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Risk factors for unsuccessful prehospital laryngeal tube placement☆

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ABSTRACT

Introduction: Laryngeal tube (LT) airways are commonly used in the prehospital setting, but there are limited data on clinical success rates across emergency medical services (EMS) agencies. We aimed to determine factors associated with unsuccessful LT placement in the prehospital setting.
Methods: We retrospectively reviewed all King LT placement attempts by prehospital providers in 35 ground advanced life support EMS agencies and one air medical critical care service with 17 rotorwing bases, between January 1, 2006 and August 31, 2011. Success of King LT placement and patient, procedural, and agency factors present were identified using descriptive statistics. Factors associated with unsuccessful laryngeal tube placement were identified using multivariable logistic regression.
Results: During the study period, we observed 511 attempts at laryngeal tube placement by paramedics or prehospital nurses in 477 patients. Unsuccessful LT placement occurred in 15.1% of first attempts and 9.9% of cases overall. The majority (79.2%) of first attempts occurred as a rescue airway after unsuccessful endotracheal intubation attempt(s), in patients with non-traumatic complaints (70.9%) and in cardiac arrest (60.8%). Gag reflex (OR 4.08, 95% CI 1.72–9.67), ground (versus air) EMS agency (OR 2.49, 95% CI 1.07–5.79), and male gender (OR 1.90, 95% CI 1.04–3.46) were associated with unsuccessful LT placement in our multivariable model.
Conclusion: The laryngeal tube is an effective airway management tool for both advanced life support and critical care prehospital providers. Gag reflex, ground (versus air) EMS agency, and male gender were associated with unsuccessful laryngeal tube placement by prehospital personnel.

1. Introduction

Performance of airway management is a complex aspect of prehospital care. Orotracheal intubation has long been the standard of practice for prehospital advanced life support providers, but concerns over low success rates and unidentified esophageal intubation have called this practice into question.[1–3] Supraglottic airway devices (SGAs) have received widespread acceptance and use in the in-hospital and prehospital settings, both as a rescue device after unsuccessful orotracheal intubation and as a primary airway device.[4–11] SGAs have been used widely in out-of-hospital cardiac arrest, and also as part of rapid sequence airway placement.[4,9,12–14]

The King Laryngeal Tube (King LT, King Systems, Nobleville, IN) has won broad acceptance in the prehospital setting due to ease of use, including a single inflation port.[4] In contrast to other available SGA devices, the King LT was primarily designed for emergency and prehospital use,[15] and studies of its use in mannequins by Emergency Medical Services (EMS) providers have demonstrated high procedural success rates in these simulated models.[16–19] Similarly, early reports of its use in patients in the operating room identified high airway placement success rates of 86–100%.[20,21] However, subsequent studies of King LT use in the prehospital setting, limited by sample size or LT use as part of a study protocol, revealed wide variability in first attempt success rates of 68–97%.[7–10,22] Additionally, there are no studies characterizing factors associated with unsuccessful laryngeal tube placement.

We aimed to identify factors that were associated with unsuccessful prehospital laryngeal tube placement. We further aimed to describe the first attempt success rate of laryngeal tube airway placement by both ground advanced life support and air critical care EMS agencies using established prehospital airway

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management protocols, and describe the final airway management strategy provided in these cases.

2. Methods

2.1. Study setting and population

We performed a retrospective review of all cases with attempted laryngeal tube placement by paramedics and prehospital nurses in 36 EMS agencies that receive medical oversight from the University of Pittsburgh Medical Center. This included 35 ground Advanced Life Support (ALS) EMS agencies in Southwestern Pennsylvania ("ground"), as well as STAT MedEvac, a multi-state air critical care transport agency with 17 base sites staffed by critical care paramedics and nurses ("air"). All of these agencies use the King LT-D or King LTS-D ("King LT") as the primary supraglottic airway device.

The 35 ground EMS agencies combined perform approximately 160,000 patient transports per year. Only paramedics deployed on advanced life support ambulances perform laryngeal tube placement in this system. Ground ALS ambulances in these agencies are typically staffed with a paramedic and an emergency medical technician, with a prehospital nurse occasionally staffing at the same level as a paramedic. All ground ALS providers in this regional EMS system received hands-on training on the use of the King LT during initial training and yearly competency testing in use of the King LT with a mannequin model. Placement of supraglottic airway devices by basic life support (BLS) providers is not permitted by Pennsylvania statewide protocols, therefore we did not evaluate placement of supraglottic airways by BLS providers.

STAT MedEvac performs approximately 10,000 patient transports per year. This critical care service is typically staffed by a paramedic/nurse team, although nurse/nurse, paramedic/physician, or nurse/physician teams may occur. The majority of transports are performed by medical helicopter, however, a minority of interfacility and scene transports are performed by the critical care team supplementing a BLS or ALS ground ambulance. In these cases, the critical care team provides primary patient management, including airway management. During the time period of this study, STAT MedEvac also staffed a critical care response vehicle, which supplemented BLS or ALS ambulances in the same manner. Training of all critical care providers (paramedics and nurses) is the same regardless of mode of transport and primary certification. These providers are required to perform at least 12 live endotracheal intubations per year and receive simulation training and competency assessments in airway management including King LT placement twice per year.

The King LT was introduced system-wide to STAT MedEvac in 2006 and to the ground EMS agencies in 2007, replacing the CombiTube (Covieden, Mansfield, MA) in both systems. STAT MedEvac had a protocol in place for rapid sequence induction utilizing etomidate preferentially for sedation and succinylcholine preferentially for paralysis during the study period. Ground EMS agencies in this region do not have capabilities for rapid sequence induction or paralysis. All patient care records for these services were documented using a National EMS Information System (NEMSIS)-compliant electronic patient care reporting program that incorporates custom reporting software (emsCharts, Pittsburgh, PA).

2.2. Study design and data collection

This study was approved by the University of Pittsburgh Institutional Review Board (PRO11100135). We retrospectively reviewed all patient care records with documented attempt at supraglottic airway placement from January 1, 2006 to August 31, 2011. Cases were identified using the custom reporting software in emsCharts. This program was used to collect demographic information, including patient age, gender, and weight. Patient care records were then reviewed individually by one of two investigators (HAP, SCR) and data were abstracted using a standard electronic spreadsheet. Standard definitions of the variables were written into the electronic spreadsheet. Chart reviewers (HAP, SCR) were trained similarly by the principal investigator (CMG), including joint review of cases as part of initial training to minimize variability in data collection. The principal investigator then confirmed data abstraction through review of at least 10% of each reviewer's charts. To further avoid reviewer bias in between-agencies comparisons, both chart reviewers collected data from air and ground EMS agencies by time period.

We identified success or failure of laryngeal tube placement, number of attempts, whether the medical category involved traumatic injury, whether the patient was in cardiac arrest during the attempt, and the certification level of the provider performing the procedure. We also identified procedural information for the first SGA attempt, including location of the attempt (scene, ambulance, helicopter, or hospital), predisposing factors at time of the advanced airway attempt, and number of preceding unsuccessful endotracheal intubation attempts, thus identifying primary versus rescue airway cases (Table 1).

Predisposing factors were based on the EMS provider's documentation of patient characteristics prior to the intubation attempt, either in a narrative text field of the activity log or as part of a standard airway procedure entry. The airway procedure entry within the emsCharts software prompts the provider to identify factors complicating the airway attempt. The factors analyzed were cervical spine precautions (documentation of cervical collar or manual stabilization prior to airway attempt), facial/oral trauma (documented in history of present illness or assessment sections), clenched jaw/trismus or gag reflex (documented prior to placement or as characteristics complicating the airway attempt), intravenous access or paralytic use (documented placement or use prior to airway attempt), and vomiting (documented occurrence prior to airway attempt, but not counted if only occurring as a result of the airway attempt).

2.3. Primary outcome

We defined the primary outcome, unsuccessful laryngeal tube placement, through two mechanisms. First, the charting system has a required documentation field (successful or unsuccessful) in the procedural record. Second, we performed individual review of the entire record by one of the investigators, which included review of post-procedure pulse oximetry and end-tidal carbon dioxide measurements (when available) as measures of adequate oxygenation and ventilation. For example, cases in which the laryngeal tube was immediately removed or otherwise identified as providing inadequate oxygenation or ventilation were counted as an unsuccessful placement, regardless of whether the procedure was otherwise documented as successful.

2.4. Statistical analysis

Patient, provider and airway characteristics are reported using descriptive statistics. We first performed univariable analyses of all demographic and clinical factors potentially related to unsuccessful laryngeal tube placement during the first attempt. Variables were selected based on consensus of the study investigators.

We then performed multivariable logistic regression to identify demographic, clinical, and provider factors associated with unsuccessful laryngeal tube placement in the first attempt. In building the