PREFACE

In the first ten years since its introduction in 1988, the Laryngeal Mask Airway (LMA) has been used over 100 million times. To date there have been over 2000 publications in medical literature describing its use and versatility.

There are two published text books (see bibliography, page 25) which the user is strongly advised to read in conjunction with this Instruction Manual. The bibliography also contains additional published material on the LMA.

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Instruction Manual
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1 DEVICE DESCRIPTION

The Laryngeal Mask Airway (LMA) is an innovative airway management device intended as an alternative airway to the face mask. Since its commercial introduction in 1988, the LMA has been used in over 100 million patients for routine and emergency procedures without a single reported fatality.

The original LMA (now termed the LMA-Classic), the wire-reinforced LMA (the LMA-Flexible) and the single-use LMA (the LMA-Unique) are the subjects of this manual. The term LMA is used in this manual as a generic term and applies to these three devices, unless otherwise specified. The LMA-Fastrach, an LMA designed to facilitate endotracheal intubation with minimal instrumentation, is not described in this manual.

The Laryngeal Mask Company Limited recommends that the LMA-Classic and the LMA-Flexible be used a maximum of 40 times before being discarded. The LMA-Unique is a single use, disposable device and should be discarded after use as it does not withstand sterilisation.

The LMA consists of three main components: an airway tube, mask and mask inflation line (Figure 1). The airway tube is a large-bore tube with a 15mm standard male airway connector (the LMA-Flexible has a narrower, wire-reinforced flexible airway). Its other end is fitted with a specially shaped cuff which is inflated and deflated via a valve on the end of the inflation line. All devices are entirely latex free. The mask is designed to conform to the contours of the hypopharynx with its lumen facing the laryngeal opening.

![Figure 1: The components of the LMA (LMA-Classic shown)]
The LMA is designed to be a minimally stimulating airway device. When fully inserted using the recommended insertion technique, the distal tip of the LMA cuff reaches the distal end of the hypopharynx immediately above the oesophageal sphincter. Its sides face into the pyriform fossae and the upper border rests against the base of the tongue (Figure 2).

Figure 2: Dorsal view of the LMA showing position in relation to pharyngeal anatomy
2 INDICATIONS AND CONTRAINDICATIONS

2.1 Indications
The LMA is indicated for use as an alternative to the face mask for achieving and maintaining control of the airway during routine and emergency anaesthetic procedures in fasted patients. The LMA is also indicated for securing the immediate airway in known or unexpected difficult airway situations.

During cardiopulmonary resuscitation (CPR) in the profoundly unconscious patient with absent glossopharyngeal and laryngeal reflexes requiring artificial ventilation, the LMA may be used to establish an immediate, clear airway. The LMA may also be used to secure an immediate airway when tracheal intubation is precluded by lack of available expertise or equipment, or when attempts at tracheal intubation have failed.

2.2 Contraindications
The LMA does not protect the airway from the effects of regurgitation and aspiration. It is therefore contraindicated in non-fasted patients, patients suspected of being non-fasted or patients who may have retained gastric contents (except in the "cannot intubate cannot ventilate" situations in which the user must decide on the risk benefit ratio of using this device). Such situations will include but are not limited to patients with:

- symptomatic hiatus hernia
- morbid obesity
- pregnancy past 14 weeks
- multiple or massive injury
- acute abdominal or thoracic injury
- conditions associated with delayed gastric emptying
- use of opiate medication prior to fasting

When used in the profoundly unresponsive patient in need of CPR, the risk of regurgitation and aspiration must be weighed against the potential benefit of establishing an airway in a potentially "non-fasted" patient.

In addition the LMA is contraindicated in patients with fixed decreased pulmonary compliance (eg patients with pulmonary fibrosis) because the LMA forms a low-pressure seal (approximately 20cm H₂O) around the larynx.
3 WARNINGS
The user should be familiar with the following warnings when considering or attempting LMA use:

- As with all devices, the components of the LMA will degrade over time and therefore the number of uses must be limited. With proper cleaning, sterilisation and handling, the LMA has a maximum of 40 uses. Continued use of the LMA beyond this number is not recommended as degradation of the components may occur, resulting in impaired performance or abrupt failure of the device.

- The Performance Tests must be carried out before each use of the device. Failure of any one Performance Test indicates that the device has passed its useful life and must be discarded.

- Failure to properly clean, rinse and dry a device may result in retention of potentially hazardous residues or inadequate sterilisation.

- The cuff of the LMA should never be over-inflated after insertion. Ideally a "just-seal" pressure of less than 60cm H₂O is desirable. Use of a larger size is recommended if higher pressures are required to achieve this "just-seal" pressure. In general it is recommended that the largest size of LMA which fits into place with the lowest pressure to obtain a seal should be used.

- Inadequate anaesthesia may lead to coughing, breath-holding or laryngeal spasm.

4 ADVERSE EFFECTS
Both minor adverse effects (e.g. sore throat) and major adverse effects (e.g. aspiration) following LMA use have been reported in the published literature. There have been no reports of death directly attributable to the LMA in over 100 million uses of the device worldwide.

- A review of published literature suggests that the incidence of aspiration is low (~2:10,000) and is comparable to the incidence of aspiration associated with outpatient general anaesthesia with the face mask or endotracheal tube. There have been no published reports of long-term morbidity or mortality associated with the LMA subsequent to aspiration.

- The incidence of sore throat following LMA use is approximately 10% (range 0-70%) and is usually mild and short-lived. Severe or prolonged sore throat, sometimes accompanied by dysphagia, has been reported in patients in whom an improperly cleaned or sterilised mask has been used.

- Unusual neurovascular events reported with LMA use include rare cases of hypoglossal nerve injury, transient tongue numbness secondary to lingual nerve injury, tongue cyanosis, tongue macroglossia, and vocal cord paralysis. These complications are probably the result of poor insertion techniques or excessive cuff pressure. However, a clear relationship to the use of the LMA has not been established.
5 PREPARATION FOR USE

With proper cleaning, sterilisation and handling, the LMA-Classic and the LMA-Flexible may be expected to survive 40 uses. Proper cleaning and sterilisation of the LMA-Classic and the LMA-Flexible are essential to ensure continued safe usage up to 40 times. Continued use of the LMA beyond 40 uses is not recommended as degradation of the components may occur, resulting in impaired performance or abrupt failure of the device.

The LMA-Unique is supplied sterile and is not intended for re-use. The procedures described below are not applicable to this device.

The LMA-Classic and the LMA-Flexible are delivered non-sterile and must be cleaned and sterilised before initial use and before each subsequent use. The packaging cannot withstand the high temperatures of autoclaving and should be discarded before sterilisation.

5.1 Cleaning

Thoroughly wash the LMA cuff and airway tube in warm water using a dilute (8-10% w/w) sodium bicarbonate solution until all visible foreign matter is removed.

Mild detergents or enzymatic cleaning agents may be used in accordance with the manufacturer’s instructions and at the proper dilution. The detergent must not contain skin or mucous membrane irritants. A specific cleaner found to be compatible with LMA use is Endozime (Ruhof, Valley Stream, NY).

Do not use germicides, disinfectants, or chemical agents such as glutaraldehyde (eg Cidex®), ethylene oxide, phenol-based cleaners or iodine-containing cleaners to clean or sterilise the LMA. Such substances are absorbed by the LMA materials, resulting in exposure of the patient to unnecessary risk and possible deterioration of the LMA. Do not use an LMA that has been exposed to any of these substances.

If the inner valve is exposed to a cleaning solution, rinse thoroughly under warm flowing tap water, remove excess moisture, and allow to dry.

Clean the LMA using a small soft bristle brush (approximately ½ inch or 12.5mm in diameter). Gently insert the brush through the aperture bars into the airway tube, taking care not to damage the bars.

Thoroughly rinse the LMA cuff and airway tube in warm flowing tap water to remove cleaning residues. Carefully inspect the LMA to ensure that all visible foreign matter has been removed.

Repeat the above as necessary.

Failure to properly clean, rinse and dry a device may result in retention of potentially hazardous residues or inadequate sterilisation.
5.2 Sterilisation

Steam autoclaving is the only recommended method for sterilisation of the LMA. Adherence to the following procedure is essential to ensure sterilisation without damage:

- Immediately prior to steam autoclaving, deflate the LMA cuff completely. Ensure that both the syringe used to deflate the cuff and the LMA valve are dry.
- Any air or moisture left in the cuff will expand at the high temperatures and low pressures of the autoclave, causing irreparable damage to the cuff and/or blue pilot balloon.
- To avoid damage to the valve, do not use excessive force when inserting the syringe into the valve port. Remove the syringe from the valve port after deflation.
- If a deflated mask immediately and spontaneously re-inflates after the syringe has been removed, do not autoclave or re-use the mask. This indicates the presence of a defective device. It is normal, however, for the LMA to re-inflate slowly over a period of several hours as the silicone rubber material is permeable to gas.
- Steam autoclave the LMA following the recommendations of the institution or the autoclave manufacturer. All steam autoclave cycles typically used for porous items are acceptable for sterilisation of the LMA, provided the maximum autoclave temperature does not exceed 135°C or 275°F. The integrity of the LMA materials may be adversely affected by exceeding these temperatures.
- Autoclaves vary in design and performance characteristics. Cycle parameters should therefore always be verified against the autoclave manufacturer’s written instructions for the specific autoclave and load configuration being used.
- Healthcare personnel are responsible for adhering to the appropriate sterilisation processes which have been specified. Failure to do so may invalidate the sterilisation process of the healthcare facility.
- After autoclaving allow the LMA to cool to room temperature before use.

5.3 Performance Tests

All of the non-clinical tests described below must be conducted before each use of the device. The Performance Tests should be conducted in an area and in a manner consistent with accepted medical practice that minimises contamination of the LMA before insertion. Failure of any one test indicates that the device has passed its useful life and should be replaced.

**Performance Test 1: Visual Inspection**

- Examine the transparency of the airway tube. The airway tube will gradually discolor with age and re-use. Do not use the LMA when discoloration of the airway tube is present as this impairs the ability to see and effectively remove foreign particles during cleaning or to see regurgitated fluids during use.
• Examine the surface of the LMA for damage, including cuts, tears, or scratches. Do not use the LMA if the airway tube is damaged in any way. Examine the interior of the airway tube to ensure that it is free from blockages or loose particles. Any particles present in the tube should be removed as they may be inhaled by the patient after insertion.

• Flex the tube up to, but not beyond 180°, as shown by the arrows (Figure 3). Should the tube kink, discard the LMA.

• Examine the aperture in the mask. Gently probe the two flexible bars traversing the mask aperture to ensure they are not broken or otherwise damaged. If the aperture bars are not intact, the epiglottis may obstruct the airway.

• Examine the 15mm connector. It should fit tightly into the outer end of the airway tube. Ensure that it cannot easily be pulled off by hand using reasonable force. Do not use excessive force or twist the connector as this may break the seal.

**Performance Test 2: Inflation and Deflation**

• Carefully insert a syringe into the valve port and fully deflate the cuff so that the cuff walls are tightly flattened against each other. Remove the syringe from the valve port. Examine the cuff walls to determine whether they remain tightly flattened against each other. Do not use the LMA if the cuff walls re-inflate immediately and spontaneously, even if only slightly.

• Inflate the cuff from complete vacuum with 50% more air than the recommended maximum inflation volume.

• Any tendency of the cuff to deflate indicates the presence of a leak and should be evident within two minutes. Examine the symmetry of the inflated cuff. There should be no uneven bulging at either end or sides.

• While the device remains 50% over-inflated, examine the blue inflation pilot balloon. The balloon shape should be elliptical, not spherical.
5.4 Pre-insertion Preparation

Prior to insertion of the LMA, the cuff should be tightly deflated so that it forms a smooth "spoon-shape" without any wrinkles on the distal edge. This can be accomplished through use of the LMA Cuff-Deflator, available from the distributor (Figure 4). Alternatively, press the LMA mask with its aperture side down on a flat surface with the fingers being used to guide the cuff into the desired shape (Figure 5).

A completely deflated, smooth leading edge facilitates insertion, avoids contact with the epiglottis, and facilitates success in achieving the correct final position of the device at the upper oesophageal sphincter (Figure 6).

In order to ensure that the LMA is completely deflated, the "flip test" should be performed. When the tip of the deflated cuff is inverted, it should flip back to its original position. If it does not, there may be air inside the cuff or the mask may be incorrectly deflated.

Lubrication of the posterior surface of the LMA should be performed just before insertion to prevent drying of the lubricant. Lubricate only the posterior surface of the LMA cuff to avoid blockage of the aperture or aspiration of the lubricant. It is recommended that a bolus of lubricant be applied to the posterior tip of the deflated cuff.

A water-soluble lubricant, such as K-Y Jelly®, should be used. Do not use silicone-based lubricants as they degrade the LMA components. Lubricants containing Lidocaine are not recommended for use with the LMA. Lidocaine can delay the return of the patient's protective reflexes prior to removal of the LMA, may possibly provoke an allergic reaction, or may effect the surrounding structures, including the vocal cords.
6 INSERTION

There is a learning curve for LMA insertion and for the maintenance of anaesthesia. An "early" learning curve for routine LMA use and a "late" learning curve for advanced use have been described. Before using the LMA the user should be familiar with all warnings, precautions and contraindications given in this manual.

6.1 Introduction

It is possible to obtain an unreliable or obstructed airway if the device is inserted incorrectly. Before insertion it is important to note the following points:

- Check that the size of the LMA is appropriate for the patient (see table on inside rear cover of manual). The ranges are approximate and clinical judgment should be used in selecting an appropriate size.
- Check the shape of the cuff and its lubrication, as described previously.
- Have a spare sterile LMA ready and prepared for immediate use. Where possible, a larger and smaller size of LMA should be available.
- Pre-oxygenate and implement standard monitoring procedures.
- Achieve an adequate level of anaesthesia ("jaw slackness" is a good indicator) before attempting insertion of the LMA. The detection of "swallowing pressure" by the advancing index finger indicates an inadequate depth of anaesthesia. "Gagging" indicates both an inadequate depth of anaesthesia and an inappropriate insertion technique. It is preferable to induce a deeper level of anaesthesia than to attempt insertion at light planes of anaesthesia. In particular it is recommended that the inexperienced user chooses a deeper level of anaesthesia.
- The ideal head position is extension of the head with flexion of the neck in the position normally used for tracheal intubation ("the sniffing position"). This can be achieved by pushing the head from behind with the non-dominant hand during insertion. A pillow can also be used to keep the neck flexed.
- Excess force must be avoided.

6.2 Induction Methods

The following induction methods are compatible with the insertion of the LMA:

- **Propofol.** This is the agent of choice for LMA insertion as it optimally obtunds upper airway reflexes and produces ideal insertion conditions. Between 2.5 and 3mg/kg may be necessary in unpremedicated ASA I patients (check the drug manufacturer’s prescribing information for details). Insertion can usually be achieved within 30 seconds after induction provided the level of anaesthesia is adequate.

- **Inhalational induction.** This provides excellent conditions for insertion in children and in some adults. The depth required is slightly more than that required for insertion of a Guedel-type airway. However, the inexperienced user should insert the LMA at an anaesthesia level closer to that required for surgical procedures.
• **Thiopentone or other barbiturate induction.** Barbiturates on their own are not ideal induction agents for LMA insertion. If used on their own, it is recommended that anaesthesia be deepened using an inhalational agent for several minutes before attempting insertion. Co-induction, using midazolam 2-5mg intravenously 3 minutes before induction with thiopentone, optimises LMA insertion conditions (ie simulates conditions using Propofol).

6.3 **Insertion Methods**

To position the LMA correctly, the cuff tip must avoid entering the valleculae or the glottic opening and must not become caught up against the epiglottis or the arytenoids. The cuff tip should therefore be kept pressed against the posterior pharyngeal wall during insertion. When the cuff is correctly deflated it forms a shallow concavity with a smooth thin leading edge, "a floppy shovel" (Figure 6). When this is pressed against the palate, the concavity flattens out along the posterior wall, thus avoiding anterior structures during insertion. To achieve this, the inserting finger or thumb must press the tube upwards (cranially) throughout the insertion manoeuvre, mimicking the action of the tongue as it propels a bolus of food during normal swallowing. The finger also acts as a "sensor" to detect swallowing. The presence of swallowing during insertion indicates an inadequate depth of anaesthesia.

There are two recommended insertion techniques: the standard technique and the thumb technique. Both techniques follow the same principles. It is important to understand the correct insertion techniques for the LMA.

6.4 **Standard Insertion Technique**

The standard insertion technique is used when access to the patient’s head from above is possible.

This technique has been shown to provide optimal LMA placement (a fibreoptic view of the laryngeal inlet is obtained in 95% of patients). The standard technique is to hold the LMA like a pen, with the index finger placed at the junction of the cuff and the tube (Figure 7). The mask aperture must face posteriorly (Figure 8) and the black line on the airway tube should be oriented anteriorly toward the upper lip.

Under direct vision, press the tip of the cuff upward against the hard palate and flatten the cuff against it (Figure 8).

Further opening of the mouth makes it easier to see into the mouth, verify the position of the mask and insert the index finger further into the mouth during insertion (Figure 9). The jaw may be pushed downwards with the middle finger or by a nurse or assistant instructed to pull the lower jaw downwards momentarily.

A high arched palate may require a slightly lateral approach. Look carefully into the mouth to verify that the tip of the cuff is correctly flattened against the palate before proceeding.

Using the index finger to guide the LMA, press backwards toward the ears in one smooth movement (Figure 10). Do not use force. Advance the LMA into the hypopharynx until
a definite resistance is felt (Figure 11). The jaws should not be held widely open during this movement as this may allow the tongue and epiglottis to drop downwards, blocking passage of the mask.

Depending on patient size, the finger may be inserted to its fullest extent into the oral cavity before resistance is encountered. Before removing the finger, the non-dominant hand is brought from behind the patient’s head to press down on the LMA tube (Figure 12). This prevents the LMA from being pulled out of place when the finger is removed. It also permits completion of the insertion in the event that this has not been achieved by the index finger alone. At this point the LMA should be correctly located with its tip pressed against the upper oesophageal sphincter.

6.5 Thumb Insertion Technique

This technique is suitable for patients in whom access to the head from behind is difficult or impossible and during cardiopulmonary resuscitation.

The principles of insertion are fundamentally the same as for the standard technique. However, the LMA is held with the thumb in the position occupied by the index finger in the standard technique (Figure 13). The tip of the mask is pressed against the front teeth and the mask is pressed posteriorly along the palate with the thumb. As the thumb nears the mouth, the fingers are stretched forward over the patient’s face (Figure 14). Advance the thumb to its fullest extent (Figure 15). The pushing action of the thumb against the hard palate also serves to press the head into extension. Neck flexion may be maintained with a head support. Before removing the thumb, push the tube into its final position using the other hand (Figure 16).

6.6 Inflation

Check to ensure that the black line on the airway tube is oriented anteriorly toward the upper lip. Then inflate the cuff with just enough air to obtain a seal. This should correspond to intracuff pressures around 60cm H\textsubscript{2}O. Frequently only half of the maximum recommended volumes are sufficient to achieve a seal. Never over-inflate the cuff. Avoid prolonged intracuff pressures greater than 60cm H\textsubscript{2}O. The initial cuff pressure will vary according to the patient, LMA size, head position and anaesthetic depth. During cuff inflation, do not hold the tube as this prevents the mask from settling into its correct location (Figure 17). A small outward movement of the tube is often noted as the device seats itself in the hypopharynx.

The signs of correct placement may include one or more of the following: the slight outward movement of the tube upon LMA inflation, the presence of a smooth oval swelling in the neck around the thyroid and cricoid area, or no cuff visible in the oral cavity.

Warning: Never over-inflate the cuff after insertion.
STANDARD INSERTION TECHNIQUE

Figure 7: Method for holding the LMA for standard insertion technique

Figure 8: With the head extended and the neck flexed ("the sniffing position"), carefully flatten the LMA tip against the hard palate

Figure 9: To facilitate introduction of the LMA into the oral cavity, gently press the middle finger down onto the jaw

Figure 10: The index finger pushes the LMA in a cranial direction following the contours of the hard and soft palates

Figure 11: Maintaining pressure with the finger on the tube in the cranial direction, advance the mask until definite resistance is felt at the base of the hypopharynx: note flexion of the wrist

Figure 12: Gently maintain cranial pressure with the non-dominant hand while removing the index finger
THUMB INSERTION TECHNIQUE

Figure 13: Method for holding the LMA for thumb insertion technique

Figure 14: With the fingers extended, press the thumb along the posterior pharynx

Figure 15: Advance the thumb to its fullest extent

Figure 16: Press gently into place with the non-dominant hand while removing the thumb

Figure 17: To allow the mask to seat optimally, inflate without holding the tube; inflate the cuff with just enough air to obtain a seal - this should correspond to intracuff pressures around 60cm H_2O; do not over-inflate the mask
6.7 Securing the LMA™

Before taping the LMA in place, insert a bite-block. The bite-block can be fabricated from three or four 10 x 10 cm (4 x 4 inch) gauze pads tightly rolled and taped into a cylindrical pad (Figure 18). Do not use an oral Guedel airway as a bite-block. The gauze bite-block should be at least 3 cm thick for adults and at least 2 cm thick for children. This is twisted into place alongside the airway tube. Gently press the LMA tube upwards into the palatopharyngeal arch and secure in this position by taping to the face (Figure 18). The airway tube may additionally be taped downwards against the chin. The bite-block and the correct taping procedures will stabilise the LMA and prevent potential occlusion of the tube. Keep the bite-block in place until the LMA is removed.

6.8 Connecting to the Anaesthetic System

Taking care to avoid dislodgment, connect the LMA to the anaesthetic circuit and employ gentle manual ventilation to airway pressures of less than 20 cm H₂O. Dislodgment does not occur when the LMA is properly inserted and when protective reflexes are properly obtunded ("adequate depth of anaesthesia"). Capnography should be used to confirm adequate gas exchange. Check airway patency by inflating the lungs. Auscultate in the anterolateral neck region to check for abnormal sounds that might indicate mild laryngeal spasm or light anaesthesia.

The mask may leak slightly for the first three or four breaths before settling into position in the pharynx. If the leak persists, check that the pulmonary inflation pressures are low and there is adequate depth of anaesthesia before assuming that the LMA requires re-insertion due to malposition.

6.9 Potential Problems with Insertion

An inadequate depth of anaesthesia may result in coughing and breath-holding during LMA insertion. Should this occur the anaesthesia should be deepened immediately with inhalational or intravenous agents and manual ventilation instituted.

If the patient’s mouth will not open adequately to insert the mask, first ensure that the patient is adequately anaesthetised. An assistant can be asked to pull the jaw downwards. This manoeuvre makes it easier to see into the mouth and verify the position of the mask. However, do not maintain downward jaw traction once the mask has passed beyond the teeth.
Difficulty in negotiating the angle at the back of the tongue is one of the most common causes of inability to insert the LMA. This is usually due to an incorrect angle of approach. The inserting finger must press the tube against the palate throughout the insertion manoeuvre, otherwise the tip may fold on itself or impact on an irregularity or swelling in the posterior pharynx (eg hypertrophied tonsils). If the cuff fails to flatten or begins to curl over as it is advanced, it is necessary to withdraw the mask and reinsert it. In case of tonsillar obstruction, a diagonal shift of the mask is often successful. If difficulty in insertion persists it is possible to use a laryngoscope to perform a jaw thrusting manoeuvre.

**Warning:** To avoid trauma, force should not be used at any time during insertion.
7 ANAESTHESIA MAINTENANCE AND RECOVERY

As with other methods of airway management, use of pulse oximetry and capnography is recommended when using the LMA.

7.1 Spontaneous Ventilation

The LMA is well tolerated in spontaneously breathing patients when used with volatile agents or intravenous anaesthesia, provided anaesthesia is adequate to match the level of surgical stimulus and the cuff is not over-inflated.

Coughing, breath-holding or movement may result from inadequate depth of anaesthesia or if the induction agent is allowed to wear off before adequate levels of anaesthesia for maintenance have been obtained. This is particularly likely to occur following the introduction of an external stimulus such as surgery or turning the patient when the level of anaesthesia has been misjudged.

Ventilation should be assisted gently until breathing returns.

7.2 Intermittent Positive Pressure Ventilation

The operator should be experienced in using the LMA with spontaneously breathing patients before using it with intermittent positive pressure ventilation (IPPV).

When a relaxant technique is chosen, the relaxant drug may be given either before or after insertion of the LMA. Alternatively, if a change in the surgical or diagnostic procedure requires conversion to a relaxant technique and mechanical control of ventilation, a muscle relaxant can be given and the ventilator circuit connected for IPPV without needing to adjust the airway. When using the LMA with IPPV, low airway pressures (<20cm H₂O) should be maintained. The LMA forms a variable low-pressure seal around the laryngeal inlet which may allow leaks if airway pressures are higher than the seal pressure.

If leaks occur while using the LMA with IPPV, some of the tidal volume may be lost and gas may pass around the cuff into the mouth with an audible sound. If the mask is not secured as described above, gas may also pass into the stomach causing gastric distention to occur over a period of time. A ventilatory pattern should therefore be chosen which results in peak airway pressures less than 20cm H₂O.

Routinely check for adequacy of seal. Leaks occurring during maintenance of anaesthesia with IPPV may be due to:

- light anaesthesia causing a degree of glottic closure
- inadequate neuromuscular block
- a reduction in lung compliance related to the surgical or diagnostic procedure or to patient factors
- displacement by head turning or traction of the LMA (unlikely if the LMA has been correctly secured in place)

Identify the cause of the leak and take appropriate measures to correct. The most common cause is light anaesthesia or inadequate neuromuscular block. The level of anaesthesia
and neuromuscular block should be reassessed. Auscultation of the anterolateral neck and lung fields may be used to differentiate between upper and lower airway factors.

In the event of a leak around the cuff, do not simply add more air to the cuff. This will not necessarily improve the seal pressure and may make the leak worse by adding tension to the normally soft cuff, pushing it away from the larynx.

7.3 Potential Problems after Insertion

Inadequate Level of Anaesthesia. The most common problem following insertion using an induction agent alone is failure to maintain an adequate level of anaesthesia. This situation can usually be corrected by administering an additional bolus of induction agent and/or increasing the concentration of volatile agent, while gently assisting ventilation.

Nitrous Oxide Diffusion. Nitrous oxide diffuses into the cuff, causing a rise in intra-cuff pressure. This varies in rate, duration and peak pressure, depending on the initial volume injected, the concentration used and the size of the LMA. Although this has not been associated with pharyngeal morbidity, post-operative throat soreness may result if cuff pressure becomes excessive. To reduce the risk of a sore throat, the cuff pressure should be periodically checked, either by monitoring with a direct pressure transducer or by feeling the tension in the inflation indicator balloon. If the inflation indicator balloon becomes hard or near-spherical in shape, this is a good indication of excessive cuff pressure. Cuff volume may then be reduced to maintain a pressure close to the initial control pressure. The cuff pressure will vary according to the patient, the LMA size, head position and anaesthetic depth but should not exceed approximately 60cm H₂O, particularly in prolonged surgery.

Malposition of the LMA. Malposition of the LMA can be assessed by capnography or by observation of changes in tidal volume (eg a reduced expired tidal volume). If LMA malposition is suspected, check whether there is a smooth, oval neck swelling extending below the thyroid cartilage. If absent it may indicate anterior misplacement of the mask tip into the laryngeal inlet, particularly if there is an unusually prolonged expiratory phase. If LMA malposition is suspected, the LMA may be removed and reinserted once anaesthetic depth is adequate for reinsertion.

Unexpected Regurgitation. Regurgitation may occur if anaesthesia becomes inadequate. A significant early sign of regurgitation is the appearance of fluid travelling up the LMA airway tube. If the patient is breathing spontaneously, coughing or breath-holding may be the first sign. The patient should immediately be tilted head down. Momentarily disconnect the anaesthetic circuit so that the gastric contents are not forced into the lungs. Verify that anaesthetic depth is adequate and deepen anaesthesia intravenously, if appropriate. Suction should then be applied through the LMA airway tube. Suction of the tracheobronchial tree using a fibreoptic bronchoscope through the LMA may be employed if the airway reflexes are adequately obtunded.

Provided oxygen saturation is maintained at an acceptable level, the LMA should not be removed at this time. Commence preparation for immediate tracheal intubation of the patient. Intubate the patient if clinically indicated. If aspiration has occurred, the patient should receive a chest X-ray and be treated, as clinically appropriate, with antibiotics,
physiotherapy, and tracheal suction.

**If airway problems persist or ventilation is inadequate, the LMA should be removed and an airway established by other means.**

### 7.4 Emergence from Anaesthesia and Removal

Reverse the neuromuscular block or allow the block to wear off before switching off the anaesthetic agents at the end of the surgical or diagnostic procedure. With gentle assisted ventilation, the patient should be allowed to start breathing. At this stage it is advisable to check the position of the bite-block and intra-cuff pressure.

The correctly placed LMA is well tolerated until the return of protective reflexes, provided that intra-cuff pressures are kept around 60cm H₂O. This means that a clear airway can be maintained until the patient is able to swallow and cough effectively. LMA removal should always be carried out in an area where suction equipment and the space for rapid tracheal intubation are present. The following procedure should be followed:

- Patient monitoring should continue throughout the recovery stage. Oxygen should be continuously administered through the anaesthetic circuit or via a T-piece. Check that an adequate bite-block is in place. If suction is required around the oral cavity or down the LMA tube, it should be carried out prior to recovery of reflexes.

- Leave the patient undisturbed until reflexes are restored, except to administer oxygen and perform monitoring procedures. It is not advisable to move the patient from the supine to the lateral recumbent position unless there is urgent reason to do so, such as regurgitation or vomiting. If the patient should be awakened in the lateral position, the patient must be turned in this position under adequate anaesthesia.

- Avoid suctioning with the LMA in place. The inflated LMA cuff protects the larynx from oral secretions and suctioning is not likely to be required when the LMA is in place. Suctioning and physical stimulation may provoke laryngeal spasm if the patient’s anaesthesia is light.

- Watch for signs of swallowing. It is usually safe and convenient to remove adhesive tape when swallowing begins. The interval between the beginning of swallowing and the ability to open the mouth varies from patient to patient according to the length and type of anaesthesia.

- Deflate the cuff and simultaneously remove the LMA and bite-block only when the patient can open the mouth on command. If the cuff is deflated before the return of effective swallowing and cough reflexes, secretions in the upper pharynx may enter into the larynx, provoking coughing or laryngeal spasm.

- Verify airway patency and respiratory depth.

- Oral suctioning may now be performed, if required.

If the LMA is to be removed in a Post-Anaesthesia Care Unit (PACU), recovery room staff should receive training in all aspects of LMA anaesthesia and LMA removal. An anaesthetist should always be readily available if the LMA is to be removed away from the operating theatre.
8 SPECIAL PATIENT POPULATIONS

8.1 Paediatric Use
The smaller LMA sizes have been shown to function effectively in children despite the differences between the adult and the infant larynx. It is recommended that LMA use in neonates and small children be performed by anaesthetists familiar with paediatric patients and already experienced in adult LMA anaesthesia.

Five sizes of LMA are available for paediatric use. Basic guidelines are given in the patient selection table (inside rear cover). In children at the transition weights, substitution of one size for another may be necessary.

LMA insertion in children is carried out in the same way as described for adults following either intravenous or gaseous induction, provided an adequate depth of anaesthesia is achieved. Insertion should be successful at the same plane of anaesthesia that would be suitable for tracheal intubation. The incidence of airway problems in children with the LMA seems to follow the same trend as in adults. However, as with any form of anaesthesia and airway management in infants and children where ventilation is inadequate, desaturation is likely to occur faster due to their higher oxygen consumption.

LMA anaesthesia in children and infants is associated with the maintenance of higher oxygen saturations compared to a face mask and Guedel airway, and the ability to cough and cry while waking up. The LMA is suitable for many short ambulatory, surgical or diagnostic procedures and those where access to the head and neck would otherwise be limited by the use of a face mask.

8.2 Gastric Drainage
Gastric drainage through a nasogastric tube is compatible with the LMA and does not interfere with its seal against the larynx. The nasogastric tube is best passed before LMA insertion. If necessary, however, it is possible to pass it during anaesthesia by slight deflation of the LMA cuff. A Magill’s forceps may be used to push the tip down behind the mask. The insertion of a nasogastric tube does not guarantee that the stomach can be drained completely as fluid can leak upwards past a blocked or kinked nasogastric tube.

The presence of a nasogastric tube does not rule out regurgitation and may even make regurgitation more likely because the tube may make the lower oesophageal sphincter incompetent.

8.3 Use with MRI
Magnetic Resonance Imaging (MRI) has been successfully used in conjunction with the LMA-Classics. The check-valve of the LMA contains a small stainless steel spring which may cause distortion of an MRI image. Caution should be exercised when using diagnostic imaging equipment such as MRI while the LMA is inserted.
9 LMA-FLEXIBLE™

9.1 Description, Indications and Contraindications
The LMA-Flexible is similar to the standard LMA-Classic but has a wire-reinforced, flexible airway tube that allows it to be positioned away from the surgical field. It may be particularly useful in procedures where the surgeon and anaesthetist are competing for access (eg procedures involving the head or neck).

The flexibility of the airway tube provides an easy connection at any angle from the mouth. It also allows the tube to be repositioned from side to side during the surgical procedure without loss of seal of the cuff against the larynx. The airway tube also resists kinking when, under normal conditions, it is flexed or compressed against a rigid mouth gag. However, the tube does not offer resistance to occlusion by biting.

The LMA-Flexible is available in a range of sizes. Patient sizes and maximum inflation volumes are the same as for the LMA-Classic (see table inside rear cover).

The indications and contraindications for the LMA-Flexible are the same as for the LMA-Classic.

9.2 Preparation for Use
Prior to use, the LMA-Flexible must be cleaned and sterilised in the same way as the LMA-Classic.

After autoclaving, all of the LMA Performance Tests (Section 5.3) must be performed. The airway tube should be inspected to ensure the tube is free from defects and the reinforcing wire is intact.

Do not use the LMA-Flexible if the reinforcing wire is not wholly contained within the wall of the tube, the wire is broken, or the airway tube is damaged in any way.

9.3 LMA-Flexible™ Use
The size selection and insertion technique of the LMA-Flexible are identical to those described for the LMA-Classic. Because of the flexible nature of the airway tube, the practice of inserting the index finger to its fullest extent into the oral cavity until resistance is encountered is extremely important for successful insertion of the LMA-Flexible. The user should review the insertion techniques described in Section 6 prior to using the LMA-Flexible.

As with the LMA-Classic, the LMA-Flexible should be secured in place with tape. If appropriate, a bite-block should be used. The reinforced, flexible airway tube does not prevent obstruction from biting. If surgical procedures are being performed in close proximity to the LMA-Flexible, the surgeon should be careful to avoid displacing or damaging the mask.
9.4 Ventilation with LMA-Flexible™

The airway tube of the LMA-Flexible is of smaller internal diameter and longer length than that of the LMA-Classic. This facilitates surgical access but the anaesthetist should be aware of the greater flow resistance offered by the smaller diameter tube.

9.5 Use of Throat Pack

The correctly placed LMA acts as a barrier, preventing soiling of the glottis or trachea by blood or secretions from above. This makes it possible to use the LMA for surgical procedures in the pharynx. However, the LMA does not protect against pulmonary aspiration in cases of vomiting or regurgitation. Where the surgeon is unable to perform pharyngeal suction under direct vision, it may be wise to insert a throat pack after insertion of the LMA-Flexible. If it is decided to insert a throat pack, always inflate the LMA cuff first with the recommended volume of air (ie enough air to obtain a seal). When inserting the throat pack, the surgeon should take care to avoid displacing the mask. Check airway patency before and after pack insertion. If there is any doubt about airway patency, remove the pack and reposition the mask.

9.6 Recovery Period

Suction and/or pack removal should be carried out with the patient under adequate anaesthesia to prevent reflex response. After suction and/or pack removal, a bite-block should be inserted and fixed in place. The recovery procedures and removal of the LMA-Flexible are the same as with the LMA-Classic. Pulse oximetry should be maintained until the patient is fully awake.

9.7 Endoscopy and Fibreoptic Intubation

As a consequence of the smaller diameter and longer length of the LMA-Flexible airway tube, only small diameter bronchoscopes may be passed through the flexible airway tube. Note that the flexible airway tube is too long and of too small diameter to allow passage of an endotracheal tube. However, an endotracheal tube may be guided into place after the LMA-Flexible has been removed over a tube changer.

The need for instrumentation should be carefully considered and evaluated prior to insertion of the LMA-Flexible. If the need for instruments that cannot be passed through the LMA-Flexible is anticipated, the use of the LMA-Classic or an alternative method of airway management should be considered.

9.8 Use with MRI

If Magnetic Resonance Imaging (MRI) is done in close proximity to the LMA-Flexible, there will be distortion of the image in the area surrounding the airway. If image quality in this region is important, the use of the LMA-Classic should be considered.
The LMA-Unique is a single use, disposable LMA. The cuff, backplate, airway tube and inflation balloon of the LMA-Unique are manufactured from clear medical grade PVC and are entirely latex free. The airway tube is clear and more anatomically curved than the soft, silicone airway tube of the LMA but is otherwise similar in appearance to the LMA. Like the airway tube of a PVC endotracheal tube, the airway tube of the LMA-Unique softens as it approaches body temperature. The LMA-Unique is supplied sterile and is not designed to withstand autoclaving.

Clinical trials have confirmed that when using the recommended insertion technique, the LMA-Unique is similar to the LMA-Classic for ease of insertion, alignment with the laryngeal inlet, ventilation of the lungs of paralysed patients requiring IPPV and incidence of immediate sore throat.

The LMA-Unique is indicated for the same use as the LMA-Classic and may be particularly suitable for use in pre-hospital and in-hospital cardiopulmonary resuscitation, and in the high infection risk patient.

Insertion, anaesthesia control and recovery when using the LMA-Unique are the same as for the LMA-Classic.

After use the LMA-Unique should be discarded and must not be re-used.
11 FURTHER READING

Text Books

- Brimacombe JR, Brain AIJ, Berry AM. The Laryngeal Mask Airway - A Review and Practical Guide. WB Saunders 1997

General LMA™ Use


LMA-Flexible™


LMA-Unique™

**Patient Selection**

The patient selection information in the accompanying table is for guidance purposes only. Research in recent years indicates that a size 4 or 5 LMA will suit most adults and that the size 3 LMA should be treated as a paediatric size. However, when selecting the size of any medical device, clinical judgment based on many factors (not just patient weight) should be used at all times.

**Inflation Volume**

The inflation volumes quoted in the accompanying table are **maximum** values and should not be exceeded. Frequently only half these maximum values will be needed to obtain an adequate seal. After insertion the cuff should be inflated until a seal is obtained. This typically corresponds to an intracuff pressure of 60cm H\(_2\)O.

If a seal is not obtained after inflating the cuff with the maximum value, then the device is either misplaced or a larger size of LMA is required. In general it is recommended that a larger size of LMA be used at a lower intra-cuff pressure.
# 12 LMA™ Specifications

## 12.1 LMA-Classic™

<table>
<thead>
<tr>
<th>LMA Size</th>
<th>Patient Selection Information</th>
<th>Maximum Inflation Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neonates/Infants up to 5kg</td>
<td>4</td>
</tr>
<tr>
<td>1½</td>
<td>Infants 5-10kg</td>
<td>7</td>
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<tr>
<td>2</td>
<td>Infants/Children 10-20kg</td>
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<td>2½</td>
<td>Children 20-30kg</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Children 30 to 50kg</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Adult 50-70kg</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Adult 70-100kg</td>
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</tr>
<tr>
<td>6*</td>
<td>Large Adult over 100kg</td>
<td>50</td>
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*Available from October 1999

## 12.2 LMA-Flexible™

<table>
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## 12.3 LMA-Unique™

<table>
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<tr>
<td>4</td>
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</tr>
<tr>
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