Supraglottic Airways: The History and Current State of Prehospital Airway Adjuncts

Daniel G. Ostermayer, MD, Marianne Gausche-Hill, MD

Abstract

This review discusses the history, developments, benefits, and complications of supraglottic devices in prehospital care for adults and pediatrics. Evidence supporting their use as well as current controversies and developments in out-of-hospital cardiac arrest and rapid sequence airway management is discussed. Devices reviewed include the Laryngeal Mask Airway, Esophageal Tracheal Combitube, Laryngeal Tube, I-Gel, Air-Q, Laryngeal Mask Airway Fastrach, and the Supraglottic Airway Laryngopharyngeal Tube (SALT).
Key words: airway; extraglottic; paramedics; prehospital; supraglottic

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Supraglottic airway devices have continued to emerge onto the medical device market since their original description in anesthesia literature over a quarter of a century ago. What began as an operating room adjunct has been adopted and widely used in the emergency room and prehospital environment. Although the term "supraglottic airway" is most commonly used to refer to these devices, the term, "extraglottic" also defines the class. These devices do not violate the larynx and are inserted via the oropharynx to provide ventilation.[1] For consistency we will use the term supraglottic to refer to all extraglottic airways. Their widespread adoption in prehosptial care directly stems from their ease of use, simplicity of training, predictability, and speed of insertion. This review discusses the history, developments, benefits, and complications of supraglottic devices in prehosptial care.

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Address correspondence to Daniel G. Ostermayer, MD, Department of Emergency Medicine, Harbor-UCLA Medical Center, 1000 W. Carson St, Box 21, Torrance, CA 90509, USA. e-mail: dan@ostermayer.co

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Laryngeal Mask Airway (LMA)

In 1981, Archie Brain invented the first supraglottic airway device, the LMA Classic (cLMA).[2] The cLMA was first sold in the United Kingdom in 1988, and then the United States in 1992 by LMA North America. The cLMA, a reusable device, has multiple variations and disposable versions (LMA-Unique). The device pictured in Figure 1 has an elliptical mask with a cuff attached to a ventilation tube. The aperture bars on the mask prevent the epiglottis from obstructing ventilation. When inserted, the LMA moves along the hard then soft palate to the hypopharynx and then proximal esophagus. The LMA masks the glottis with the distal tip sitting just posterior to the cricoid cartilages and the proximal portion against the base of the tongue. Many companies produce similar LMA style devices, which include the Ambu Aura series, AES Ultra, GE Vital Seal, Smith Portex Soft Seal, and Teleflex Sheridan LMA, Cobra PLA, and King/VBM LAD, many of which are not employed in the prehospital setting.

In 1992 Greene et al. reported the first two uses of the cLMA in managing a prehospital airway. A 21-year-old man was unable to be extricated from the passenger seat of a front-end collision. He was trapped in the upright position with a Glasgow Coma Scale (GCS) of 3, and paramedics could not obtain proper visualization for endotracheal intubation (ETI), so a cLMA was passed blindly from the front to manage his airway until extrication. In a similar rescue, a 32-year-old man had a cLMA placed and iv fluids started while extrication was in progress.[3]

In 1992, Pennant et al. demonstrated that paramedical students could ventilate a patient 94% of the time on first attempt with a cLMA, while only 69% had first-pass success with an endotracheal tube (ETT).[4] A few years later, multicenter data demonstrated that during a cardiac arrest trained nurses could insert the cLMA with 71% success on first attempt further establishing the supraglottic device as a viable airway adjunct in emergent situations.[5]

An in-hospital anesthesia-based meta-analysis of randomized prospective trials performed by Brimacombe in 1994 compared the benefits of the LMA to ETI and bag-valve- mask ventilation (BVM). Compared to BVM, a LMA was easier to place by newly trained practitioners, had less reported hand fatigue, and improved oxygen saturation. When compared to ETI, an LMA had faster placement speed (38.6 sec for LMA vs. 88.3 sec for ETI), and a similar aspiration risk as

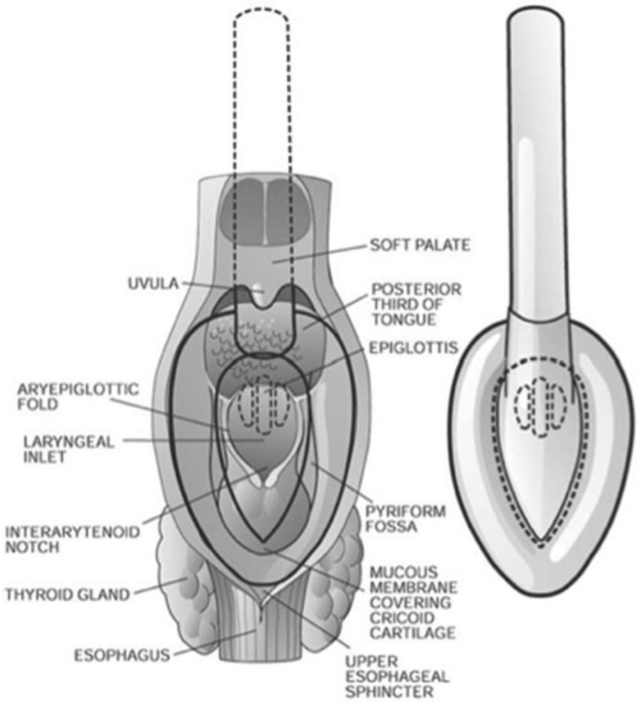

FIGURE 1. Placement of the LMA from a dorsal view of pharynx. (Image Courtesy of LMA North America, Inc.)

ETI and BVM. Overall success rates for placement were 82.7%, and 86.2% when used as a rescue device[6] (Figure 2).

LMA in Pediatrics

The LMA has gained increasing popularity as an alternative airway device in pediatrics due to the variety of size offerings and successful reported use in neonates and in patients with difficult anatomic abnormalities, such as Pierre-Robin syndrome.[7–9] A prospective survey of LMA placement in an in-hospital setting demonstrated success in 90% of first attempts, 8% on the second attempt, and 2% required alternative techniques. Insertion difficulty has been reported with use of the size one laryngeal mask and involved oxygen saturation decreasing below 90% in 1.7% of the placements.[10]

During the resuscitation of 369 neonates (≥34 weeks) in a prospective study, successful resuscitation occurred with greater frequency in the LMA group and ventilation time was shorter with the LMA than with BVM. The study group also demonstrated 98.5% first attempt insertion with the most significant adverse event consisting of aspiration. If suction of amniotic fluid was performed prior to LMA insertion no aspiration complications occurred.[11]

With prehospital ETI being demonstrated to offer no survival or neurologic outcome benefit over BVM in children 12 years or younger,[12] the LMA offers an alternative in difficult to ventilate children during respiratory or cardiac arrest. Paramedic students on the first attempt successfully ventilated pediatric manikins during a simulated arrest.[13] The LMA is available in all sizes, from premature infants to adult sizes (Table 1).

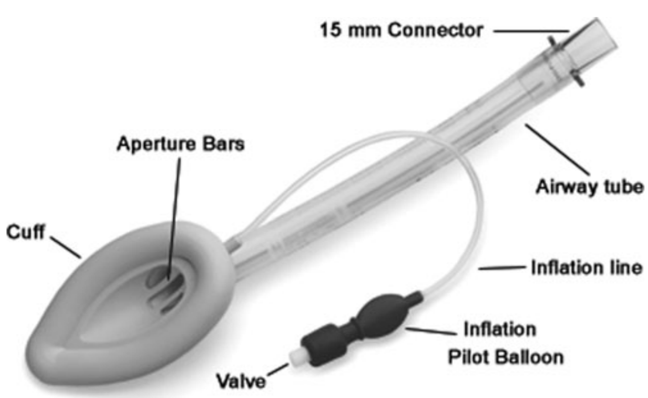

FIGURE 2. LMA Classic. (Image Courtesy of LMA North America, Inc.)

LMA Complications

The LMA does not function as a definitive airway. Since the LMA only masks the glottis it does not protect the trachea from aspiration. However, a meta-analysis of in-hospital usage of the LMA demonstrated the infrequency of aspiration complications associated with the device.[14] Major LMA complications with usage consist of poor seal, failed insertion, and need for re-insertion and repositioning.[15] Oropharyngeal leak pressures are small and can be corrected with head and neck repositioning.[16] In children poor positioning can lead to increased inspiratory pressures, stomach insufflation, and vomiting.[17]

ESOPHAGEAL TRACHEAL COMBITUBE (ETC)

First described in 1987 by Frass et al. in Austria as a means for establishing rapid airway management during cardiopulmonary resuscitation, the Esophageal Tracheal Combitube (ETC) ("Combitube") emerged as a device specifically for prehospital care.[18] Unlike the LMA, the ETC would gain popularity in prehospital and emergency care due to studies demonstrating airway rescue during resuscitation.[19,20] The new device was designed as an improvement over the Esophageal Obturator Airway (EOA), which when used in the prehospital environment had a high frequency of complications.[21–24]

The ETC is a disposable double-lumen, double-cuffed device with separate inflation for the proximal and distal cuffs. On insertion, the Combitube normally enters the patient's esophagus and the proximal tube is used to ventilate the patient after confirmatory

TABLE 1. Summary of discussed supraglottic devices

Device (date introduced)	Lumen	Cuff	Adult and pediatric sizes	Special features
cLMA (1988)	Single	Single, periglottic	Neonate <5 kg – adult 100 kg	Reusable
LMA Unique (1997)	Single	Single, periglottic	Neonate <5 kg – adult 100 kg	Disposable
LMA Supreme (2007)	Single (with gastric drainage)	Single	Neonate <5 kg – adult 100 kg	Gastric suction, bite block, disposable
LMA ProSeal (2000)	Single (with gastric drainage)	Single	Neonate <5 kg – adult 100 kg	Gastric suction, bite block, increased seal pressure, reusable
ETC (1988)	Double	Double, proximal and distal	Adult height 120 cm – >180 cm	Gastric suction, disposable
EasyTube (2003)	Double	Double, proximal and distal	Adult height 90 cm – >180 cm	Fiber-optic intubation through proximal lumen, Gastric suction, disposable
VBM LT (D) (2003)	Single	Single	Neonate <5 kg – adult height >180 cm	Curvature eliminates tracheal intubation, reusable or disposable
VBM LTII (2004)	Single (with gastric drainage)	Single	Neonate <5 kg – adult height >180 cm	Adds gastric drainage to LT
King LT-D (2004)	Single	Single	Pediatric >12 kg – adult height 90–122 cm	Curvature eliminates tracheal intubation, disposable
King LTS-D (2004)	Single (with gastric drainage)	Single	Pediatric >12 kg – adult height 122–180 cm	Adds gastric suction to LT-D
I-Gel (2003)	Single	Single	Neonate 2 kg – adult >90 kg	Reusable, no cuff inflation
Air-Q (2004)	Single	Single	Pediatric <7 kg – adult 100 kg	Wider and shorter lumen for ETT conduit, disposable
Air-Q SP (2012)	Single	Single	Pediatric <4 kg – adult 100 kg	Self pressurizing cuff, disposable
LMA Fastrach (1995)	Single	Single	Adult 30–100 kg	Intubation through lumen, reusable or disposable
SALT (2005)	Single	None	Adult 6.5–9 mm ETT	Function as oropharyngeal airway, provides conduit for intubation

lung auscultation. If a tracheal intubation is achieved then ventilation is switched to the more distal lumen. Auscultation is unreliable to confirm placement and capnometry is required for ventilation confirmation[20] (Figure 3).

With only two sizes available to increase simplicity of use in the field, the ETC has no place in pediatric airway management. The original ETC offered a 41 French for use in patients taller than 6 feet, and a 37 French for smaller adults between 4 and 6 feet tall.[25,26]

As with the LMA, medical practitioners untrained in ETI can easily perform blind insertion of the Combitube faster than a physician performing direct laryngoscopy without added complications.[27] A case report from an intensive care unit demonstrated successful mechanical ventilation through the ETC for up to 8 hours.[28] With ease of training and insertion, the Combitube became a favorite airway adjunct in prehospital care. Mean insertion speeds for the ETC have ranged from 27 to 53 seconds with overall success rate of 85.4% and 81.8% as a rescue device.[6,27,29–31]

ETC Complications

A 10-year database of prehospital intubations in Quebec attributed 13 (5%) complications to Combitube usage in 282 patients. The most frequent complications were upper airway bleeding, esophageal laceration, esophageal perforation, and mediastinitis.[32] Decreasing balloon inflation has been suggested as a means of lessening the chance of pharyngeal and esophageal injuries.[33]

Speed and multiple steps to insertion remain the major criticism of the ETC. The extra step of deciding when to use which port on the ETC increases the chances for error and time for insertion. The Combitube required twice the time to place as its major competitor, the Laryngeal Tube, when prehospital providers were observed during simulation.[30]

NEWER DEVICES

According to the 16 states participating in the 2008 National Emergency Medical Services Information System (NEMSIS), 2.5% of airway interventions were

FIGURE 3. Combitube (Image courtesy of Covidien).

managed with supraglottic devices and 11.7% with ETI. The majority of the supraglottic interventions were using the Combitube, with the LMA as the second most prevalent device. ETI first pass success rate was 77% with a cardiac arrest and RSI ETI success rate of 78%. The overall Combitube success rate was 83.6% and the LMA success rate was 95.2%. Devices such as the King LT were underrepresented in the NEMSIS data; however, use of the device by prehospital providers has increased in recent years.[34]

LARYNGEAL TUBE (LT)

Introduced in Europe in 1999 by VBM Medizintechnik and sold as a disposable form in the United States by King Systems since 2003, the device was a major competitor to the ETC. The LT disposable (LT-D) is also offered with a gastric suction drain (LTS-D) (Figure 4). The LT was designed to remedy the complexity of the double-lumen ETC. At the distal end of the tube is an esophageal cuff and proximally there is an oropharyngeal cuff. Both cuffs inflate with a single inflation port. The shape of the LT was designed to eliminate the approximate 5% of tracheal intubations that occur with the ETC and ensure consistent esophageal intubation.[35] If tracheal intubation with the LT were to occur it would completely occlude the airway with inability to ventilate. Even with using a laryngoscope in 500 mannequin intubations, the LT could not be placed into the trachea.[36]

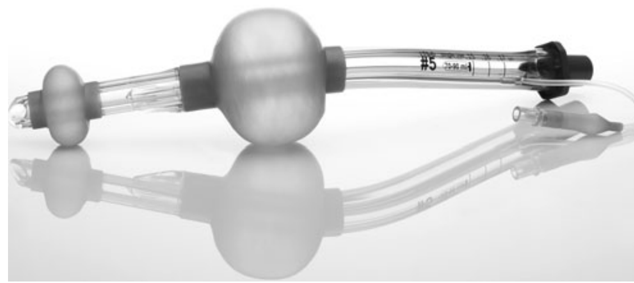

FIGURE 4. Laryngeal Tube Suction (Image courtesy of King Systems).

Using manikins, inexperienced Finnish military responders were able to successfully insert the LT with a maximum of two attempts after a short video lecture.[37] In the United States undergraduate students with no experience using the LT were directed over the phone to place the airway in a manikin. Successful placement occurred 80% of the time.[38] A pilot study using rapid-sequence airway placement in a prehospital setting reported 100% successful LT placement after two attempts.[39]

When the King LT was compared to the ETC in a group of air medical personal who primarily use the ETC, after 10 minutes of instruction the mean time for placement was 24.4 seconds for the King LT and 37.9 seconds for the ETC. Also, preference ratings for the King LT were higher than for the ETC.[29] Meta-analysis shows an overall success rate of 96.5% for placement.[6] In contrast to these data, Fascone et al., in a randomized controlled trial coordinated between four EMS systems, showed no difference between the ETI and King LTS-D regarding placement success rate or time to insertion as a primary outcome. This study did not count equipment preparation time or account for hands-off time during chest compressions, which have been demonstrated to create significant time differences.[40,41] The number of chest compressions per simulated cardiac arrest was greater when using the King LT compared to BVM, although time to first ventilation was longer for the LT group.[42]

LT Complications

Oropharyngeal leakage occurs with 45 degrees of flexion in adults and children, which can impede proper ventilation and eventually require ETI.[43,44] The practice of converting an LT to ETI by bougie-assisted tube exchange has been shown to result in violation of the aryepiglottic folds.[45]

LT in Pediatrics

Although VBM offers LT sizing for neonates in disposable versions for prehospital use, the smallest King LT is designed for a 12-kg patient. Success rates are similar in pediatrics when comparing the LMA and LT.[46] Prehospital trials for pediatric use have not been conducted. Using a size 2 King LT, no statistical difference was demonstrated in time to insertion compared to intubation with an ETT in a pediatric simulator.[47]

EASYTUBE (EZT)

The Rusch EasyTube, manufactured by Teleflex Medical, introduced in the U.S. market in 2006, resembles the ETC with double lumen and two inflation balloons. Two sizes are available (28 and 41 French), with the smallest for use in patients down to 3 feet tall. Ventilation can occur through either lumen, similar to the ETC, depending on placement in the pharynx or trachea. Multiple studies have demonstrated the effectiveness of the device for airway management by prehospital providers and emergency physicians with insertion times comparable to other supraglottic devices.[41,48,49] In an operating room, anesthesiologists found easier and faster insertion of EzT with the ability to accommodate a larger gastric tube as compared to the ETC.[50] No significant speed difference was demonstrated by prehospital providers between the two devices, although EzT placement was faster than ETI placement.[51] Due to increased time and difficulty with inserting dual-lumen devices, the ETC and EzT have largely been supplanted by single-lumen devices such as the LT.[52]

LMA FASTRACH (FT-LMA)

The FT-LMA, also known as the intubating LMA, allows for passage of an endotracheal tube (ETT) through the device for transition from rescue to definitive airway. The major differences between the FT-LMA and the cLMA are a more rigid airway tube, a tracheal tube guiding ramp, and a 13-mm internal diameter able to accommodate an special manufacturer ETT up to size 8.0.[53]

The FT-LMA, unlike the cLMA, is only produced in three sizes, one for children and two for adults.[54] The child sizes do not accommodate infants and neonates originally supported by the cLMA.

A small single-center trial suggested that the FT-LMA could be successfully used in a prehospital environment. Paramedics were able to demonstrate an overall intubation success rate using the FT-LMA of 88% versus a 63% rate with ETI without sedation or paralysis.[55] An in-hospital multicenter study involving 500 patients demonstrated 96.2% successful intubation rate after three attempts through an FT-LMA with 79.8% occurring in the first attempt, while a cadaveric study demonstrated a 67% success rate.[56,57] Nurses have demonstrated similar success rates of 86% using blind intubation through the FT-LMA.[58] Case reports in emergency departments describe successful use of the FT-LMA in patients who failed rapid-sequence intubation, although the ability to ventilate does not translate to the ability to successfully intubate through the device.[59] No large prehospital trials using the FT-LMA have been performed.

In an operating room setting, helicopter emergency services personal did not demonstrate a significant difference in placement or time to ventilate with the cLMA or FT-LMA.[60] However, with paramedical students simulating a cardiac arrest, the FT-LMA was inserted successfully on the first attempt more frequently than the LT. Times needed to ventilate were similar between the groups.[61] In a cadaver study, time to ventilate was faster with the FT-LMA than with the cLMA.[57] For patients with in-line cervical spine stabilization, using the LT resulted in less first attempt success and required greater time to insertion than the FT-LMA.[62]

Unfortunately, the FT-LMA requires a special reinforced ETT that has a molded tip produced by the manufacture and is considerably more expensive than a standard polyvinylchloride (PVC) ETT. Using the standard PVC ETT, on first attempt the success rate for intubating through the FT-LMA was only 48%. On first attempt, even with the manufacturer-produced FT-LMA ETT tube, a recent randomized trial on anesthetized patients demonstrated a 90% blind intubation rate.[63]

In the prehospital setting, no studies have been conducted on the conversion of a supraglottic device to ETT, which may cause harm by creating another step of complexity for airway management. Providers at the receiving hospital, however, may opt to utilize the supraglottic device as a conduit for ETI. Complications with the FT-LMA are similar to those involving direct laryngoscopy. Esophageal intubation has been well documented in case reports.[64–66] Compared to the cLMA the FT-LMA caused more minor injuries to the upper airway.[67]

I-GEL

A new device, the I-Gel, invented by Muhammed Nassir in 2003 and developed by Intersurgical in Berkshire, UK, has the advantage of not requiring inflation of a cuff. Made from a thermoplastic elastomer (styrene ethylene butadiene styrene), the device should conform precisely to the pharyngeal and laryngeal anatomy (Figure 5). When compared to the cLMA, the I-Gel was as effective with ventilation and was associated with a similar profile of adverse events.

FIGURE 5. I-Gel (Image Courtesy of Intersurgical, Ltd.).

Greater seal pressures were observed.[68] The I-Gel only reliably accommodates ETT passage under fiber optic guidance. A small prospective study demonstrated that blind intubation through an I-Gel is both difficult and unpredictable and concluded that it should not be attempted.[69] A randomized controlled trial of 160 patients demonstrated successful tracheal intubation on the first attempt in 69% of patients with the I-Gel and 74% of patients with the FT-LMA.[70]

A prehospital case report describes the successful placement and ventilation through an I-Gel in a woman with severe blunt head and face trauma.[71] Another case report describes 100 successful uses during cardiopulmonary resuscitation by nurses and junior physicians.[72] In theory, the I-Gel should afford faster insertion times since there is no need for inflation. However, in a observational study of simulated cardiac arrests, prehospital providers had 15.9 seconds of hands-off time using the I-Gel and only 8.4 seconds using the LT.[41]

I-Gel in Pediatrics

Intersurgical does manufacture the I-Gel in sizes small enough for neonates. A randomized trial in children comparing the I-Gel and cLMA demonstrated similar leak pressures but a shorter insertion time when using the I-Gel. Similar complications occurred with pediatric usage of the I-Gel when compared to the cLMA.[73]

There are currently no large-scale published studies on prehospital or emergency room comparisons between the I-Gel and other devices in adults or pediatrics. All current literature involves studies in a general anesthesia or simulated environment.

COOKGAS AIR-Q

In 2004 Daniel Cook, founder of Cookgas, developed the Air-Q Intubating Laryngeal Airway with the goal of use as a primary intubation adjunct. In comparison to the cLMA, the Air-Q has no aperture bars in the laryngeal mask, a wider ventilating lumen, and a removable connector, allowing the shaft to be used as a conduit to intubation.[74] The Air-Q also allows for passage of a conventional PVC ETT instead of requiring a special reinforced tube as used in the FT-LMA. The removable proximal connector translates to an increased diameter of the airway tube, facilitating larger ETT insertion. The overall length of the Air-Q is shorter than the FT-LMA, easing the removal of the supraglottic device over the ETT after intubation.

Karim and Swanson in a randomized trial in an operating room setting showed that the LMA Fastrach had a higher rate of success (99%) in facilitating blind intubation than did the Air-Q (77%). The study, however, used the special manufactured ETT for the FT-LMA.[75]

Air-Q in Pediatrics

Unlike the FT-LMA, the Air-Q is available in a wide range of pediatric sizes.[76] Positive case reports describe successful intubation through the device in both infants and children and in patients with difficulty airway anatomy, such as in Pierre-Robin sequence.[77] One notable disadvantage is the difficulty in placing the device in neonates weighing less than 4 kg.[78]

Cookgas recently created the first self-pressurizing supraglottic device (Air-Q SP), which allows positive pressure ventilation to self-pressurize the mask cuff. In order to increase the cuff seal during positive pressure inflation the cuff inflates to maximum pressure at the peak of ventilation. Although no statistically significant differences between initial leak pressures in the Air-Q SP or LMA-Unique (disposable version of the cLMA) were observed under general anesthesia there was a 2-second average speed to insertion difference between the LMA disposable and the Air-Q SP. The speed advantage of the Air-Q SP is due to the elimination of manual inflation.[79] Currently, no published studies on prehospital or emergency room use of the Air-Q or Air-Q SP exist. All current literature involves studies in a general anesthesia environment.

SUPRAGLOTTIC AIRWAY LARYNGOPHARYNGEAL TUBE (SALT)

Developed by Microtek Medical EcoLab and approved by the FDA in 2005, SALT resembles an oropharyngeal airway but provides a conduit for blind ET insertion. A cadaver study demonstrated successful BVM ventilation of a patient with the SALT functioning as an oropharyngeal airway. Although the device prototype was modified during the study, when used as a conduit for ETI, 59% experienced first-pass ETI with successful ventilation.[80] No trials have compared the SALT to the Air-Q or FT-LMA as intubation conduits. EcoLab manufactures the SALT in only one size for adult patients, and when compared to standard oropharyngeal airways it is significantly more expensive (Table 1).

DEVICES IN AUSTERE ENVIRONMENTS

The endotracheal tube, Combitube, and King LT, have been tested in cadavers for force needed to dislodge the device from an airway. The ETC requires the most force (28.3 lbs), the LMA second (18.3 lb), then the ETT (14.4 lb) and lastly the King LT (12.5 lb).[81] Data collection from Combat Support Hospitals in 2008 demonstrated that 86.3% of prehospital managed airways were managed with an ETT, 7.2% with an ETC, and 0.7% with a LMA. Although the ETC is the standard rescue airway device for the U.S. Army, poor skill retention has been demonstrated with the device among medics.[82] Paramedics demonstrated 100%

skill retention after 3 months in all supraglottic devices except ProSeal (85%) and only 58% for ETI.[83] After a battlefield trauma course, Naval SEAL or reconnaissance combat corpsmen were able to insert the LMA in as fast as 22.3 seconds, while the ETT required 36.5 seconds and ETC required 40.0 seconds.[84] EMS providers wearing personal protective equipment have also demonstrated increased speed of placement with a LT compared to an ETT.[85] In simulated tactical settings, medic exposure to hazard was less when using the King LT compared to ETI for airway management, although ETI was most successful among experienced personnel.[86]

FUTURE DEVELOPMENTS

Rapid-sequence Airway (RSA) Placement

RSA refers to the placement of an alternative airway, such as a supraglottic device, after pharmacologic treatment with a paralytic and sedative. Using a King-LT, RSA allowed for 100% successful placement after two attempts.[39] In a randomized nonblinded simulation trial RSA allowed for shorter time to airway management than rapid-sequence intubation (RSI).[87] RSA administration does not preclude the need for standard airway management such as suction, preoxygenation, and positioning, but offers prehospital providers the option of proceeding straight to a supraglottic airway instead of using the device only in the case of failed initial airway management. The usefulness of RSA is illustrated by a case of severe facial trauma requiring airway management in the field. The patient's airway was managed primarily with an LMA Supreme after medication with rocuronium and etomidate. ETI would have proven extremely difficult and cricothyrotomy was outside of the prehospital providers scope of practice in that EMS system. Demonstrating the LMA's ability for long-term airway management, the device was left in place until surgical airway was established in the operating room.[88,89]

Currently the National Association of EMS Physicians (NAEMSP), American College of Emergency Physicians (ACEP), and American College of Surgeons Committee on Trauma (ACS-COT) support the use of drug-assisted intubation (DAI) in the prehospital environment if strict oversight safety guidelines are in place.[90] Although supraglottic devices do not offer definitive airway management, new devices with greater seal pressures and ability for gastric decompression may significantly decrease aspiration risk.[91] Placement of a supraglottic device may obviate the complications and hypoxia that occur with multiple ETI attempts, but just as prehospital DAI with ETI has been shown to be complicated by desaturation,[92] proper preoxygenation should be employed during all emergency airway management.[93] No trials have compared the risks and benefits of drug-assisted supraglottic airway placement to non-drug-assisted placement.

Airway Management in Out-of-Hospital Cardiac Arrest (OHCA)

Within the last 10 years there has been a focus on the neurologic outcomes of out-of-hospital resuscitation. It is not enough to have a return of spontaneous circulation if there is significant morbidity as a result. In Japan, a nationwide observational study of all OHCA between 2005 and 2007 demonstrated slightly poorer 1-month neurologic outcomes in the patients whose airways were managed with supraglottic devices. Neurologically favorable 1-month survival as evaluated by the physician on follow-up appointment was 1.14% in the ETI group, 0.98% in the LMA group, and 1.04% in the group that contained a combination of ETC, LT, and EOAs.[94] A similar prospective, nationwide, population-based study from 2005 to 2010 on out-of-hospital cardiac arrest in Japan demonstrated that any advanced airway management was independently associated with decreased neurologically favorable survival compared to BVM.[95] In the United States, extending airway intervention with ETC to lower-level first responders (EMT-B) provided no improvement in patient survival compared to ETI by paramedics.[96]

A swine model has demonstrated a decrease in carotid artery blood flow when a supraglottic device for CPR was used during a cardiac arrest. Normal carotid blood flow immediately returned once the device was removed. The ETT did not affect carotid blood flow. There were no significant differences between aortic, intracranial, or coronary perfusion pressures. Carotid blood flow changes have yet to be demonstrated in humans.[97] An anatomical analysis of MRI imaging of the Cookgas Air-Q places doubt on the swine model translating into significant human outcomes. With an Air-Q inserted, the carotid arteries appeared posterolateral to the inflated cuff at all times without any vascular distortion.[98]

For pediatric patients (age ≤ 12) no clear neurologic or survival benefit has been demonstrated between ETI and BVM in prehospital airway management.[12] However, no analysis of similar outcomes has been performed in a prehospital pediatric population regarding BVM and supraglottic devices.

Comparison of neurologic outcomes between specific devices has yet to be performed Although supraglottic airways decrease hands-off time during resuscitations, it is unclear whether *any* advanced airway offers a neurologic survival benefit when compared to simple BVM in a prehospital setting.[99] Also, the devices are inserted at varying times during the resuscitation efforts and the ideal timing of insertion to maximize patient-oriented outcomes remains unknown.

Many factors, such as post arrest hypothermia, percutaneous coronary interventions, and associated trauma, affect the neurologic recovery of patients, making analysis of any prehospital airway device inherently difficult.

Since prehospital airway management devices largely evolve from the field of anesthesia, much of the medical literature regarding new devices focuses on the operating room. With the many obvious practical and clinical differences between these clinical settings, further studies in the prehospital environment are needed, specifically trials correlating neurologic outcome to supraglottic device. In the past, trials focused mainly on effectiveness and safety of ventilation with a supraglottic device. Most current literature describes the speed and ease of insertion over ETI. Future studies must focus on determining clinically significant harms or benefits to using supraglottic devices in a prehospital setting during specific clinical situations at specific times during resuscitation in both adults and pediatrics.

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