Emergency Department Management of Out-of-Hospital Laryngeal Tubes

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Study objective: Laryngeal tubes are commonly used by emergency medical services (EMS) personnel for out-of-hospital advanced airway management. The emergency department (ED) management of EMS-placed laryngeal tubes is unknown. We seek to describe ED airway management techniques, success, and complications of patients receiving EMS laryngeal tubes.

Methods: Using a keyword text search of ED notes, we identified patients who arrived at our ED with a laryngeal tube from 2010 through 2017. We performed structured chart and video reviews for all eligible patients. In our ED, emergency physicians perform all airway management, and there is no protocol dictating airway management for patients arriving with a laryngeal tube. Using descriptive methods, we report the techniques, success, and complications of ED airway management.

Results: We analyzed data on 647 patients receiving out-of-hospital laryngeal tubes, including 472 (73%) with cardiac arrest from medical causes, 75 (21%) with cardiac arrest from trauma, and 100 (15%) with other conditions. For 580 patients (89%), emergency physicians exchanged the laryngeal tube for a definitive airway in the ED. Of the 67 patients not intubated in the ED, 66 died in the ED without further airway management. Of the 580 patients intubated in the ED, orotracheal intubation was the first method attempted for 578 (>99%) and was successful on the first attempt for 515 of 578 (89%). Macintosh video laryngoscopy (88% of initial attempts) and a bougie (68% of initial attempts) were commonly used adjuncts. For 345 of 578 patients (60%), the laryngeal tube was removed before intubation attempts. For 112 of 578 patients (19%), the first intubation attempt occurred with the deflated laryngeal tube left in place. Three patients (<1%) required a surgical airway.

Conclusion: In this cohort, emergency physicians successfully exchanged an out-of-hospital laryngeal tube for an endotracheal tube, using commonly available airway management techniques. ED clinicians should be familiar with techniques for exchanging out-of-hospital extraglottic airways for an endotracheal tube. [Ann Emerg Med. 2019;74:403-409.]

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INTRODUCTION

Background

Airway management is an essential out-of-hospital intervention for victims of cardiac arrest and other disease or injury processes that lead to loss of airway reflexes and respiratory failure. Although emergency medical services (EMS) paramedics typically perform endotracheal intubation for critically ill patients, there is increasing use of extraglottic devices (including laryngeal tubes, laryngeal mask airways, and Combitubes, also collectively known as supraglottic airways). Extraglottic devices are commonly placed by EMS providers because they are easy to use and have high success rates and seem to provide ventilation similar to that of endotracheal tubes.[1-4]

Importance

The optimal strategy for ED management of the out-of-hospital extraglottic device is unclear. Some clinicians leave the device in place for initial ED resuscitation, and some remove the extraglottic device and perform direct laryngoscopy and intubation.[5,6] Others perform a tube exchange using a bougie or fiber-optic bronchoscope with Aintree catheter.[7,8] Some authors advocate that many patients arriving at the ED with a laryngeal tube be taken to the operating room for a surgical airway rather than receive orotracheal intubation in the ED.[9,10] Pitfalls of these strategies include the loss of a functioning airway if the extraglottic device is removed for laryngoscopy and intubation is not possible; the significant time required to complete a bronchoscope-guided exchange, which may not be available for patients with competing

Editor's Capsule Summary

What is already known on this topic

Emergency medical services (EMS) personnel often use supraglottic airways for out-of-hospital airway management.

What question this study addressed

How does the emergency department (ED) manage the airway for patients arriving with an EMS laryngeal tube supraglottic airway?

What this study adds to our knowledge

In this series of 647 patients transported to the ED with an EMS laryngeal tube, emergency physicians left the laryngeal tube in place in 67 (10.4%), converted to an endotracheal tube by using oral or video laryngoscopy for 569 (88%), converted to an endotracheal tube by using an intubating laryngeal tube airway for 8 (1.2%), and performed cricothyroidotomy for 3 (0.5%).

How this is relevant to clinical practice

As EMS supraglottic airway use increases, clinicians must be familiar with techniques to manage it in the ED.

resuscitation priorities; and the morbidity of and the delay inherent in transportation to the operating room to initiate a surgical airway. The results from 2 recent clinical trials showed equivalent or better outcomes with extraglottic device compared with endotracheal intubation, and thus extraglottic device use in out-of-hospital cardiac arrest may increase.[3,4]

Goals of This Investigation

We sought to describe ED airway management techniques, success, and complications of patients arriving at the ED with an EMS-placed laryngeal tube.

MATERIALS AND METHODS

Study Design

We performed a retrospective, observational study at an urban academic ED. This study was approved by our local institutional review board.

Setting

This study was conducted at Hennepin County Medical Center, an urban, academic ED with an annual census of approximately 100,000 visits. There are 5 EMS agencies serving the immediate catchment area of the study hospital, staffed by 2 paramedics for all 911 calls. The airway management protocols effective for all 5 EMS services include standing orders for bag-valve-mask ventilation, orotracheal intubation, and alternative advanced airway devices as specified by the service's medical director (eg, laryngeal tube, laryngeal mask airway). Although all the paramedics are trained to perform orotracheal intubation, most are not permitted to use neuromuscular-blocking agents.

The EMS agency that accounted for the majority of patients in this study serves an urban area with an average transport time of 6 minutes. The disposable King Laryngeal Tube with suction channel (Ambu, Ballerup, Denmark) was the extraglottic device most commonly used by local out-of-hospital agencies during the study period. According to data from 2016 to 2017, approximately 90 patients per year are transported to the study hospital with a laryngeal tube in place. The only significant change in airway protocols during the study period was the addition of video laryngoscopy in early 2015.

On patient arrival at the ED, all airway management decisions and procedures are determined and performed by the treating emergency physicians. Senior emergency medicine residents (postgraduate year 3 or higher) perform the majority of intubations (>85%); junior residents and attending emergency physicians perform the remainder. When patients arrive at the ED with a laryngeal tube, there is no protocol for care or removal of the tube. Sedation and neuromuscular blockade are uniformly used for all laryngeal tube exchanges unless the patient is in active cardiac arrest.

Selection of Participants

Using the electronic medical record (Epic Systems, Verona, WI), we identified ED patients who arrived with a laryngeal tube in place from 2010 through 2017 by searching the text of all ED notes for "king," "laryngeal tube," and "ILMA/LMA" (intubating laryngeal mask airway/laryngeal mask airway); the latter was used because sometimes the use of an extraglottic device is coded in templated procedure notes as "ILMA/LMA" because there is no specific option for laryngeal tube. The date range was used because videos were not routinely recorded before 2010. We did not include other extraglottic devices because they were infrequently used by paramedic agencies during the study period. For patients identified through this text search, an abstractor manually reviewed each chart to determine whether the patient arrived at the ED with a laryngeal tube in place.

Methods of Measurement

Trained, unblinded abstractors performed a chart and video review (if available) for each identified patient and entered data into a standardized form, using Research Electronic Data Capture (Vanderbilt University, Nashville,

TN).[11] The initial data collection form was refined after review of the first several patients. The study team met periodically to retrain and answer questions about data collection to ensure data uniformity.

Using manual chart review, abstractors collected patient demographics, whether out-of-hospital intubation attempts occurred before laryngeal tube placement, the indication for laryngeal tube placement and subsequent intubation, the time elapsed from laryngeal tube placement to ED arrival, and whether purported risk factors for complications on laryngeal tube removal were present (head, neck, or facial trauma; out-of-hospital intubation attempts; and whether blood, vomit, or edema was present in the mouth, tongue, or periglottic structures). We relied on physician documentation of blood, vomit, or airway edema in ED notes because there was no standard documentation of these during the study period.

In the ED, critically ill or injured patients receive care in a 4-bay stabilization room. Each resuscitation bay has 3 ceiling-mounted video cameras activated by motion sensors. Automated software combines the video streams with output from the patient cardiac and vital sign monitor, as well as audio recording of the room. The videos are stored on a secure database and are used for peer review, quality assurance, and research purposes. Using video review, abstractors recorded ED airway management, including how the laryngeal tube was managed, how intubation was performed, and whether hypoxemia occurred.

If the resuscitation video was not available, the abstractor reviewed nursing and physician notes in the electronic medical record to attempt to ascertain the variables planned to be abstracted from the video. In some instances, these variables were not able to be collected from chart review and were recorded as missing with no assumed value. We tabulated the number of observations with missing data for each variable and displayed them as table footnotes.

Outcome Measures

The primary outcome measure was the intubation technique used. Secondary outcomes included successful intubation on the first attempt, attempt duration, and hypoxemia (oxygen saturation <90%). An intubation attempt was defined as single insertion of the laryngoscope into the mouth and then its removal. The attempt duration was the time elapsed between insertion and removal of the laryngoscope.

Primary Data Analysis

Baseline characteristics, intubation process measures and outcomes, and management of patients in cases of first-attempt failure were analyzed with descriptive techniques; frequencies, proportions, and medians are presented as appropriate.

To calculate interobserver agreement and unweighted κ values, a second abstractor reviewed 10% of the videos for the number of intubation attempts, the method of handling the laryngeal tube during intubation, and the presence of head, neck, or facial trauma. We used Stata (version 15.1; StataCorp, College Station, TX) for data analysis.

RESULTS

Of 1,153 patients initially identified by the text search of ED notes, 647 arrived at the ED with a laryngeal tube in place (Table 1). Resuscitation videos were available for 486 patients (75%); the remainder underwent chart review only. The most common indication for out-of-hospital laryngeal tube placement was cardiac arrest from a medical cause (472 patients; 73%). There were 133 patients (21%) with head, neck, or facial trauma. Median elapsed time between ED arrival and the start of the intubation attempt was 8 minutes (interquartile range 5 to 11 minutes).

For 580 patients (89%), the laryngeal tube was exchanged for a definitive airway in the ED. Of the 67 patients not intubated in the ED, 66 died in the ED without further airway management (Figure).

Orotracheal intubation was attempted for 578 of 580 patients and was successful on the first attempt in 515 cases (89%). A video laryngoscope with a standard geometry Macintosh curved blade (C-MAC; Karl Storz) was used on the first attempt in 505 instances (88%); a bougie was used in 393 instances (68%). A variety of techniques was used to manage the laryngeal tube while intubation was performed (Figure). Most commonly, the laryngeal tube was removed before the first intubation attempt; however, 112 patients (19%) had intubation attempted while the laryngeal tube remained in place. Two patients underwent a surgical airway as the first method of ED airway management; a third underwent cricothyrotomy after failed intubation attempts.

The most common reason for first intubation attempt failure was difficulty visualizing the glottic inlet. After first-attempt failure, most patients (54/63; 86%) were intubated orally with use of a video laryngoscope. Intubation process measures and details of airway management after first-attempt failure are presented in Table 2.

Interobserver agreement was 84% for number of intubation attempts (κ=0.72), 75% for method of handling the laryngeal tube during intubation (κ=0.56), and 95% for the presence of head, neck, or facial trauma (κ=0.84).

LIMITATIONS

Retrospective chart reviews are inherently challenged, but the availability of video review in 75% of cases overcomes much of the limitation of this study design.

Table 1. Baseline characteristics.

Characteristic	Value (N = 647)
Age, median (IQR; range), y	54 (39–65; 1–100)
Male sex, No. (%)	461 (71)
Body mass index,* median (IQR; range), kg/m^2	29 (24–34; 14–69)
Out-of-hospital intubation attempt, any, No. (%)	76 (12)
No. of attempts, if attempted, median (IQR; range)	1 (1–2; 1–5)
Location of out-of-hospital intubation attempts,† No. (%)	
Out-of-hospital, EMS	67 (11)
Outside hospital, before transfer	7 (1)
Both	2 (<1)
Out-of-hospital laryngeal tube dwell time,‡ median (IQR; range), min	24 (14–33; 1–78)
Primary indication for out-of-hospital airway management, No. (%)	
Cardiac arrest from medical causes	472 (73)
Cardiac arrest from trauma	75 (12)
Airway protection	75 (12)
Head or facial injury	36 (6)
Polytrauma	22 (3)
Altered mental status, other causes	17 (3)
Acute respiratory failure	15 (2)
Other	10 (2)
Presence of head, neck, or facial trauma, No. (%)	133 (21)
Laryngeal tube functioning on arrival,§ No. (%)	627 (97)
Elapsed time between ED arrival and first intubation attempt,‖ median (IQR; range), min	8 (5–11; 0–65)
Total laryngeal tube dwell time,¶ median (IQR; range), min	33 (23–42; 3–87)

IQR, Interquartile range.
*Body mass index available for 424 patients.
†Two patients had intubation attempted both out-of-hospital and at an outlying hospital.
‡Dwell time is the total time the laryngeal tube was in place. Fire personnel occasionally placed the laryngeal tube before EMS arrival, and in these cases dwell time was considered to be started when paramedics arrived. Data are available for 396 patients.
§Laryngeal tube assumed to be functioning on arrival if left in place for more than 2 minutes of ED bag-valve-mask ventilation. In cases without video, we recorded the laryngeal tube as not functioning only if physician notes stated that it was not working on arrival.
‖Unable to calculate in 151 cases because of lack of video and adequate documentation.
¶Defined as the time elapsed between out-of-hospital placement and ED removal. Data were available for 299 patients.

Nonphysician data abstractors may have less insight into the details of airway management; however, they also bring less bias than primary investigators, and our 10% quality assurance analysis demonstrated good agreement.

Our search strategy could have missed eligible patients who did not have key words in the electronic notes. This limitation, however, is not likely to have biased the data in a systematic way to exclude patients with worse airway management outcomes. It seems that patients with complications related to placement or removal of the laryngeal tube would be more likely to have key words mentioned in notes. Although we recorded whether vomit was present in the oropharynx, complications such as tracheal aspiration and anoxic brain injury could not be recorded reliably with chart and video review. Even prospective assessment of these variables could be difficult because all patients with out-of-hospital extraglottic devices are at high risk of aspiration[12] and poor neurologic outcome on the basis of the disease process that led to the need for emergency airway management. Therefore, ascribing these events to airway management related to laryngeal tube removal would be difficult; markers such as intubation success and duration[13] are perhaps reasonable surrogates for the likelihood that a complication could be due to ED airway management.

This study examined only the laryngeal tube. Data for ED management after placement of other commonly used extraglottic devices are also lacking. Future research should determine the success of intubation techniques in a wider variety of extraglottic devices. Additionally, the optimal timing of extraglottic device removal in the ED has not been defined and remains an area of future investigation. It is possible that patients would have done equally well if the laryngeal tube had been left in for initial resuscitation and imaging. We did not record whether the patient was receiving chest compressions during the intubation attempt and cannot stratify techniques used or success rate by cardiac arrest status. These results may not generalize to other institutions that infrequently care for patients with laryngeal tubes or do not routinely use neuromuscular-blocking agents during airway management.

DISCUSSION

In this series, we describe ED airway management after EMS placement of an out-of-hospital laryngeal tube. Emergency physicians were successful in converting all cases to tracheal intubation, except for one patient who went to the operating room urgently for other reasons. Most intubations were performed with Macintosh-style video laryngoscopy and a bougie, common ED tools known to improve first-attempt success.[14,15] Because out-of-hospital extraglottic device use is likely to increase,[3,4] these data provide key lessons on the management of patients who arrived at the ED with an extraglottic device in place.

Recommendations for management of extraglottic devices in the ED are based mostly on consensus and

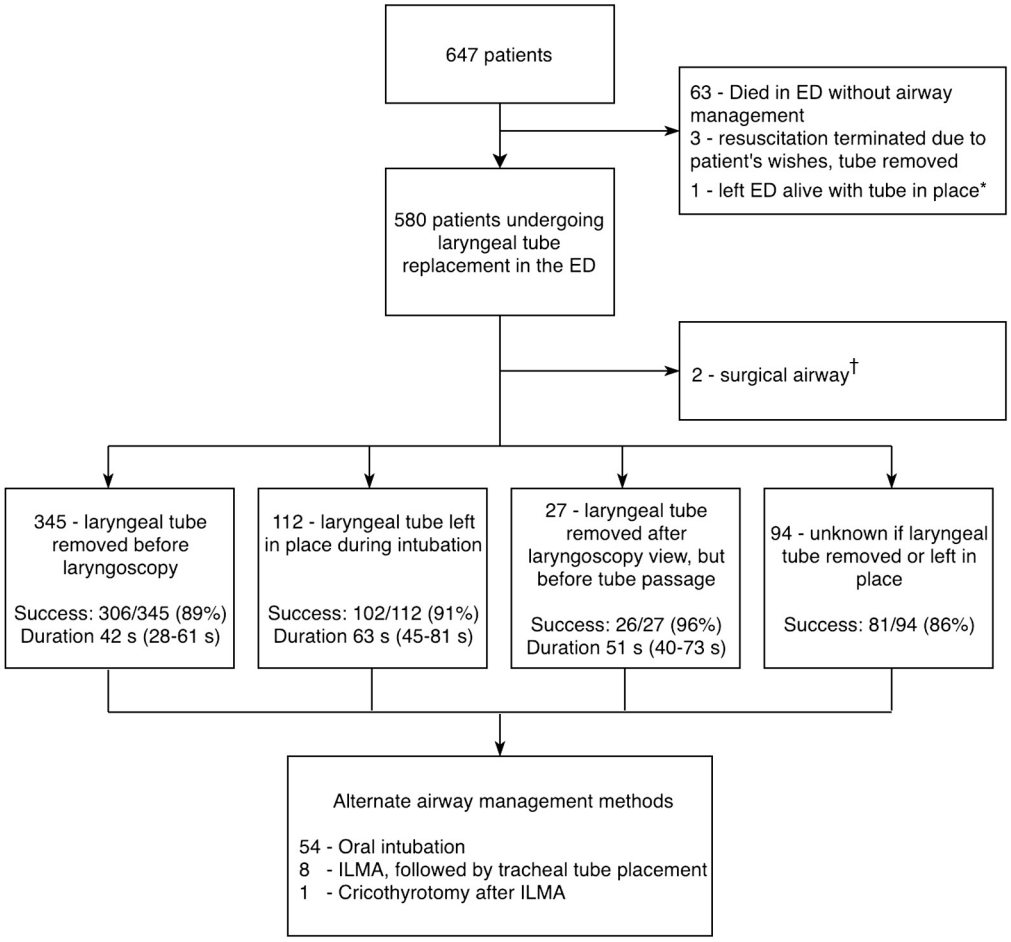

Figure. Airway management of patients arriving at the ED with a laryngeal tube in place, including success and duration (interquartile range) of the first attempts stratified by the technique used to manage the laryngeal tube. The attempt duration is defined as the time elapsed between inserting and removing the laryngoscope blade; this outcome was able to be abstracted for 428 of 578 patients. The bottom box displays methods of airway management after failed first attempts. *The patient was orally intubated by an anesthesiologist in the operating room. †In the first case, the patient had a torso crush injury, causing cardiac arrest. The jaw could not be opened and the tongue appeared swollen. A tracheostomy was completed in the ED. In the second case, the patient had an opioid overdose with prolonged cardiac arrest time. Because of rigidity, the jaw could not be opened and a cricothyrotomy was successfully performed in the ED.

expert opinion.[16,17] To our knowledge, existing data for ED management of out-of-hospital–placed extraglottic devices are limited to 2 small studies from a single tertiary care center (104 patients total, including 65 patients with trauma) that demonstrated surgical airway rates of 29% to 36%.[9,10] In these series, physicians from multiple specialties (eg, anesthesia, otolaryngology, trauma surgery, emergency medicine) performed airway management, often in the operating room. Although surgical airways were common in previous studies, in this cohort the need for a surgical airway was low (<1%). Other reported strategies for this patient population include exchange over a bronchoscope and Aintree catheter or tube exchange catheter,[7,8] which requires special equipment and expertise, or placement of a bougie through the laryngeal tube, which has a low success rate and risk of airway perforation.[18]

Our series identified alternative approaches to laryngeal tube replacement. For example, 60% of patients were managed by removing the laryngeal tube and then performing orotracheal intubation, a technique best suited for those without significant predicted intubation difficulty. Nineteen percent of patients underwent intubation without removal of the laryngeal tube. When this technique is performed,[5,19] a video laryngoscope is inserted into the mouth until the larger hypopharyngeal laryngeal tube cuff is visualized. The cuffs are then deflated, the glottic view is optimized, a bougie is passed, and orotracheal intubation is completed. If at any point the patient becomes hypoxemic or intubation is not possible, the laryngoscope is removed,

Table 2. Intubation process measures.

Intubation Parameter	Value
First-attempt details	N=580
Oxygen saturation at the beginning of the intubation attempt,* median (IQR), %	95 (83–100)
Lowest oxygen saturation during the first attempt,* median (IQR), %	92 (79–99)
Hypoxemia during first intubation attempt,† No. (%)	34/406 (8)
Findings during intubation attempt, No. (%)	
Blood in oropharynx	93 (16)
Vomit in oropharynx	100 (17)
Airway edema	15 (3)
First-attempt failure and subsequent attempts	N=63
Reason for first-attempt failure,‡ No. (%)	
Difficulty visualizing glottic inlet	47 (75)
Unable to pass bougie	16 (25)
Unable to pass tracheal tube	2 (3)
Laryngeal tube in the way	3 (5)
Airway obstruction§	3 (5)
Unable to determine	11 (17)
Total number of intubation attempts, if first attempt failed, median (IQR; range)	2 (2–3; 2–6)
Lowest oxygen saturation during subsequent attempts,‖ if first attempt failed, median (IQR), %	79 (66–92)
Hypoxemia during subsequent attempts,‖ No. (%)	22/49 (45)

This table displays intubation process measures for patients arriving with an out-of-hospital–placed laryngeal tube. Of the 580 patients who underwent advanced airway management, a video was available for review in 434 instances (75%); the remainder underwent chart review only.
*Data were available by video review for 223 patients for the beginning oxygen saturation and 260 patients for the lowest oxygen saturation during the first attempt.
†Data unavailable for 174 patients.
‡Some patients had more than one reason for first-attempt failure.
§Two patients had airway edema; one had a mass as a result of throat cancer.
‖Data not available for 14 patients.

and the laryngeal tube cuffs are reinflated to resume ventilation and oxygenation. This technique may be useful for patients with laryngeal tubes who have predicted intubation difficulty or suspected tongue or glottic edema.

Experts express concerns with select complications of laryngeal tube insertion, including tube kinking, soft tissue injuries, tongue edema, and malpositioning in the piriform sinus or trachea.[20-25] These complications may impair ED airway management. For example, one case report highlighted laryngeal tube removal that was complicated by massive tongue swelling; another case series described tongue edema in 39% of laryngeal tube uses.[20,23] However, in this cohort we observed few of these complications. The dwell time in our series was relatively limited (33 minutes), which may partially explain the results.

EMS practitioners now commonly use primary extraglottic device insertion to prevent interruptions in cardiopulmonary resuscitation chest compressions. With the results of the PART (Pragmatic Airway Resuscitation Trial) and AIRWAYS-2 trials,[3,4] EMS primary use of extraglottic devices may become even more common. Emergency physicians must be prepared for the management of these cases. In this series, emergency physicians exchanged the majority of laryngeal tubes by using Macintosh (standard geometry) video laryngoscopy, often using a bougie, both widely available tools. Although this series provides strong evidence of the high success rate and safety of emergency physician–performed laryngeal tube exchange without specialized equipment, future research should determine whether these results generalize to other clinical settings. Additionally, there are patients (eg, those with massive tongue edema) for whom a fiber-optic or surgical technique, or intubation through a laryngeal mask airway, is the best first approach.

In conclusion, in this cohort emergency physicians successfully exchanged out-of-hospital laryngeal tubes for an endotracheal tube, using commonly available tools. Surgical airways were rarely required. Keeping the laryngeal tube in place during intubation attempts had high success and allows cuff reinflation and resumption of ventilation should intubation fail.

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Author contributions: BED, SKS, DAB, and RFR conceived and designed the study. BED trained and supervised the data abstractors. SKS and GBH performed chart and video review. BED and SKS performed the data analysis. DAB and NSS used out-of-hospital expertise to interpret the data. BED drafted the initial article, and all authors contributed substantially to its revision. BED takes responsibility for the paper as a whole.

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