

## The use of the laryngeal mask airway by nurses during cardiopulmonary resuscitation

### RESULTS OF A MULTICENTRE TRIAL

#### Summary

*A multicentre study was undertaken to assess the potential value of the laryngeal mask airway when inserted by ward nurses during resuscitation as a method of airway management, prior to the arrival of the Advanced Life Support Team with tracheal intubation capability. The nurses underwent a training programme agreed by all the participating hospitals and followed an identical protocol and data recording system. One hundred and thirty nurses were trained and 164 cases of cardiac arrest were studied. The laryngeal mask airway was inserted at the first attempt in 71% and at the second attempt in 26% of cases. Satisfactory chest expansion occurred in 86% of cases. The mean interval between cardiac arrest and laryngeal mask airway insertion was 2.4 min. Regurgitation of gastric contents occurred before airway insertion in 20 cases (12%), during the insertion in three cases (2%), but there was clinical evidence of pulmonary aspiration in only one patient, who survived to leave hospital. We conclude that the laryngeal mask airway offers advantages over other methods of airway and ventilation management, such as the bag-valve-mask or mouth-to-mouth methods that are currently used by ward nurses in resuscitating patients with cardiac arrest. In this study, the laryngeal mask airway was not being compared with the tracheal tube.*

#### Key words

*Complications;* cardiac arrest.

*Equipment;* laryngeal mask airway.

*Ventilation;* artificial.

*Manpower;* nurses.

Airway management and lung ventilation are key factors in cardiopulmonary resuscitation (CPR), except perhaps in those patients with ventricular fibrillation who respond rapidly to immediate defibrillation. However, management of the airway is probably the most difficult skill to acquire in basic and advanced life support.

In the majority of cases of cardiac arrest in hospital the nurse is the first responder. Hitherto, nurses have been taught mouth-to-mouth, mouth-to-mask or bag-valve-mask ventilation, with airway control using manual methods to align the head and neck in the clear airway position. In many instances these techniques have been less than satisfactory and it is clear that the lungs of the majority of patients managed in this way are inadequately ventilated and, in addition, are exposed to gastric inflation, regurgitation and pulmonary aspiration. Postmortem

examination of patients who failed to respond to CPR attempts have shown that more than 60% have evidence of pulmonary aspiration [1] although some contamination of the lungs may have occurred after death.

Nowadays, most nurses are adverse to performing direct mouth-to-mouth or mouth-to-nose ventilation on patients in hospital, for both aesthetic reasons and fear of cross infection [2]. Mouth-to-mask ventilation is preferred, but inspired oxygen concentrations are likely to be low unless added oxygen is used. The problem of leaks at the face-mask interface and the potential of gastric inflation, regurgitation and pulmonary aspiration remain. The bag-valve-mask technique is reassuring to use but several studies have shown that it is poorly performed by those with modest training and practice [3-5]. Several authorities [6, 7] now recommend that the bag-valve-mask technique should be

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performed by two people, unless an individual is experienced in its use. At best, the technique provides good ventilation but leaves the airway unprotected and at risk of contamination from regurgitated gastric contents.

Clearly, the cuffed tracheal tube achieves the best airway during CPR. However, tracheal intubation is a relatively difficult skill to acquire and retain and manikin practice must be reinforced by supervised training on patients. Furthermore, the large numbers of nurses to be trained relative to the number of patients who require intubation means that it is impossible to provide adequate training and experience for everyone.

Since the first descriptions by Brain in 1983 [8] and report of its use in clinical practice in 1985 [9] the laryngeal mask airway (LMA) has been widely accepted in anaesthetic practice and there have been more than 360 publications on its use, which mainly extol the virtues and versatility of the device.

Although absolute protection from regurgitation and pulmonary aspiration is not guaranteed by the inventor or the manufacturer, reports of actual aspiration have been remarkably few [10–12] in what must now amount to many millions of insertions. One prospective study of 2359 cases reported that two patients were alleged to have regurgitated but no untoward sequelae related to aspiration occurred [13].

Prompted by suggestions that the LMA might have a place in CPR [14–16] and after a preliminary study had shown encouraging results, [17] it was decided to proceed with a multicentre study in order to achieve a sufficient number of patients.

### **Method**

Study teams were recruited from three hospitals; Conquest Hospital, Hastings, Royal Berkshire Hospital, Reading, and Frenchay Hospital, Bristol. A protocol and data recording system was agreed and approval for the study was given by the ethics committee at each hospital.

#### *Training programme*

Volunteer nurses, skilled in basic life support, were offered theoretical and practical training in the use of the laryngeal mask airway.

The theoretical training was given by an anaesthetist or the Resuscitation Training Officer. This consisted of: (1) an introduction to the concept of the LMA; (2) an overview on the use of the LMA in anaesthesia; (3) the rationale for the use of the LMA during resuscitation; (4) a video presentation illustrating preparation of the LMA, correct insertion and removal techniques and potential complications; (5) demonstration of preparation of the LMA and practice on a manikin; (6) study of a booklet outlining the above.

The method of preparation and the insertion technique followed precisely that recommended by the inventor [18]. At the end of the theory session (approximately 90 min) candidates were required to achieve a mark of 90% in a written and oral examination before proceeding to practical training.

Practical training was undertaken in the anaesthetic room under the supervision of an anaesthetist. The nurse was assessed on the preparation of the LMA, correct head

and neck alignment, insertion technique, connection to the ventilating apparatus and satisfactory inflation of the lungs. Each attempt was recorded, including failures and the reason for failure. A minimum of five successful insertions was required for certification of competence and a certificate and badge were given to identify these nurses on the ward. Certification was deemed to expire after one year after which re-certification was required. One hundred and thirty nurses were trained in the three centres.

#### *Patient selection and management*

Use of the LMA was confined to adult patients who were unresponsive, apnoeic and pulseless. Basic life support using conventional CPR techniques (five external chest compressions — pause — one ventilation sequence) was instigated as soon as the arrest was diagnosed. Ventilation using mouth-to-mouth or bag-valve-mask was used prior to insertion of the LMA, if this could not be accomplished immediately. Upon arrival of the Advanced Life Support team, the LMA was changed for a tracheal tube or left in place, according to the clinical judgment of the anaesthetist in the team.

Specially produced LMAs with a red stripe were provided for the trial by the manufacturers and this feature enabled the LMAs used in the wards to be separately identified in the central sterile supply department from those used in the operating rooms (black stripe). Size 4 LMAs were used in normal sized and large adults and the size 3 was reserved for small adults. The LMAs were distributed to all wards where there was a nurse certified in its use and were kept on the resuscitation trolley.

#### *Data collection*

The same data recording form was used in all three centres (Fig. 1).

The following details were recorded; (1) the nature of arrest, whether witnessed or not, and outcome in terms of return of spontaneous circulation; (2) method and time to first ventilation; (3) number of attempts required for successful insertion of LMA; (4) incidence of successful ventilation with LMA, as indicated by rise and fall of chest; (5) time to successful ventilation with LMA; (6) size of LMA used; (7) incidence of regurgitation occurring before inserting, during placement and after removal of the LMA; (8) incidence of pulmonary aspiration; (9) any other untoward complications or difficulties.

### **Results**

The LMA was used by nurses in 164 patients during the resuscitation attempt (Hastings 116, Frenchay 29, Reading 19).

#### *Nature of the arrest and return of spontaneous circulation*

Table 1 indicates the nature of the apparent arrest recorded by the initial ECG traces. It is clear that the figures include some patients in whom there was clinical evidence of cardiac arrest, as indicated by pulselessness, but which was associated with a rhythm on the ECG not always associated with an absent pulse, e.g. atrial fibrillation and extreme bradycardia. Seventy seven per cent of the arrests



**Table 1.** The nature of the apparent cardiac arrest.

Atrial fibrillation	1	(0.5%)
Extreme bradycardia	10	(6.0%)
Ventricular fibrillation	83	(50.5%)
Ventricular tachycardia	7	(4.0%)
Asystole	46	(28%)
Electromechanical dissociation	18	(11.0%)
Total	164	(100%)

were witnessed; the remainder were unwitnessed. There was a return of spontaneous circulation in 55 patients (33.5%).

#### Skill rates

The number of attempts required for successful insertion of the LMA are recorded in Table 2. The LMA was inserted satisfactorily at the first attempt in 71% and at the second attempt in 26% of patients.

The success rates for lung ventilation using the LMA are recorded in Table 3. The chest expanded satisfactorily in 88% of cases. Three cases of ventilation failure were associated with significant pulmonary oedema.

The methods of first ventilation are recorded in Table 4.

In 62% of patients initial ventilation was by a self-inflating bag-valve-mask, in 4% by mouth-to-mask and in 34% by the laryngeal mask airway.

In 116 cases (71%) the size 4 LMA was used and in 48 cases (29%) the size 3 LMA was used.

#### Tracheal intubation failure

In 11 patients (7%) difficulties with tracheal intubation were experienced by the anaesthetist when attempts were made to replace the LMA with a tracheal tube. In all of these cases the LMA was replaced and ventilation continued satisfactorily and two of these patients received ventilation for 120 and 420 min respectively.

#### Timings

The interval from discovery of arrest to initial ventilation, by whatever method, was recorded in two centres and ranged from 0–4 min with a mean of 1.8 min (144 cases).

**Table 2.** The number of attempts required for successful insertion of the LM.

First attempt	117	(71%)
Second attempt	43	(26%)
Third attempt	4	(3%)
Total	164	(100%)

**Table 3.** Chest expansion after ventilation through laryngeal mask airway (LMA).

Chest expanded after ventilation through LMA	144	(88%)
Chest did not expand after ventilation through LMA	20	(12%)

**Table 4.** Initial method of lung ventilation.

Bag-valve-mask	101	(62%)
Laryngeal mask	56	(34%)
Mouth-to-mask	7	(4%)

**Table 5.** Incidence of regurgitation and pulmonary aspiration occurring during the resuscitation attempts.

Regurgitation before LMA inserted	20	(12%)
Regurgitation during LMA use	3	(2%)
Regurgitation after removal of LMA	10	(6%)
Clinical evidence of pulmonary aspiration	1	(0.6%)

The interval from discovery of arrest to insertion of the laryngeal mask airway ranged from 0–5 min in all centres, with a mean of 2.4 min. If insertion of the LMA was not immediate, bag-valve-mask or mouth-to-mouth was used as a temporary measure.

The duration of ventilation using the laryngeal mask airway ranged from 1–65 min with a mean of 8.5 min. (These figures do not include the two patients in whom ventilation was continued with the LMA for 120 min and 420 min.)

#### Regurgitation

The details of the incidence of regurgitation of gastric contents occurring during the resuscitation attempts are shown in Table 5.

It should be noted that the bag-valve-mask was used before LMA insertion in 17 of the 20 cases in which gastric regurgitation was observed and had been used beforehand in all three cases in which regurgitation was seen during use of the LMA.

The single patient in whom there was clinical evidence of pulmonary aspiration of gastric contents had regurgitated prior to insertion of the LMA and survived to leave hospital with no pulmonary sequelae.

#### Discussion

The use of the LMA during resuscitation was readily accepted and practised by the nurses trained in its use, and by their colleagues, and by the members of the Advanced Life Support Team who responded to the cardiac arrest call. Our nurse insertion success rates are comparable to other series using anaesthetists [20] and nurses [20, 21]. The interval between arrest and insertion of the LMA (mean 2.4 min) compares well with the normal interval between arrest and tracheal intubation performed by the Advanced Life Support teams in the wards of our hospitals. Our aims in future would be to have a nurse trained in LMA insertion in each ward and this would reduce the arrest to LMA insertion interval considerably. In one of the centres the study was concentrated in one ward only and the mean arrest to LMA insertion time was then reduced to 1.25 min.

Adequate lung ventilation was only assessed clinically, by observation of the rise and fall of the chest after inflation through the LMA. It is accepted that this measurement is imprecise. Attempts were made to measure end-tidal CO<sub>2</sub> values but the many variables contributing to such values during cardiac arrest is likely to make results meaningless. Attempts were also made to measure tidal volumes using a respirometer, but the nurses found this device cumbersome and frequently did not actually use it. In the small number of cases in which a volume respirometer was used, tidal volumes of between 800–900 ml were achieved. In all cases the chest movement achieved was

observed and recorded by the responding Advanced Life Support Team.

We were particularly interested in the security of the LMA during external chest compressions, and in no case did the LMA become dislodged during CPR.

When compared with the other methods of airway management practised by our nurses the incidence of regurgitation was remarkably low. Most episodes occurred prior to the first LMA insertion attempt and the majority of patients had been ventilated with a bag-valve-mask beforehand. Our previous experience with the bag-valve-mask technique had shown it to be associated with a high incidence of gastric inflation and subsequent increased risk of regurgitation, except when practised by skilled operators.

Only one patient actually showed clinical signs of pulmonary aspiration and fortunately he survived and was discharged. Although there have been isolated reports of pulmonary aspiration with the LMA [10-12, 22], with both larynx and upper oesophagus viewed with a fiberoptic bronchoscope through the LMA, a recent fiberoptic study of the laryngeal mask position in 140 patients did not show a view of the hypopharynx or oesophagus in any patient [23].

It should be emphasised that our study set out to compare the LMA with other methods of airway management usually practised by ward nurses; that is to say bag-valve-mask or mouth-to-mask, and not with tracheal intubation, which is a skill not attained by the majority of nurses.

We found that the use of the LMA can be readily taught to nurses in a short time, that the technique is acceptable and provides them with personal isolation from the patient's airway during resuscitation. The satisfactory insertion rates and airway management achieved during CPR, combined with the remarkably low incidence of complications found during this study, are encouraging. We conclude that it is worth while extending the use of the LMA for airway management by nurses during CPR.

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## A comparison of the 2% and 1% formulations of propofol during anaesthesia for craniotomy

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### Summary

*This study investigated the pharmacodynamic and pharmacokinetic equivalence of 1% and 2% propofol emulsions when used for total intravenous anaesthesia for intracranial surgery. The same infusion rate ( $6.7 \text{ mg.kg}^{-1}.\text{h}^{-1}$ ) of the two preparations was administered. Induction doses, recovery times, and haemodynamic profiles were identical. Similar propofol concentration profiles were produced and total body clearance of propofol was identical. Both preparations were associated with a similar incidence of injection pain but neither resulted in venous thrombosis or thrombophlebitis at 24 h. Plasma triglyceride concentrations were significantly higher with the 1% solution, but there were no differences in cholesterol concentrations. The 1% and 2% emulsions appeared to be pharmacologically equivalent with similar minor effects on arterial blood pressure and heart rate. Two percent propofol may be preferable to the 1% solution for maintenance of anaesthesia in patients in whom a large lipid load might be considered undesirable.*

### Key words

*Anaesthetics, intravenous; propofol.  
Anaesthesia; neurosurgery.*

The infusion of large quantities of propofol raises concern over the lipid load administered to patients with hyperlipidaemia due to deficient metabolic and enzyme systems. Doubling the concentration of the active drug would reduce the lipid load by 50%. The objectives of this investigation were to compare a new 2% formulation of propofol with the currently available 1% formulation (Diprivan, ICI) in respect of their cardiovascular effects, pharmacodynamic and pharmacokinetic equivalence, and effects on triglyceride and cholesterol concentrations in plasma during anaesthesia for intracranial procedures.

### Methods

Sixty patients, between 18 and 60 years of age, ASA 1 or 2, participated in this randomised, open investigation. The study protocol was approved by the Ethics Committee/Clinical Trials of the Faculty of Medicine of the Katholieke Universiteit Leuven and written informed consent was obtained from each patient. The patients were randomly assigned to either group 1 (propofol 1%) or group 2 (propofol 2%).

All patients received phenobarbitone 100 mg intramuscularly for premedication, and immediately before induction alfentanil 1 mg was administered intravenously.

An identical propofol infusion regimen was used in both treatment groups. Anaesthesia was induced with an infusion of propofol administered at a rate of  $20 \text{ mg.kg}^{-1}.\text{h}^{-1}$ . After the first 10 min the infusion rate was decreased to  $8 \text{ mg.kg}^{-1}.\text{h}^{-1}$  for the next 20 min, after which it was further decreased to  $6 \text{ mg.kg}^{-1}.\text{h}^{-1}$  for the remainder of the surgical procedure. A continuous intravenous infusion of alfentanil was administered to provide analgesia. The alfentanil infusion rate was  $2 \text{ } \mu\text{g.kg}^{-1}.\text{min}^{-1}$  until the dura mater was opened; thereafter the rate was decreased to  $0.5 \text{ } \mu\text{g.kg}^{-1}.\text{min}^{-1}$  until closure of the dura mater. Additional alfentanil was administered as  $10 \text{ } \mu\text{g.kg}^{-1}$  bolus doses if necessary to maintain haemodynamic stability. Following loss of consciousness, all patients received pancuronium  $0.1 \text{ mg.kg}^{-1}$  to facilitate tracheal intubation, which was performed 10 min following the start of the propofol infusion. Neuromuscular blockade was maintained with supplementary doses of pancuronium as clinically indicated. Patients were ventilated with a mixture of 40% oxygen and air, to maintain moderate hypocapnia.

The key pharmacodynamic endpoints were induction time and induction dose. The interval between the beginning of the continuous infusion of propofol and the loss of response to verbal commands was recorded as the induc-

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