Air Medical Journal 35 (2016) 132–137

Contents lists available at ScienceDirect

Air Medical Journal

journal homepage: http://www.airmedicaljournal.com/

Original Research

Intubation Performance of Advanced Airway Devices in a Helicopter Emergency Medical Service Setting

John W. Hafner, MD, MPH, FACEP [1, 2, *], Blake W. Perkins, MD [3], Joshua D. Korosac, DO [4], Alayna K. Bucher, MD [1], Jean C. Aldag, RN, PhD [1], Kelly L. Cox, MD, FACEP [5, 6]

[1] University of Illinois College of Medicine at Peoria, Peoria, IL, USA
[2] Department of Emergency Medicine, OSF Saint Francis Medical Center, Peoria, IL, USA
[3] Department of Anesthesiology, University of Chicago, Chicago, IL, USA
[4] Department of Emergency Medicine, Mercy Clinic, Springfield, MO, USA
[5] Department of Obstetrics and Gynecology, University of Pittsburgh Medical Center, Pittsburgh, PA
[6] Air Evac Lifeteam, Air-Evac, Inc, O'Fallon, MO, USA

A B S T R A C T

Objective: This study attempts to determine if newer indirect laryngoscopes or intubating devices are superior to a standard laryngoscope for intubation success among helicopter emergency medical service (HEMS) personnel.

Methods: Flight nurses and paramedics intubated standardized mannequins with a normal airway, a trauma airway, and a difficult airway using a standard laryngoscope, a gum elastic bougie, the Airtraq laryngoscope (King System Corp, Noblesville, IN), the Glidescope Ranger laryngoscope (Verathon Inc, Bothell, WA), and the S.A.L.T. device (Microtek Medical, Inc, Lehmberg, IN) in grounded helicopters wearing helmets and flight gear. Participant demographics, time to glottic view, the modified Cormack-Lehane score, total intubation time, number of attempts, and overall successful intubation were recorded for each type of airway.

Results: Two-hundred thirty-six subjects were initially enrolled across 107 bases in 15 states, and 177 completed the study. First-attempt success rates did not vary by device for the normal airway ($P = .203$), but the Airtraq laryngoscope and the S.A.L.T. device were highest in the difficult airway (82.0% and 85.0%, respectively; $P < .0001$). The time to first-attempt success in the difficult airway was lowest for the S.A.L.T. device and the Airtraq laryngoscope (mean = 9.72 seconds and 19.70 seconds, respectively; $P < .0001$).

Conclusion: Using HEMS providers, the Airtraq laryngoscope and the S.A.L.T. device showed the fastest and highest intubation success on the first attempt in difficult simulated HEMS airway scenarios.

In emergency medical service (EMS) settings, failed prehospital intubations (PHIs) are common, occurring in upwards of 31% of attempts.[1] Studies have shown that failed PHIs may be associated with increased morbidity and mortality when compared with traditional bag mask ventilation.[1-4] Some risk factors identified to be associated with PHI failure have been the type of equipment used for intubation, the education of the person intubating, the position of the patient, oropharyngeal trauma, the view of the glottis, and patient obesity.[1,5] These contributing factors associated with difficult or failed intubations are compounded when the person is being transported by helicopter EMS (HEMS) crews. Despite the ability for HEMS to provide rapid transfer of patients to trauma centers, the environment of a helicopter does not provide ideal intubating conditions because of the lack of space, the inability to auscultate breath sounds,[6] helicopter movement, and long transport distances.

Traditional direct endotracheal intubation using a Macintosh laryngoscope requires that the oral, pharyngeal, and laryngeal axes align for direct visualization of the vocal cords with the naked eye to facilitate endotracheal tube (ETT) insertion.[5] Despite the usefulness of the standard direct laryngoscope, visualization of the vocal cords can still be difficult in some patients, particularly those who are morbidly obese or have their cervical spine immobilized by cervical collars. Newer airway technologies are now available that

Presented as a poster at the 2012 American College of Emergency Physicians Scientific Assembly Research Forum Denver, CO, October 8-11, 2012.

* Address for correspondence: *John W. Hafner, MD, MPH, FACEP, Department of Emergency Medicine, OSF Saint Francis Medical Center, 530 NE Glen Oak Avenue, Peoria, IL 61637.*

E-mail address: jhafner@uic.edu (J.W. Hafner).

1067-991X/$36.00

http://dx.doi.org/10.1016/j.amj.2015.12.016

allow for indirect visualization of the vocal cords by using fiberoptic video cameras such as the Glidescope (Verathon Inc, Bothell, WA) and mirror systems such as the Airtraq (Prodol Meditec SA, Vizcaya, SpainProdol Meditec SA, Vizcaya, Spain). Additionally, there are other products available such as the gum elastic bougie and the Supraglottic Airway Laryngopharyngeal Tube (S.A.L.T.; Microtek Medical, Inc, Lehmberg, IN) that do not require any visualization of the cords and can be placed blindly into the airway to facilitate placement of an endotracheal tube. These newer devices are now the preferred intubation technique in some hospital settings[7] and may become the gold standard in the future.

The performances of several of the newer intubating techniques (Glidescope and Airtraq) have been studied using mannequins with increased rates of successful intubation over traditional direct laryngoscopy intubation.[5,8] However, the newer, more advanced laryngoscopes are significantly more expensive than the traditional Macintosh laryngoscope and take up additional space that could be occupied by other resources. Few studies have examined the performance of these newer technologies in HEMS settings, and indirect laryngoscopes have shown variable results in simulated difficult airways.[5] The objective of this study was to determine if these newer indirect laryngoscopes (Airtraq laryngoscope and Glidescope Ranger laryngoscope) or intubating devices (S.A.L.T. and gum elastic bougie) are superior to a standard direct laryngoscope for first-attempt intubation success in a standard, trauma, and difficult airway model among HEMS personnel.

Methods

Study Design

This study was a prospective, multisite, randomized, crossover trial of simulated normal, trauma, and difficult airway intubations using several laryngoscopes and airway devices (Macintosh laryngoscope, Airtraq laryngoscope, Glidescope Ranger laryngoscope, and S.A.L.T. device). Participants were flight nurses and paramedics from a large national HEMS agency (Air Evac Lifeteam, O'Fallon, Missouri). The Peoria Community institutional review board approved this study before initiation.

Study Participants

Air Evac Lifeteam operates as an independent, for-profit corporation using > 110 helicopters (all Bell 206 Long Ranger helicopters) flown from 95 air medical bases in 14 states. Air Evac Lifeteam services over 1,000 hospitals and 700 EMS agencies with interfacility transfers and on-scene flights. Airway training and management protocols are standardized among all bases and flight personnel. Study participants were flight nurses or paramedics employed by Air Evac Lifeteam self-selected to participate in the study. Recruitment occurred at their respective Air Evac Lifeteam EMS bases, and informed consent was obtained.

Study Protocol

Participants underwent a standardized video didactic lecture and hands-on training session for the Airtraq laryngoscope, Glidescope Ranger laryngoscope, and S.A.L.T. device before experimentation. Participants were allowed a single intubation attempt with each device on a simulated normal airway mannequin. The supervising investigator provided feedback and answered any questions participants may have had regarding protocol, individual device usage, and mannequin simulation.

The 5 intubating devices compared for the study were the traditional Macintosh direct laryngoscope with a size 3 metal blade and flexible ETT stylet, the Glidescope Ranger video laryngoscope using an adult large blade (GVL 4) and rigid stylet, the Airtraq laryngoscope (Prodol Meditec SA, Vizcaya, Spain) size 2 (ETT 6.0-7.5), the S.A.L.T. device, and the gum elastic bougie preloaded with a 7.0 ETT used as an airway adjunct with a traditional Macintosh direct laryngoscope with a size 3 metal blade. All indirect laryngoscopes were used according to the manufacturers' instructions. The Airtraq was used as a traditional optical laryngoscope with no external video screen attached and preloaded with a lubricated ETT secured in the lateral guide groove on the device. The S.A.L.T. device was used in a blind technique in which the device was inserted much like a laryngeal mask airway. After the S.A.L.T. device was placed into the oropharynx, a prelubricated ETT was advanced along the natural curvature of the device and through the glottis. All intubations were performed using a size 7.0 cuffed tracheal tube (ETT).

Participants were excluded from participating or analysis if they failed to obtain informed written consent, received only partial completion of the study didactic training session, failed to complete all device testing on simulated airway scenarios, or desired to terminate participation in the study at any point. Prior use of the Airtraq device, Glidescope Ranger, S.A.L.T. device, or gum elastic bougie was not included as exclusion criteria. After completion of the training session, participants were assigned a participant number and randomized into 5 categories according to which device and simulated airway they were to be tested on first, proceeding in a random rotation from station to station with each station having a different airway device.

Each participant then performed an intubation attempt with each of the 5 devices being compared on the Laerdal Airway Management Trainer (Laerdal Medical Inc, Wappingers Falls, NY) in 3 simulated clinical scenarios: 1) standard normal airway, 2) trauma airway (a rigid cervical collar and a spine board were applied to the mannequin), and 3) difficult airway (a rigid cervical collar and a spine board were applied to the mannequin, and the tongue was inflated using the provided inflation bulb for 3 full compressions). The intubation order of the devices was randomized for each participant. All simulated airway scenarios occurred in grounded helicopters with participants in full flight gear including helmets to simulate space constraints and environmental conditions seen in the HEMS setting. Participants were allowed up to 3 attempts per device on each simulated airway mannequin scenario. All intubation attempts were confirmed by investigators regardless of the participants' confidence in the placement of the tracheal tube. ETT tube placement was confirmed using visual inspection of the airway through a removable tracheal flap on the mannequin.

Variables and Measurement

The primary study outcome measures were 1) device first-attempt intubation success rate, 2) device time to first-attempt intubation success, and 3) device failed intubation proportion. Time to intubation was measured from when the participant introduced the device into the oral cavity of the simulated airway mannequin until the participant verbalized the tip of the tracheal tube had passed through the vocal cords (in the case of the S.A.L.T. device and the gum elastic bougie when participants felt they had successfully completed intubation). If a device was removed from the oral cavity for any reason and then readvanced, the total elapsed time from the initial entry of the device was not reset, and the time to intubation was measured until the participant verbalized passage through cords. An intubation attempt was defined as a 1) withdrawal of the device from the mouth followed by repositioning after the first insertion of the device for any reason, 2) the total elapsed time from the entry of the device into the mouth was > 1 minute without successful intubation or the participant verbalizing placement of the ETT, or 3) the participant verbalized placement of the ETT through the glottis. A failed intubation attempt was defined as a failure to intubate in < 1 minute or any esophageal intubation. A failed airway was defined as failure to