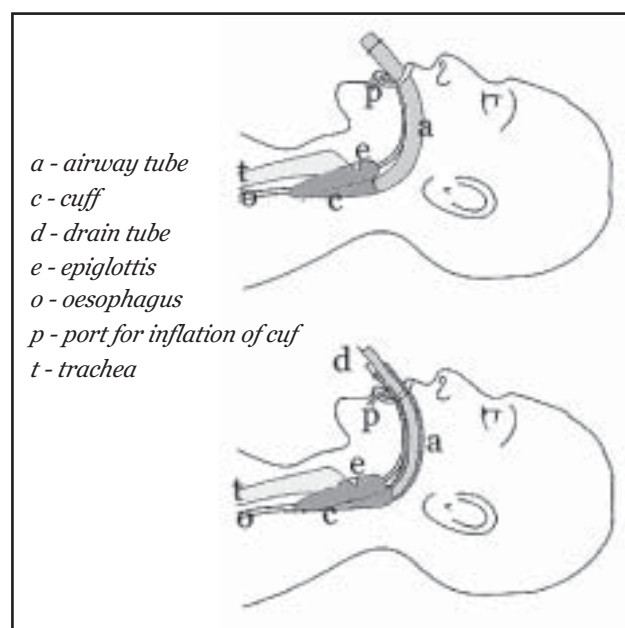


Figure 1a: The Classic LMA and b) the ProSeal LMA in position. Note how the tip of the cuff in both variants should be at the oesophagus. The cuff of the ProSeal is also bigger and more wedge shaped, which should seal better the larynx.

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Closed-loop systems go one better by introducing an input signal which is continuously compared to a target. Any difference between the target and the actual value is used to alter the infusion of a drug so as to bring the patient's value closer to the required target.⁷ Simple systems exist for precise control of blood pressure and neuromuscular blockade (using infusions of nitroprusside and muscle relaxant respectively). Absolam[®] was the first to study a closed-loop system that actually correlates depth of anaesthesia with the dose of anaesthetic administered. Depth of anaesthesia is measured with a Bispectral-Index™ System (a method of processing EEG into a numerical score from 1 to 100 with a score less than 70 indicating lack of awareness and a score less than 40 indicating excessive depth of anaesthesia). This feeds into the processor which is linked to a propofol target-controlled infusion. The system was able to control anaesthesia adequately in twenty patients undergoing body surface surgery.

Closed-loop systems have the potential for more precise matching of anaesthesia to patient need thus reducing the risk of underdosing (with the potential for awareness) and overdosing (with problems of side-effects and prolonged recovery). Closed-loop systems may become one way in which anaesthesia is administered in the future.

The anaesthetic management of hypertensive patients

Hypertension is very common in practically all populations, and it is hence inevitable that anaesthetists will frequently encounter hypertensive patients, who may or may not be controlled. Previous studies in the 1970s have shown that hypertensive patients have a more vigorous response to noxious stimuli.⁹ However, no large randomised controlled trial has ever been performed that attempts to establish the relative risk of patients with high blood pressure.

Howell, Sear and Foëx¹⁰ have reviewed data collected over the past 30 years, and have concluded that moderate hypertension alone does confer a small risk, but this was judged to be clinically insignificant. They argue that the increased afterload on the myocardium may be offset by a number of measures, including peri-operative beta-blockers and thoracic epidurals. As for severe hypertension, it is the presence of hypertensive-related organ damage which increases perioperative cardiac risk. The authors stress that surgery in a hypertensive patient should not be postponed purely on the basis of blood pressure readings; if, however, there is evidence of end-organ damage then the surgery should be postponed to allow time for the optimisation of the damaged organ. Either way, anaesthesia for the severely hypertensive patient requires experienced anaesthetists, as it is more important but more difficult to maintain haemodynamic stability than in the normotensive population.

Needleless techniques for nerve localisation

Upper and lower limb blocks can be very useful alternatives to general anaesthetics: some patients welcome the lack of a recovery period and sick patients can have their surgery performed with minimal systemic disturbance. Blocking major nerves always involves puncture of the skin with a needle and attempted localization of the nerve using a nerve stimulator to

elicit a muscle contraction; the contraction is strongest when the needle is closest to the nerve. Anatomical landmarks are fairly reliable at directing the needle to the nerve but interpatient variability means that several passes of the needle may be necessary before the nerve is localized. Multiple passes make the procedure more painful and increase the risk of complications such as major vessel damage and haematoma formation.

Urmey et al¹¹ describe the trial of a percutaneous (as opposed to transcutaneous) technique for nerve localization. A sheathed electrode indents but does not puncture the skin and directs the current to an area immediately below the indented skin. When the nerve is localized the needle is passed through the sheathed electrode and nerve localization is continued in the usual way. The investigators were able to demonstrate the success of the technique and the reduction in the number of passes required to localize a major nerve. A subsequent paper by another team shows that it is possible to accurately localize smaller peripheral branches to increase the success rates of nerve blockade, without increasing patient discomfort.¹² Percutaneous nerve localization could soon become the preferred method of performing regional anaesthesia.

Obstetric anaesthesia

A major advance in obstetric anaesthesia has been the widespread increase in the use of epidural infusions for obstetric analgesia, with epidural analgesia being used in 22% of births in the United States in 1981 compared to 66% in 1997.¹³ In the National Sentinel Caesarean Section Audit Report published in 2001, the epidural rate of UK hospitals was 24.5%.¹⁴

With epidural analgesia, a solution of local anaesthetic such as bupivacaine or ropivacaine with or without opiates is infused through a fine bore catheter into the epidural space, marked by the ligamentum flavum posteriorly and the dural membrane anteriorly.

The increase in the use of epidural analgesia has been attributed to a number of factors. It is superior with regards to pain relief when compared to pethidine or Entonox™. It allows easy conversion to an emergency caesarean section under neuroaxial blockade, which has been shown to reduce both foetal and maternal complications. In a study by Sharma et al¹⁵, whereby epidural analgesia was compared with intravenous pethidine, pain relief was superior with epidural analgesia, with 95% of women who received epidural analgesia rating their satisfaction as excellent or good compared with 69% of women who received intravenous pethidine analgesia. Neonatal outcome was better in mother with epidural analgesia, with Apgar score being higher at 1 minute, and with less need for rescue treatment for neonatal depression.

It has been claimed that the superior analgesia offered by epidurals comes at the expense of a higher rate of instrumental and Caesarean deliveries.¹⁶ However studies supporting this claim tended to use high concentrations of local anaesthetic in the epidural mixture, which caused a motor blockade that might have prevented the parturient from pushing effectively. The modern trend is to use very dilute local anaesthetics, supplemented with opiates (which have no motor blocking effects) that tend to block the sensory fibres only, sparing motor fibres. The COMET trial (Comparative Obstetric Mobile

Epidural Trial)¹⁷ established that the incidence of vaginal deliveries increases when low-dose epidural analgesia is used, without any loss of adequacy in analgesia.

Opiates for chronic non-malignant pain

Pain is the commonest symptom that causes patients to seek medical advice. Pain is described as persistent when it has been present for about 3 months. Common examples of persistent pain are low back pain, osteoarthritis and postherpetic neuralgia. Persistent pain is a very common problem but it is more difficult to treat than acute pain as while acute pain is often a straightforward consequence of tissue damage, persistent pain is conditioned by psychological, behavioural and social aspects. The relationship between actual damage and intensity of chronic pain is much less clear.

The use of strong opioids in cancer pain has become accepted practice. Their use for non-cancer pain has been less enthusiastic¹⁸, this despite a growing body of opinion that suggests that in a sub-group of patients with persistent non-cancer pain, strong opioids can provide analgesia and improve quality of life, without rapidly escalating doses or problem drug use. The Pain Society has issued a consensus statement¹⁹ that attempts to provide guidelines to practitioners involved in the care of such patients for the safe and rational use of opioids in the setting of persistent non-cancer pain. The main areas addressed are:

1. The importance of proper patient selection
2. Care to the prevention and treatment of opioid side-effects
3. Putting the risk of tolerance and addiction into perspective: patients established on a fixed dose of opiate do not seem to develop tolerance, while addiction is rare occurrence.
4. The importance of careful follow-up with emphasis on the fact that persistent non-cancer pain needs a multidisciplinary approach and that one treatment modality alone is unlikely to be enough.
5. Patients who do not derive benefit should have their opioid discontinued.

These recommendations should form the basis for development of more detailed local policies and guidelines.

Activated drotrecogin alfa in sepsis

The PROWESS trial established that recombinant activated protein C (drotrecogin alfa) was an effective treatment for severe sepsis with reductions in mortality and morbidity.²⁰ Drotrecogin alfa was the first pharmacological treatment for sepsis to show benefit in a randomised controlled trial. This paper²¹ looks at the long-term outcome of survivors from the trial. Older observational studies suggested that sepsis survivors continued to suffer increased mortality even after their episode of sepsis had resolved.

In a blinded and independent fashion, Angus and colleagues²¹ assessed long-term survival in subjects from PROWESS. Although PROWESS enrolled patients from 1998 to 2000, the long-term follow-up study could not commence until 2001 in order to guarantee that sufficient numbers of patients had the potential to have lived an additional 2.5 years. Strikingly, although 1220 persons survived to day 28 in PROWESS, only 93 individuals were lost to follow-up. In other

words, more than 90% of patients from many different nations were identified.

The potential follow-up times ranged from 15 to 45 months and the median available follow-up time was 43 months. In the Kaplan-Meier survival curves for the entire cohort, the difference noted at day 28 persisted out to 2.5 years. These results are important for two reasons. First, they show that after day 28, there was not some sudden increase in mortality in the drotrecogin alfa (activated) arm that negated the initial treatment benefit. Second, they highlight that drotrecogin alfa (activated) offers an extended survival advantage and reinforces the conclusion that clinicians are not simply delaying the inevitable. The median survival in the placebo arm eventually measured 846 days compared with 1113 days in the active treatment group (an increase of 32%).

Hormone replacement in organ donors

Organ transplantation has resulted in dramatic improvements in the quality of life of patients who would have otherwise relentlessly deteriorated. However the major obstacle in all transplantation programmes has been the availability of organ donors. The number of donors has reached a plateau in most countries and there are no signs yet that this situation is set to improve. It is therefore imperative that patients who do get to the organ donation stage have their organs maintained in the best possible condition in order that the maximum number of organs can then be harvested, thus gaining the greatest benefit from an act of kindness.

In a retrospective analysis²² of all brain-stem dead donors in the United States from January 1, 2000 to September 30, 2001, it was demonstrated that it is possible to improve yield of organs by implementing so-called 'hormone resuscitation' on a background of haemodynamic stability. Hormone resuscitation consists of a bolus of 15mg/kg methylprednisolone, an infusion of vasopressin and an infusion of triiodothyronine or thyroxine. Hyperglycaemia is treated with insulin. The theory is that brain-stem death leads to failure of the hypothalamo-pituitary axis and that this results in severe metabolic derangement leading to changes in cardiac muscle and other organs. This protocol resulted in a 22.5% increase in the number of organs recovered.²³ Hormone resuscitation is included in the standardized management protocol of the United Network for Organ Sharing. If hormone resuscitation can be shown to work in a prospective trial, the number of organ donations will increase with considerable benefit to many seriously ill patients.

Induced hypothermia following resuscitation

Resuscitation methods in the past focused on establishing a circulation after cardiac arrest, but current research now aims to improve neurological outcome following successful cardiac resuscitation. Pharmacological methods, such as thiopentone, corticosteroids and nimodipine, have not shown any benefit. These target one pathway, however brain ischaemia and subsequent reperfusion, activate a complex cascade of events which is not regulated by just one pathway. A more global approach needs to be used, and this may be achieved with mild hypothermia soon after resuscitation.

Two large studies^{24,25} have shown that induced hypothermia confers a good degree of neuroprotection from ischemia and

reperfusion injury, with 51-55% of patients treated having good neurological outcome compared to 26-39% in normothermic patients. This was at the expense of more hyperglycaemia, bleeding, pneumonia and sepsis.

Following these studies, the European Resuscitation Council has advocated the use of mild hypothermia, (32-34°C) for 12-24 hours, in comatose survivors of out-of-hospital cardiac arrest caused by ventricular fibrillation.²⁶ The Council is currently keeping a registry of patients treated in this way in order to document the clinical use of mild hypothermia and its outcome, so as to issue appropriate guidelines. Inpatients and patients with non-cardiac causes of arrest may also benefit, but the use of induced hypothermia in such patients has not been sufficiently studied.

Training with simulators

Anaesthesia is commonly looked upon by outsiders as being 95% boredom and 5% adrenaline. This statement may be only partially correct but it does emphasize the fact that in anaesthesia it has become rare to encounter serious problems. When things go wrong however, they do go wrong in a major fashion and there is only a limited time-frame available in which corrective measures can be applied with success. The analogy with flying an airplane is appropriate and indeed most flights are a breeze but when things go wrong there is no time to look up the manual!

Because anaesthetic mishaps are so uncommon it is difficult for trainee anaesthetists to gain direct experience in their handling. Hence, as in pilot training the development of full scale simulators which attempt to reproduce as faithfully as possible changes in clinical scenarios has been a major step forward. Trainee anaesthetists can then be trained and assessed in their handling of rare situations which can lead to a fatal outcome e.g. anaphylaxis.²⁷

The use of full-scale simulators in anaesthesia is increasingly common over the past decade. Wong²⁸ attempted to find evidence that their use has led to better training and assessment. Although it is tempting to assume that this is so, and students consistently provide positive feedback, no studies could be found that conclusively prove that use of simulators can eventually lead to better patient outcomes. This does not mean that simulation should be discarded; it merely reflects that these systems are new and need to be evaluated and perfected. We believe that the usefulness and reliability of these tools will be evident and an exciting future lies ahead for simulation exercises in anaesthesia.

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