Is the LMA becoming the “ETT” of the 21st century?

Lundgren AC
Chris Hani Baragwanath Hospital, University of the Witwatersrand, Johannesburg
Correspondence to: Prof C Lundgren, e-mail: Chris.Lundgren@wits.ac.za

INTRODUCTION
Extraglottic airways have been around since 1874, which is when our pioneering colleagues first became aware of the problems associated with airway obstruction and the management thereof. A leading article in the Lancet at the time stated that “We have seen surgeons pull forward the tongue with forceps in cases of danger during the inhalation of anaesthetics, but we have always considered it a very rough proceeding, and we are glad to hear from Mr. Clover that the elevation of the chin is quite sufficient and altogether preferable.”

Joseph Thomas Clover was the leading scientific and practical anaesthetist in Britain after the death of John Snow in 1858. He invented a chloroform inhaler in 1862, and together with this a nasopharyngeal tube, which was in fact the first known extraglottic device. Many devices followed, including various forms of oropharyngeal airways.

Tracheal intubation was borne of necessity after the First World War, and the two pioneers in this field were Ivan Magill and Stanley Rowbotham. The purpose of tracheal intubation in these pre-curare times was airway protection, and needed very deep anaesthesia or topical anaesthesia. And in fact the hallmark of a good anaesthetist at that time was the ability to manage the airway using an extraglottic device. Has the pendulum swung and are we back in a similar era?

With the discovery of curare in 1942 and Suxamethonium in 1951, as well as Mendelsen’s publication on acid aspiration, endotracheal intubation became the gold standard of airway management.

In 1981 Dr Archie Brain began looking at the anatomy of the upper airway and he began the development of the laryngeal Mask Airway (LMA). There were many prototypes, and in December 1987, Dr Brain received the first factory made LMA’s. In the year prior to this (1986), Propofol was launched, and this played a significant role in the early success of the LMA, as it made its placement in the upper airway much easier. The LMA was eventually launched in the USA in 1991, as an alternative to the facemask, but not as an alternative to the endotracheal tube.

CURRENT INDICATIONS
There seem to be very few types of cases where one cannot safely use the laryngeal mask airway. This includes types of surgery, as well as varying patient positions. Numerous studies have been performed using one or other type of LMA in these different scenarios, using different modalities of ventilation, with or without muscle relaxation.

Figure 1: A selection of different types of laryngeal mask airways

The types of LMAs
The following LMAs are at our disposal:

Classic LMA (Figure 2)
Reusable, silicone rubber; the original, released in 1988 and the gold standard. The patent on this model has expired and there are numerous other versions of this mask.

Disposable LMA
Released in 1998 and designed for single use only, made of polyvinylchloride (PVC), it is meant to be identical to the classic LMA, with a thicker cuff and a more rigid tube. The original was called the Unique, and many other models have followed, one recent innovation which has a solid non-inflatable cuff made of a thermoplastic elastomer.
Figure 2: The *Classic* LMA (the gold standard) with a disposable example

*Flexible LMA* (Figure 3)
ENT, head and neck and oral, released in 1992. Reusable, with a flexible, wire-reinforced tube that is longer and narrower than the classic LMA. *This is available in a disposable form.*

*Intubating LMA (Fastrach®)* (Figure 4)
Released in 1997, reusable, with an anatomically curved, short, wide rigid airway tube with an integral guiding handle and an epiglottic elevating bar. (best removed after intubation). *This is available in a disposable form.*

*Proseal® LMA* (Figure 5)
Released in 2000, has a modified cuff and a drain tube. It is reusable, and made of silicone. *It is now available in disposable form and this is also made of silicone.*

**Types of Surgery**
The LMA has been successfully used in many different types of surgery, such as:

**Cardiovascular**

*Cardiac*
The LMA has been shown to be effective and safe for children having cardiac investigations.

**Vascular**
The LMA (in one form or other) is recommended for Carotid Endarterectomy (CEA) as there is a marked reduction in haemodynamic responses, particularly on emergence. Certain precautions need to be taken to expedite its use during this procedure. In aortofemoral surgery, the use of the LMA is feasible, particularly if used in combination with epidural anaesthesia.

**Dental**
There are many publications on the safe use of the LMA in dental anaesthesia. Brimacombe has reviewed many of the publications on the subject and states the following:

- Hypoxia is less common with the LMA than with the nasal mask
- Case turnover is higher with the flexible LMA than with the nasotracheal tube
- Airway obstruction is more common with the flexible LMA than the nasotracheal tube during extraction
Epistaxis and aspiration of blood is less common with the flexible LMA than the nasotracheal tube.

The flexible LMA is superior to the classic LMA in dental patients.

**Endoscopy**

**Bronchoscopy**
This can be done effectively and safely in awake and anaesthetized patients.

**Gastroscopy**
The LMA can be used successfully in sedated and anaesthetized patients for this procedure. The cuff should be partially deflated to allow the passage of the gastroscope under the mask. This is best done in the lateral position.

**Ear, nose and throat (ENT)**
There are many procedures where the LMA can be successfully used. In the general surveys most problems are related to the tonsillar gag.

**Minor ear surgery**
There is less hypoxia and less interference with the surgical field with the LMA than with the face mask.

**Major ear surgery**
The LMA has a high success rate and low complication rate, with ventilatory performance matching that with endotracheal intubation. In addition smooth emergence is ensured. The flexible or Proseal LMA is recommended.

**Nasal surgery**
In numerous studies it has been shown that the LMA has a high success rate and a low complication rate for nasal surgery. The incidence of aspiration of blood during nasal surgery is 0.5%. Emergence characteristics are better for the LMA (flexible) than the endotracheal tube after intranasal surgery.

**Adenotonsillectomy**
There needs to be close co-operation between the surgeon and anaesthesiologist, and meticulous attention to detail. It is not a popular technique, but can be used (success rate 96%). In addition emergence characteristics are good.

**Vocal cord biopsy**
Vocal cord biopsy is feasible with the LMA.

**General surgery**
These include anorectal surgery, pilonidal surgery, breast surgery, abdominal surgery and thyroid/parathyroid/thymic surgery.

**Anorectal and pilonidal surgery**
It is feasible to use the LMA for these types of surgery, although they are performed in the lithotomy and prone positions respectively, and there is very little literature available.

**Breast surgery**
Either the flexible or classic LMA’s are suitable for this type of surgery, but there is no literature dedicated specifically to this.

**Abdominal surgery**
The use of the LMA is feasible for abdominal wall herniorrhaphy and lower intra-abdominal surgery. It is not recommended for upper intra-abdominal (non-laparoscopic) surgery. In laparoscopic surgery, the Proseal LMA can be used, but in grossly obese patients the endotracheal tube is preferable.

**Thyroid/parathyroid and thymic surgery**
The LMA can be used, resulting in better emergence and less recurrent laryngeal nerve injury. The Proseal is recommended, with IPPV. However, success rates are quoted as 90%.

**Gynaecological**
These procedures include transvaginal procedures, laparotomies and laparoscopies.

**Transvaginal procedures**
There is very little data, but the LMA is safe and suitable for short procedures, and the Proseal for longer procedures, particularly in the lithotomy and Trendelenburg position.

**Laparotomies**
The LMA can be used, but is probably not an advantage.

**Laparoscopies**
Numerous studies indicate that the LMA (Proseal) is safe and effective.

**Medical imaging**
The MRI-safe LMA is very suitable for the MRI and the conventional LMA for radiotherapy. The classic LMA has ferromagnetic springs in the valve.

**Neurosurgery**
More than 15 publications are available, and it appears that the LMA is suitable for these procedures, including V-P shunt insertions, minimally invasive neurosurgery and craniotomy. The Proseal LMA is recommended, with muscle relaxation and IPPV.

**Obstetrics**
Brifax recommends that the LMA only be used in situations where a neuraxial block and an endotracheal tube cannot be utilized.

**Ophthalmology**
There are in excess of 40 studies on this subject.

**Extraocular**
The LMA is effective and probably safe for extraocular surgery, and may offer some advantages over the endotracheal tube. This also applies to patients having intraocular surgery in terms of an attenuated haemodynamics stress response, lower intraocular pressures and less coughing during emergence. There is no evidence of improved clinical outcome. The Proseal and flexible LMA are suitable.

**Orthopaedic**
There are many studies on the use of the LMA in these patients. It is safe and effective in patients having limb surgery. In spinal surgery, the endotracheal tube is probably better, but can be replaced by an LMA at the time of emergence.

**Plastic surgery**
The LMA is suitable for many different types of plastic surgery. It is recommended that the type of LMA be tailored to the type of surgery.

**Respiratory tract**
The LMA is a useful airway adjunct for lung surgery, but can be used for insertion of tracheal stents and tracheal dilatation. It has also been used successfully for tracheostomy after airway rescue.
Urology

The LMA can be used safely for many urological procedures

The use of the LMA has not been looked at in patients undergoing electroconvulsive therapy (ECT)

The absolute contra-indications

The absolute contraindications would probably include:

- Cardiac surgery, as high airway pressure ventilation and postoperative respiratory support are frequently required.
- Open lung surgery, requiring one-lung-ventilation

PAEDIATRICS

Children differ from adults from an anatomical, physiological and pathological perspective, with important implications for the conduct of airway management and the risk of complications. More than 400 publications exist on different aspects of the use of the LMA in paediatric patients, and in summary, it has been shown that the LMA is safe and effective for paediatric airway management. However, adverse airway events are more common in infants than in older children. It offers advantages over the face mask in terms of better gas exchange and easy instrumentation of the respiratory tract. It offers advantages over the endotracheal tube in terms of an attenuated haemodynamics stress response, better tolerance during emergence, and reduced aspiration of blood during oral surgery. The efficacy of the seal is similar to that in adults, performance as a ventilatory device is similar to an uncuffed tube, and airway protective reflexes are more readily activated. And finally, it is possibly superior over an endotracheal tube in a child with an URTI.

Figure 6: The Supreme, which is a disposable hybrid between the Fastrach® and the Proseal®

PATIENT POSITIONS

The impact of body position on the use of the LMA is primarily related to:

- Increased intra-abdominal pressure, making regurgitation more likely
- Decreased pulmonary compliance, making positive pressure ventilation more difficult
- Reduced positional stability, making displacement more likely
- Movement into the new position, making patient stimulation and injury more likely

Table 1 summarises in which patient positions the LMA can be used safely.

Table 1: Safe patient positions in which to use the LMA

| Position                          | Decision                  |
|-----------------------------------|---------------------------|
| Lateral                           | Yes                       |
| Lithotomy                         | Yes                       |
| Head – down (trendelenburg)       | Proseal - yes             |
| Head-up (reverse trendelenburg)    | Unknown, but probably okay |
| Prone                             | Effective, yes            |
| Jack-knife                        | No studies; Proseal probably okay |
| Beach chair                       | No studies; Proseal probably okay |

MODE OF VENTILATION

This is dependent on many factors, such as:

- The type of induction agents used
- The use of muscle relaxants
- Type of surgery
- Body position
- Patient’s physical status

The modes of ventilation that have been looked at with the use of the LMA are summarised in table 2:

Table 2: Mode of ventilation

| Mode of ventilation | Notes                                      |
|---------------------|--------------------------------------------|
| SPONTANEOUS         | The LMA provides better oxygenation than the face mask in spontaneously ventilating patients |
| PRESSURE SUPPORT    | Effective ventilation with the LMA         |
| POSITIVE PRESSURE   | Effective ventilation with the LMA         |
| ~pressure controlled|                                           |
| POSITIVE PRESSURE   | Effective ventilation with the LMA         |
| ~volume controlled  |                                           |
| HIGH FREQUENCY      | Feasible with the LMA                     |

COMPLICATIONS AND PROBLEMS

These need to be compared with endotracheal tube use, and can be divided into the following:

Functional

- Failure to insert/seal/use as airway device is 1-2%
- Failure to protect from supracuff soiling is 0.5%

Pathophysiological

**Cardiovascular system**

On a local level, the microcirculation is unaffected, unless the cuff volumes are high or the ILM is used. Systemically there is considerably less of a haemodynamics stress response in comparison with endotracheal intubation, but there is no evidence for improved cardiovascular outcome with the LMA

**Respiratory system**

Airway obstruction with LMA use for non-intraoral surgery is 1.5% in comparison with up to 31% for intraoral surgery. The incidence of occurrence of airway protective reflexes is 4.1%, and postoperative laryngeal function impairment varies from 4% for impaired phonation (better than with endotracheal tube), to 25% for impaired airway protection. Systemically, the incidence of hypoxia is 1% and the LMA does not impede ciliary motility, or cause bronchoconstriction. The incidence of aspiration is 0.012% (usually due to inappropriate patient selection and inadequate anaesthetic
depth), and of pulmonary oedema <0.01%. Work of breathing and inspiratory resistance is less than with the endotracheal tube.

Airway morbidity includes pharyngolaryngeal discomfort of 3-13% (the latter for sore throat), and dry mouth/throat occurring in up to 60%. Tissue trauma with visible bleeding occurs in 4.5%, and compression of neck structures is rare.

Gastrointestinal system
Occasional compression of salivary ducts occurs. Gastric insufflation during IPPV occurs in 0 – 0.3%. Oesophageal dysfunction is similar to that occurring with endotracheal tube, and measured pharyngeal regurgitation occurs in 5%. The incidence of hypersalivation is up to 33% (especially with awake removal), and nausea and vomiting similar to that with intubation.

Nervous system
There is evidence that suggests the LMA has a pre-emptive analgesic effect, as postoperative analgesic requirements have been reduced in patients having the same surgery (cholecystectomy), some with the LMA and others with endotracheal intubation. However, more work needs to be done in this area.

Ocular
Intraocular pressure increases are less than with endotracheal intubation, as well as being lower during emergence.

Bacteraemia
LMA insertion does not trigger a significant bacteraemia

Disease transmission
It is recommended that the disposable mask be used in the presence of prior disease. There is one reported case of hepatitis C transmission, but this was via the circuit.

Pollution
Less theatre pollution occurs than with masks and also probably tubes?

Damage to equipment
This can occur with the cuff (herniation or puncture), pilot balloon and the actual tube, which may fracture or deform.

How do these complications compare with those from endotracheal intubation?
The ASA closed claims database indicated the following with respect to airway injury: 6% of the claims were for airway injury. The most frequent sites of injury were the larynx (33%), pharynx (19%) and oesophagus (18%). Forty-two % of the claims for airway injuries were associated with difficult intubation. Most airway injuries were temporary or non-disabling, but 8% resulted in death. It would appear that the majority of airway injuries were associated with endotracheal tube intubations, or the use of oesophageal probes, such as nasogastric tube and oesophageal stethoscope insertion. No comment is made about LMA use.

In 2003 Zuccherelli reviewed the postoperative “sore throat”. Sore throat was defined as one of the following: • Pharyngeal dryness • Continuous throat pain, mild, moderate or severe • Dysphagia, which is unco-ordinated swallowing or the inability to swallow or eat • Odynophagia, which is pain on swallowing or eating • Dysphonia, which encompasses hoarseness or voice changes

Table 3 tabulates the comparative findings of the incidences of these complications following the use of the LMA in comparison with the endotracheal tube.

Table 3: Incidences of complications. LMA versus ETT

|                        | LMA          | ETT          |
|------------------------|--------------|--------------|
| Sore throat            | 6 – 34%      | 14 – 50%     |
| Hoarseness             | 9 – 21%      | 4 – 42%      |
| Permanent Dysphonia    | 0.4 – 5%     | 0.4 – 5%     |
| Pharyngeal Dryness     | 61%          | 75%          |

So as can be seen, the incidence of complications with the LMA is less than with endotracheal intubation, but it can and does still occur. Interestingly, there is a small but definite incidence of postoperative sore throat with the face mask, even without the use of a Guedel airway.

ROLE OF THE LMA IN DIFFICULT AIRWAY MANAGEMENT
The LMA has an established role in the management of the difficult airway, as it provides an alternative means of intubation and ventilation that is independent of the factors making conventional airway management techniques difficult. The reasons for this include: • The anatomic and/or technical factors making face mask ventilation and laryngoscope-guided tracheal intubation difficult, do not usually influence LMA insertion and function • The LMA can be used as a ventilatory device AND an airway obturator • Tracheal intubation can take place in an unhurried way whilst the patient is being oxygenated and ventilated • Insertion of the LMA is relativelyatraumatic and does not reduce the chances of other techniques subsequently succeeding • The widespread use of the LMA ensures that it is readily available and that most anaesthetists are reasonably skilled in its use

A considerable body of increasingly prospective data supports its use in the predicted and unpredicted difficult airway. However, success may be impeded if the pathology interferes with its placement. It is usually included in the “Difficult Airway Algorithm”, particularly in the “cannot ventilate, cannot intubate” scenario, but perhaps one should consider using it de novo in a patient with a difficult airway?

HAS THE LMA REPLACED THE ENDOTRACHEAL TUBE IN AIRWAY MANAGEMENT IN THE 21ST CENTURY?
If one looks at the United Kingdom, the trend seems to indicate that this is in fact the case. This is so much so, that anaesthesia trainees are not getting sufficient practice at endotracheal intubation. If one reads the literature, there is increasing evidence that at least one of the LMA’s available can be used for most cases presenting for anaesthesia and surgery, and as Mazen et al state in Anesthesiology, “Is routine Endotracheal Intubation as Safe as We Think or Wish?”

References:
1. Howard B. Observations on the upper air passages in the anaesthetic state. Lancet 1880; 1:763-708
2. Magill FW. Technique in endotracheal anaesthesia. Proc Roy Soc Med 1928; 22:183-88
3. Coffill HB, Johnson GE. The use of curare in general anaesthesia. Anesthesiology 1942;5:418
4. Mendelsohn CL. The aspiration of stomach contents into the lungs during obstetric anaesthesia. Army Obs. Crouch 1946;19:121-24
5. Brain AJ. The laryngeal mask – a new concept in airway management. Br J Anaesth 1985;55:801-810
6. Bromage JR. Laryngeal Mask Anaesthesia, 2nd Edition
7. Peck D, Holland R, Merry A. Parastic cardiac catheterization and the laryngeal mask: Anaesth Intens Care 1995;23:643-644
8. Maninio DR et al. Cardiovascular stability during carotid endarterectomy: endotracheal intubation versus laryngeal mask airway. J Clin Anesth 1998;10:34-57
9. Bromage JR. The laryngeal mask airway for access to the upper gastrointestinal tract. Anesthesiology 1995;84:1913-1914
10. Watsila MF et al. Laryngeal mask airway vs. face mask and Guedel airway during paracutaneous thyroideotomy. Arch Otolaryngol Head Neck Surg 1994;120:877-880
11. Wehrly AC et al. Anaesthesia for intranasal surgery: a comparison between tracheal intubation and the flexible reinforced laryngeal mask airway. Anesth Analg 1998;88:421-425
12. Domino KD et al. Airway injury during Anaesthesia. Anesthesiology 1999;91:705-11
13. Zuccherelli L. Postoperative upper airway problems. SAJAA 2005; May; 12-16

Editorial

SAJAA 2007;13(4) July/Aug