Intubating laryngeal mask airway for difficult out-of-hospital airway management: a prospective evaluation

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Background. Out-of-hospital airway management is a critical skill, demanding expert knowledge and experience. The intubating laryngeal mask airway (ILMA) is a ventilatory and intubating device which may be of value in this arena. We evaluated the ILMA for out-of-hospital management of the difficult airway.

Methods. Twenty-one anaesthesia-trained emergency physicians (EPs) completed a training programme and used the ILMA in patients with difficult-to-manage airways. Indications for use of the ILMA included patients with difficult laryngoscopy, multiple intubation attempts, limited access to the patient's head, presence of pharyngo-laryngeal trauma, and gastric fluids or bleeding obscuring the view of the vocal cords.

Results. During the study period, 146 of 2513 patients underwent tracheal intubation or alternate rescue airway insertion. In 135 patients, laryngoscopy was performed and Cormack–Lehane view was recorded as grade I in 72 (53.3%), II in 45 (33.3%), III in 10 (7.4%), and IV in 8 (5.9%). EPs encountered 11 patients (7.5%) with difficult-to-manage airways. ILMA insertion and ventilation was possible in 10 patients in the first and one patient in the second attempt. ILMA-guided tracheal intubation was successful in all patients, in 10 after the first and in 1 after two attempts.

Conclusions. In this study, ventilation and intubation with ILMA was successful in all patients with difficult-to-manage airways. Our data support the use of the ILMA as rescue device for out-of-hospital airway management by staff who have appropriate airway skills and have received appropriate training.

Keywords: airway, complications; airway, patency; complications, intubation tracheal; equipment, airway

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The 2005 European Resuscitation Council Guidelines for Adult Advanced Life Support state that the tracheal tube remains the gold standard for securing the airway during cardiopulmonary resuscitation (CPR), when placed by experienced personnel.1 The advantages of tracheal intubation over bag-mask or extraglottic airway device ventilation include maintenance of a patent airway, protection from the aspiration of gastric contents or blood from the oropharynx, the ability to provide an adequate tidal volume during chest compressions, the ability to suction tracheal secretions, the provision of a route for giving drugs, and the ability to deliver higher positive pressure ventilation.1 Several studies have documented out-of-hospital tracheal intubation success rates from 98% to 100% in non-trauma or mixed patients groups when the rescuer is experienced in airway management,2–5 but these results are derived from self-reporting and are subject to potential reporting-bias. When the position of out-of-hospital placed tracheal tubes was re-examined by independent observers, either on arrival in the emergency department or in the field, unrecognized oesophageal intubation was recorded in 6–25% of patients.6–9 These findings were independent of whether the rescuers were paramedics or emergency physicians (EPs). Success rates as low as 50% have been noted.
for providers who do not frequently perform tracheal intubation.10

When out-of-hospital intubation proves difficult, extraglottic airway devices (e.g. the laryngeal mask airway)* are acceptable alternatives to tracheal intubation. The intubating laryngeal mask airway (ILMA, LMA Fastrach™, Laryngeal Mask Company, Hemsley on the Thames, UK) was designed to facilitate both extraglottic ventilation and tracheal intubation.11 It has proved to be effective when used by experienced anaesthesiologists and by EPs in patients with difficult airways from a number of causes, including morbid obesity and immobile cervical spine.12 13 Because of these encouraging results, many authors have proposed the ILMA as an ideal device for advanced out-of-hospital and emergency department airway management.14–16 Use of the ILMA for airway resuscitation of the out-of-hospital patient has been described in case reports, but no controlled study has attempted to determine its utility in this setting.17–20

The aim of our study was to evaluate prospectively the use of the ILMA by anaesthesia-trained EPs for ventilation and intubation in patients with difficult-to-manage airways in out-of-hospital situations.

Methods
After formal approval by the institutional ethics committee, anaesthesia-trained EPs from the Department of Anaesthesiology, Emergency, and Intensive Care Medicine, Georg-August University, Goettingen, Germany were asked to participate in the study. Before their assignment to out-of-hospital emergency medical teams, all EPs needed to have completed 2 yr in anaesthesia, 1 yr in intensive care medicine training, and an 80 h curriculum in emergency medicine.21 During this period, EPs performed at least 1000 laryngoscopic intubations and 150 LMA classic™ insertions on patients, and received practical skills training in Combitube™ (Tyco-Kendall, Mansfield, MA, USA) and Laryngeal Tube™ (VBM Medizintechnik GmbH, Sulz a.N., Germany) insertion and needle cricothyrotomy in manikins.

EPs participating in the study also had to attend a training course consisting of a 90 min lecture on the use of the ILMA followed by 90 min of practical training on a Laerdal® airway management trainer. After successful demonstration of the use of the ILMA for ventilation and intubation with the manikin, all participants had to perform at least three successful intubations using the ILMA on routine surgical patients in theatres.

During the study period, the EPs were instructed to use rapid sequence intubation with orotracheal intubation by direct laryngoscopy with applied cricoid pressure as the default-choice technique of airway management. Pre-oxygenation was applied in spontaneously breathing patients when clinically appropriate. No bag-mask ventilation was employed before the first attempt at orotracheal intubation. Laryngoscope-assisted nasotracheal intubation or blind nasotracheal intubation was used as an alternative technique when judged clinically appropriate by the EP, for example, when spontaneous breathing was to be maintained, or oral access was limited.

EPs were encouraged to use the ILMA as the first alternative intubation technique in the case of difficult laryngoscopy, after multiple intubation attempts, where there was limited access to the patient’s head, in the presence of pharyngo-laryngeal trauma, or when gastric fluids or bleeding obscured the view of the vocal cords.

The ILMA was inserted according to the LMA Fastrach™ instruction manual: a lubricant was applied to the posterior tip of the ILMA (Endosgel®, Farco-Pharma GmbH, Cologne, Germany) which was inserted using the one-handed rotational technique.22 Size 3 was recommended for adolescents from 30 to 50 kg body weight, size 4 for all female adults, and size 5 for all male adults. The cuff was inflated with air to achieve a ‘just airtight seal’ or to a maximum pressure of 60 cm H2O (maximum air volumes: size 3, 20 ml; size 4, 30 ml; size 5, 40 ml). Each ventilation or intubation attempt was confirmed by physical examination and end-tidal carbon dioxide detection (Lifepack12, Medtronic GmbH, Germany or Bruker Defigard 2002 CO2 Module, Schiller Medical, Switzerland). After connection to a mechanical ventilator, ventilation via the ILMA was graded as follows: grade 1 (adequate), rectangular capnograph wave form with no air leak at airway pressure of 20 cm H2O; grade 2 (possible), capnograph wave form with air leak at airway pressure below 20 cm H2O; or grade 3 (impossible), no capnograph wave form detected. When ventilation via the ILMA proved impossible, one replacement of the ILMA was allowed and ventilation was reattempted. After two failures, the physician would be expected to proceed to other airway manoeuvres. We recommended that the ILMA should remain in place until care of the patient was transferred to the emergency department physician. Depending on the experience of the EP, the ILMA could also be removed immediately after confirmation of tracheal tube placement, using Magill forceps15 23 or stabilizing rod technique as described in the instruction manual.22

During the 1-yr study period from May 1, 2004 until April 30, 2005, all data were recorded into an electronic template described earlier.4

In all cases where an ILMA was employed, the number of insertions, quality of ventilation, number of intubation attempts, and sequence of airway management events leading to its use were documented. For subject inclusion in the data analysis, all airway-related fields had to be completed in the electronic medical record. Reports of missing data were made to the primary investigator who then requested the EP to complete the data documentation within 1 month of the case event.

*LMA® is the property of Intavent Ltd.
**Results**

Twenty-one anaesthesia-trained EPs completed the training course and attended 2513 patients during the study period. No patient was excluded from the study because of incomplete data. Pre-hospital advanced airway management techniques were attempted in 146 (5.8%) patients. Forty per cent of these patients were females and the mean age (range) was 63.0 (3–94) yr. Patients requiring advanced airway management had suffered traumatic injuries in 34 cases (23.3%), underwent CPR in 55 cases (37.7%), and had other medical conditions in 57 cases (39.0%).

EPs secured the airway in 92.5% (135) of patients by tracheal intubation. Oral, nasal, and blind nasal intubation were successful after three attempts in 124 (93.2%), 3 (100%), and 8 (57.1%) patients, respectively. In all six cases of failed blind nasal intubation, oral tracheal intubation was successful. No patient required prolonged bag-mask ventilation or performance of needle cricothyrotomy. In 135 patients, laryngoscopy was performed and view was graded using the Cormack–Lehane score as grade I in 72 (53.3%), II in 45 (33.3%), III in 10 (7.4%), and IV in 8 (5.9%).

The ILMA was successfully used in the remaining 11 patients, in 8 patients after failed oral intubation, and in 3 patients without a prior attempt at intubation.

Eight EPs encountered 11 patients with difficult-to-manage airways, assessed according to the study protocol, and used the ILMA. Eight ILMA applications were performed after failed oral intubation, and three ILMA applications were performed without prior attempts of laryngoscopic intubation (Fig. 1). In two cases, intubation (one patient) or intubation and Combitube insertion (one patient) had been attempted by other EP, who were first on scene. Intubation via the ILMA was successful in 10 patients after one and in 1 patient after two attempts. Ventilation with the ILMA was possible in all patients after one (10 patients) or two (one patient) insertion attempts. The quality of ventilation was assessed as ‘adequate’ in 10 patients and as ‘possible’ in one patient (Table 1). The ILMA was removed in five patients immediately after confirmation of tracheal tube placement and in six patients after arrival at the hospital. During this procedure, no tube dislocation was reported.

**Discussion**

Failure to secure the airway in critically ill emergency patients can drastically increase likelihood of a poor or fatal outcome. In the emergency setting, the presence of debris, secretions, blood, vomitus, s.c. emphysema, anatomic derangement, dental damage, or the application of cervical spine immobilization devices and in-line axial stabilization can further reduce the ability to use direct or indirect laryngeal visualization techniques and face mask...
ventilation. Additionally, difficult out-of-hospital airway management is mostly unanticipated, airway equipment is limited, respiratory dysfunction and hypoxia are often present, and the position of the patient can make access to the head difficult. Other issues complicating the airway management of the emergency patient include CPR or other medical procedures being performed simultaneously, altered and varying levels of patients consciousness, and lack of professional help. In a previous study, we demonstrated a significantly increased incidence of difficult laryngoscopy, number of intubation attempts, and the use of extraglottic airway devices in the out-of-hospital arena when compared with data obtained from the operation theatre, even when tracheal intubation was performed by experienced anesthesiologists. In this study, difficult laryngoscopy (Cormack–Lehane grades III and IV) was reported in 13.3%, lower than in our previous study, where a 19.2% rate of difficult laryngoscopies was reported.4

In our study, all patients with difficult-to-manage airways could be successfully ventilated with the ILMA. The advantage of the ILMA lies in the provision of both, ventilation and guided intubation, which was achieved in all our study patients.

In the operating room, experienced anaesthesiologists have been demonstrated to have a 100% success rate both for ventilation and for TI guided by the ILMA in patients with difficult-to-manage airways. Success rates with the ILMA are lower with less experienced operators. Therefore, we suggest that lectures, demonstrations, skill training on manikins and on patients in the controlled environment of an operating theatre should be compulsory before out-of-hospital use of the ILMA. Our EPs had limited experience with the ILMA before its use in prehospital patients. Although some investigators have noted that 20 ILMA insertions are needed to gain proficiency in this device, we feel that our EP training mirrors the experience of most German EPs—the opportunity to practice new airway management techniques in an elective, controlled situation is limited. Although more real patient training would be the ideal, our study indicates that a sufficient, although not expert, level of competence is achievable with limited real patient practice.

<table>
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<th>No.</th>
<th>Age, gender</th>
<th>Diagnosis</th>
<th>Number of previous intubation attempts</th>
<th>Cormack-Lehane grade</th>
<th>ILMA size</th>
<th>Number of ILMA insertions/quality of ILMA ventilation</th>
<th>Number of ILMA-guided intubation attempts</th>
<th>Remarks</th>
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<td>1</td>
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<td>1</td>
<td>Multiple failed intubation attempts and Combitube insertion by first EP. Patient trapped in vehicle Difficult laryngoscopy Failure of multiple intubation attempts by first EP; pharyngeal bleeding Difficult laryngoscopy, limited access to patient’s head</td>
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<td>45, m M</td>
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<td>74, m M</td>
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<td>5</td>
<td>57, m CPR</td>
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<td>Difficult laryngoscopy Difficult laryngoscopy Difficult laryngoscopy Difficult laryngoscopy, limited access to patient’s head</td>
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<td>6</td>
<td>76, f T</td>
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<td>9</td>
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<td>#5</td>
<td>1/1</td>
<td>1</td>
<td>Limited access to patient’s head</td>
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Table 1 Characteristics of patients with difficult intubation managed using the ILMA. T, trauma; CPR, cardiopulmonary resuscitation; M, other medical condition; EP, emergency physician; n.e., not evaluated.
Some limitations of the ILMA should be considered when it is used for intubation. First, operator experience and skill levels vary. It has to be recognized that in different emergency medicine systems, practitioners may not have the level of training in anaesthesia of the EPs in this study. In other countries, as well as in other areas in Germany, most pre-hospital advanced airway management is undertaken by personnel who are not trained to this level. Secondly, the TI via the ILMA is a ‘blind procedure’ eliminating the most important methods of TI verification—visualization of the tracheal tube passing between the vocal cords. Therefore, additional confirmatory adjuncts to verify tracheal tube placement must be available. In our study, every TI via the ILMA was confirmed by bilateral auscultation of breath sounds and end-tidal carbon dioxide detection. The use of the fibrescope or an ILMA with integrated fibreoptic elements (LMA CTrach™) have been introduced to improve TI success rates in patients with difficult airways. Other alternative techniques of ILMA intubation verification (e.g. the use of a Trachlight™) have been reported. The presence of a hard cervical collar and the application of cricoid pressure have been reported to prevent correct placement of the ILMA, by some, but not by all, authors. Finally, the costs of the ILMA device, access to training and sterilization processes has to be considered when weighing other airway management options. The recently developed disposable ILMA (LMA Fstrach™ single use) might be a more favourable and suitable option for the out-of-hospital setting.

In conclusion, this study demonstrated the successful use of the ILMA for ventilation in all patients with difficult-to-manage airways in an out-of-hospital setting, when performed by anaesthesia-trained EPs. Additionally, successful ILMA-guided TI was possible in all patients. We believe that the ILMA is an important airway device in the out-of-hospital arena for use in the case of difficult tracheal intubation by routine direct laryngoscopy. We recommend that the EP without anesthesia training learn the use of the ILMA on both manikin and patients in the controlled environment of the operating theatre. Although extensive real patient training may not be possible for all EPs, we have shown that even a limited exposure may elicit reasonable proficiency with this device. Since this survey reports only a small numbers of ILMA airway resuscitations, further studies should analyse if these encouraging results are transferable to other patient populations and a broader range of non-anaesthesia-trained emergency medical personnel.

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References
18 Combes X, Leroux B, Jabre P, Margenet A, Dhonneur G. Out-of-hospital rescue oxygenation and tracheal intubation with...
22 Brain AJI. LMA-Fastrach™ Instruction Manual. The Laryngeal Mask Company Ltd, 1997
30 Harry RM, Nolan JP. The use of cricoid pressure with the intubating laryngeal mask. *Anaesthesia* 1999; 54: 656–9