

**Resident Journal Review**

**An Update on Airway Management in Emergency Medicine**

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There are few clinical skills as important to the emergency physician as emergency airway management. The field of airway management is constantly changing, and the practicing physician must keep abreast of the current trends in laryngoscopy, medication management, prehospital intubation, and the potential complications of intubation. Reviewed here are some of the key airway-related articles published over the past two years.

**Direct Laryngoscopy Compared to Video Laryngoscopy**


While most of the studies comparing direct laryngoscopy (DL) and GlideScope® video laryngoscopy (GVL) generally show GVL to be faster with higher success rates, the research settings are operating rooms and simulation labs. Platts-Mills et al. published the first ever study comparing DL and GVL success rates in the emergency department (ED) and found no significant difference between the two, supporting GVL as an alternative to DL. Two studies out of the University of Arizona support GVL as not only an alternative, but as a potentially superior intubation technique.

In the earlier-published study, Sakles et al. performed a retrospective observational study using prospectively collected data including all patients intubated in a tertiary care university ED over a 24-month period, in which either DL or GVL was the initial device used. For every intubation, physicians completed a form that documented initial device, success rate, operator experience, airway characteristics, complications, reasons for failure, and performance characteristics of GVL, if applicable. Primary outcome was successful intubation on first attempt, an "attempt" being defined as insertion of the laryngoscope blade into the patient's mouth, whether or not passage of an endotracheal (ET) tube was attempted.

The authors found that GVL had a higher first-attempt success rate than DL (75% versus 68%, p=0.03), and higher overall success rates in airways with two or more difficult airway predictors (70% versus 56%, p listed as 0.00). Failed DL intubations were reportedly due mainly to inability to visualize the airway, while failed GVL intubations were generally due to inability to direct the ET tube into the visualized airway. Interestingly, DL had a higher overall success rate in intubations requiring more than one attempt with the initial device (57% versus 38%, p=0.003). The authors hypothesized this finding may be related to the previously mentioned reasons for device failure. Repositioning, blade adjustment, and other maneuvers can improve cord visualization in DL, but there are few maneuvers the operator can utilize to improve ET tube passage through the cords if this is the reason for failure. Also, as most physicians are generally more comfortable with DL, it was hypothesized that they tend to make multiple attempts before abandoning DL, while GVL is more quickly abandoned for another device.

With regards to study limitations, the authors report that they may have a lower DL success rate than in the Platts-Mills study due to the "many rescue devices available" at their institution. Other limitations include lack of randomization, no determination of data form inter-rater reliability, and inclusion of self-report bias, as the data forms were completed by each provider after the intubations were performed.

In the later study, the same researchers compare DL and GVL success in patients with difficult airways emergently intubated in the ED. They used the exact same patient population as their first study, and the study parameters were virtually identical: a retrospective review of prospectively collected data over a period of 23 months. A data form was completed by every physician post-intubation, documenting the indication for intubation, device used, presence of difficult airway predictors (DAPs), Cormack-Lehane view, complications, and GVL performance characteristics, if applicable. The same definition of attempt was used, and the primary outcome was successful tracheal intubation on first attempt.

The authors found that in patients with DAPs present, GVL had a higher first-attempt success rate than DL (78% versus 68%, p=0.007), but their success rates were similar for rescue attempts. Looking at success of GVL over DL, the odds ratio (OR) for success in overall first-attempts was 2.26 (95% CI 1.62-3.15), with three or more anatomic DAPs, the OR was 2.72 (CI 1.73-4.29) for first attempts and 1.84 (CI 1.04-3.26) for rescue attempts. The authors noted that patients with GVL selected as the initial device had more predicted DAPs than those with DL selected as the initial device. They also found that certain DAPs (i.e., the presence of blood, a small mandible, obesity, and a large tongue) were independent predictors of intubation failure in DL as compared to GVL.

The limitations of this study are largely the same as in the authors' prior study: inclusion of possible self-report bias, uncertain inter-rater reliability with regards to patient DAPs or intubation characteristics, and the consideration that the Cormack-Lehane grading was created for assessment of patients prior to DL, but not video laryngoscopy.

These two studies are born from the same patient airway database. Their results indicate that GVL is superior at visualization, especially in patients with multiple DAPs (2+ in the first study, 3+ in the second) which often translates to superior intubation success, but not always. It is important to note that DL still has its role in both first-attempt and rescue attempts, and troubleshooting is much easier with DL than GVL.
While not without limitations, these studies certainly provide data that indicate the superiority of GVL in certain settings, especially in patients with difficult airways, and set the stage for further research.

Fiberoptic Laryngoscopy Compared to Video Laryngoscopy


When it comes to intubating critically ill patients, emergency physicians are generally well-versed in standard and rescue techniques required for the intubation of a supine positioned patient. However, there are certain conditions that make supine positioning less ideal due the increased likelihood of rapid desaturation such as acute heart failure, angioedema, advanced pregnancy, and morbid obesity. Traditionally, upright awake intubations utilized flexible fiberoptic techniques which come with their own set of difficulties. Therefore, this study examined the possibly of utilizing the GlideScope® laryngoscope for this clinical problem, via the “tomahawk” position.

This was a prospective, randomized, crossover study in twenty-three awake volunteers, given local anesthesia followed by a face to face approach to laryngoscopy. The investigators compared the use of a GlideScope® video laryngoscopy via the blade held upside down “tomahawk” position versus flexible fiberoptic laryngoscopy. Exclusion criteria included age less than 18 years old, pregnancy, hypertension, heart disease, liver disease, epilepsy, diabetes, history of epistaxis, nasal problems, current infectious disease, an allergy to drugs used during the procedure or previous adverse reaction to the topical anesthesia.

The primary end point of this study was time to a Cormack-Lehane grade II or better view based on the operator’s report.

The study included 10 women and 13 men. A grade II or better Cormack-Lehane view was reported 95.6% of the time when the GlideScope® was used and 100% of the time when flexible fiberoptic laryngoscopy was used. The study was powered to assess for a 40-second difference between the approaches. On one volunteer, the best obtainable view was a grade III, and after three attempts the effort was terminated due to gagging. The median time to highest grade view for the GlideScope® video laryngoscopy was 16 seconds versus 51 seconds for the flexible fiberoptic approach. On average, the GlideScope® video laryngoscopy was 39 seconds faster than flexible fiberoptic laryngoscopy (p=0.049).

There are smaller studies looking at awake GlideScope® intubations; however, these were done in the supine position. This study is the first to look at its use in the upright patient in the face to face position. Although, this study does not necessarily demonstrate superiority of either approach, it does provide initial data to suggest this may be a viable option when flexible fiberoptic laryngoscopy is not available.

Choice of Paralytic Agent in Rapid Sequence Intubation


This study examines the effect of dose and type of paralytic agent used on first-attempt intubation success in the ED. This was a retrospective evaluation of information collected prospectively in a quality improvement database between July 1, 2007, and October 31, 2008, at an academic, tertiary care ED with a 3-year residency program. The database recorded all patients that were intubated in the ED with the physician having full access to a RSI (rapid sequence intubation) medication box that contained etomidate for induction and succinylcholine or rocuronium for paralysis. The physician did have other paralytics available, and choice was based on physician preference. Patients were excluded from the study if they did not receive RSI, did not receive etomidate for induction or succinylcholine or rocuronium for paralysis, if they were less than 18 years of age, or had any missing documentation in the database or medical record. An intubation attempt was defined as the laryngoscope being introduced into the mouth, regardless of whether the endotracheal tube was inserted or not.

A total of 327 patients were included in the final analysis. Of these 327 patients, 113 (35%) patients received succinylcholine and 214 (65%) patients received rocuronium. For succinylcholine and rocuronium, the first-attempt intubation percentages were similar, 72.6% versus 72.9% respectively, with a non-significant p-value of 1.0. The median number of attempts were also similar for succinylcholine and rocuronium (p=0.87). The median dose used for succinylcholine was 1.65mg/kg (IQR=1.26-1.95mg/kg) and for rocuronium was 1.19mg/kg (IQR=1-1.45mg/kg).

The authors found that there was no difference between succinylcholine and rocuronium in first-attempt intubation success. It is important to note that the median dose of rocuronium used in this study was higher than what was previously reported in prior literature (1.19mg/kg versus 0.9 – 1.2mg/kg in previous studies). There was an increased use of rocuronium in this study which the authors attributed to current practice at the institution.

The study included no information on complications or drug related adverse effects, information on the type of laryngoscope blade used, and no information was available regarding the time between drug administration and intubation attempt. Due to these limitations, possible unmeasured confounders may have led to the equality in success noted with rocuronium and succinylcholine. Despite these limitations, rocuronium, when dosed appropriately, appears to create a similar intubation experience to succinylcholine, in contrast to what earlier studies have found.
Prehospital Considerations in Airway Management


Management of the post cardiac arrest patient can be very challenging, and appropriate airway management is a critical component of their care. Unfortunately, there is little literature to guide when advanced airway techniques should be used in place of basic bag-mask ventilation (BVM), or in the setting of prolonged resuscitation or transport when BVM should be transitioned to advanced airway ventilation (AAV). There are significant advantages and disadvantages to both methods. Per the American Heart Association (AHA) 2010 statement, what is clear is that if an advanced airway is chosen, it must be performed by an experienced provider, and placed, ideally, in less than 10 seconds if placed during cardiopulmonary resuscitation (CPR). When this is not the case, unacceptably long pauses in compressions, airway trauma, hypoxemia from prolonged intubation attempts, and failure to recognize tube misplacement or displacement occur at unacceptably high rates. On the other hand, when quickly and successfully placed, AAV decreases the risks of aspiration and gastric inflation, may provide an additional route for medications, and allows for direct airway suctioning. The study by Nagao et al. addresses many of these questions.

This was a retrospective observational study done through a database review of Tokyo’s Fire/EMS department. This study included 355 cardiac arrest patients from 2006-2007 with 156 receiving BVM and 199 receiving AAV. The transport time exceeded 30 minutes in both groups. The primary endpoint was survival to hospital discharge and favorable neurological status, with secondary outcomes being the rate of return of spontaneous circulation (ROSC) and rate of admission to the intensive care unit (ICU). The rate of admission to the ICU and ROSC were both higher in the advanced airway group (AAV) with p=0.035 and p=0.009, respectively. There were no significant differences found between the two groups when comparing the rate of prehospital ROSC or favorable neurologic outcome. Patients were excluded if they were given epinephrine during the resuscitation, were less than 18 years old, or deemed to have suffered a non-cardiac etiology of arrest. Patients were not excluded if they underwent therapeutic hypothermia or percutaneous coronary intervention.

There are a few important points to this study that need to be highlighted, to better interpret these results. First, all patients per protocol received two minutes of CPR and BVM prior to the decision being made to place an advanced airway. AAV was left to the discretion of the EMT’s, who were then granted approval via an on-call physician. Advanced airways in this study included laryngeal masks, esophageal-tracheal combitubes, and endotracheal tubes. Of the 199 AAV patients, endotracheal tube was chosen for just 10 patients, laryngeal mask for 147, and esophageal-tracheal combitube for 42. ROSC was obtained in 37 AAV patients, and of those, just one had an endotracheal tube placed. Although not statistically significant, there was a trend toward witnessed arrest in the AAV group compared with the BVM group (37.7% versus 28.8%, p=0.09). Similarly, bystander CPR was initiated in 13.5% of the BVM group and 20.1% of the AAV group. Overall, ROSC and ICU admission was associated with the use of an AAV as well as a witnessed cardiac arrest. There was no difference in primary outcomes between the two groups.

Though the primary outcomes showed no difference based upon prehospital airway management in this study, there are some limitations to keep in mind. Only 10 patients in the AAV group were ventilated via endotracheal tube placement as the others received other supraglottic devices. The benefit of survival in this subgroup is not clear. A limitation to the random group assignment was that there was a trend toward more patients with witnessed arrests and patients receiving bystander CPR in the AAV; these groups of patients have been shown in previous studies to have more favorable outcomes. Patients who received epinephrine in the field were excluded from the study. This was done because only certain EMT providers in Japan were able to administer epinephrine, and excluding these patients eliminated a possible confounder for ROSC. Since epinephrine administration represents the standard-of-care for cardiac arrest, and no patients who received epinephrine were included in the study, the results must be interpreted with this limitation in mind. Finally, there was no difference in primary end points, which suggests that although AAV may allow for survival to the ICU it does not benefit overall outcome. At this point, additional research is required to determine the timing and role of AAV in the post cardiac arrest patient undergoing prolonged transport.


This study examines the role of video laryngoscopy (VL) in prehospital medicine. This study examines the role of two particular devices in a simulated difficult airway mannequin. The GlideScope® Ranger utilizes...
a laryngoscope that is placed midline in the patient's oropharynx to visualize the vocal cords. A proprietary rigid stylet is used to pass an ET tube through the angle of the glottis through the cords. The Venner® A.P Advance acts like a laryngoscope with a difficult airway blade and utilizes tongue manipulation to gain appropriate video-based visualization of the vocal cords. A laterally placed channel on the blade precludes the need for a stylet, acting as a guided track for ET tube delivery.

Thirty paramedics were studied in convenience fashion after a short demonstration. None had any experience with VL, and median prior experience was 60 lifetime intubations (range 20–300). The participants initially attempted intubation via direct laryngoscopy. Subsequently, participants were randomly assigned to start with one of the two airway devices and instructed to intubate a modified Grade III (Cormick-Lehane classification) mannequin with both the GlideScope® and Venner® devices. Primary outcome measures were time to secure tracheal intubation and an assessment of objective and subjective measures of airway trauma.

Time to tracheal intubation was shorter for both VL techniques when compared to DL. When compared head to head, the Venner® APA was faster than the GlideScope® in time to intubate (mean 25 versus 46 seconds, p<0.0001). Based upon assessment of discrete forward movements of the ET tube during intubation, the Venner® APA had less potential for airway trauma than the GlideScope®. A total of 83% of Venner® APA attempts had successful tube delivery on the initial pass, while 30% of GlideScope® attempts had similar first pass success (p<0.0001). After all intubation attempts, each study participant rated the force of laryngoscopy on a 10cm visual analog score. The Venner® APA was rated as less forceful than the GlideScope® or DL (1.6 versus 3.3, p<0.001).

This mannequin-based study adds to previous literature regarding shorter times to intubation with VL as compared to DL. This study also suggests that there are differences between specific VL devices, and track-based laryngoscopes may result in faster intubations with less trauma than rigid-stylet based devices. This study is limited by its mannequin-based design, as it is unclear how these results would perform in clinical practice. Although time to intubation may be a good surrogate measure of efficient laryngoscopy, it does not inform us whether patients’ outcomes would be any different due to a 21-second difference in tube delivery. One of the investigators is a co-inventor and patent holder of the Venner® device (Venner Medical).

Considerations in Tube Delivery


The Gum Elastic Bougie (bougie) has been used for years, but lately has gained more and more popularity and use as a rescue airway device in blind and semi-blind intubations. These authors designed a prospective, observational study to evaluate the rate of success of the bougie in intubations and to identify the most common causes of difficulty when using the bougie. All participants received a short training course on bougie use prior to study participation. In any intubation where the bougie was used, the practitioner involved completed a form detailing their level of training, past experience with the bougie, grade of laryngeal view, and features of the bougie insertion, including reason for failure, if applicable. They also examined the percentage of bougie failure, defined as failure by first practitioner, and overall success, defined as successful intubation regardless of the number of attempts.

In a cohort of 88 patients, the bougie failure rate was 28.4%. The overall success rate was 79.6%. The most common cause of bougie failure was inability to insert the device past the hypopharynx in 53% of the failures, followed by inability to pass the ET tube over the bougie in 24% of failures, and esophageal intubation in 16% of failures. Of the 25 cases of initial bougie failure, seven were subsequently intubated using the device, yielding an overall success rate of 79.6%. Of the 18 full bougie failures, 14 were subsequently intubated by a more experienced emergency physician using DL. The authors also noted that practitioners less-experienced with the bougie accounted for a disproportionate amount of bougie failures — those operators with a history of three or fewer prior bougie uses constituted 55% of the participants but accounted for 64% of the GEB failures.

The authors note several limitations of their study, including a small cohort, the use of trainees and inexperienced physicians, and inability to know whether improper technique was the case of the failure. The bougie is a useful airway device, but its success in emergency situations is not 100%. Inability to pass the hypopharynx and inability to pass the ET tube are two common points of failure.


The use of video laryngoscopy has become increasingly common in the ED, especially in the predicted-difficult airway. Due to the angle of many video laryngoscopes, companies that produce these products often also produce a rigid stylet to be used in conjunction with their laryngoscope. This study sought to determine whether these rigid, specifically-designed stylets performed superiorly when compared to a standard malleable stylet (SMS).

In this retrospective study, the authors used a continuous quality improvement database to examine all intubations in their ED using a GlideScope® video laryngoscope, specifically looking to determine whether use of a SMS or a GlideRite rigid stylet (GRS) was superior. First-attempt success and overall success rates were the primary outcomes measured. The authors compared the two stylets with regard to the incidence of complications, which included oxygen desaturation, aspiration, and airway trauma. The two groups were similar, as the percentage of patients in each group with Grade I or II views and the number of pre-defined DAPs (e.g., c-collar, facial trauma, blood or vomit in airway, obesity, short neck, small mandible, large tongue, and airway edema) were similar between the SMS and GRS groups.

Data for 473 patients was evaluated. In the 322 patients intubated using GRS, the first-pass and ultimate success rates were 82.9% and
93.5%, respectively. The success rates in the GRS group were found to be significantly higher than the SMS group which had first-pass and ultimate success rates of 67.5% and 78.1% (p<0.001). Furthermore, the mean complication rate in the GRS group was 25%, significantly lower than the 47% found in the SMS group (p=0.003). The authors report that this was mostly due to higher rates of desaturation in the SMS group (18% versus 31%, p=0.0028).

The limitations of this study include self-report bias; all the data was extracted by a single author. When using video laryngoscopy, it appears that using a rigid stylet specifically designed for use with the video laryngoscope provides significantly higher rates of success and lower rates of complications when compared to the use of a SMS.

Ultrasound in Emergent Airway Assessment


Predicting the difficult airway in the emergency setting is challenging. Traditional teaching focuses on features of the clinical history, and the head and neck exam to identify DAPs. To date, the use of ultrasound in emergency intubation has focused on confirmation of successful tube placement.1 The authors of this study examined whether focused ultrasound can identify difficult airways, and set out to compare ultrasound measurements of anatomic structures to traditional screening tools such as the Mallampati score, thyromental distance, and interincisor gap.

This is a prospective observational study of patients undergoing elective surgical procedures. Study team members collected demographic information and performed difficult airway screening tests prior to elective intubations. Ultrasound was used to measure tongue thickness and neck soft tissue thickness at predefined locations. Comack-Lehane classification of the laryngoscopic view was recorded by anesthesiologists who were blinded to the predicted airway assessment.

Fifty-one eligible patients were included in the study, and six patients were found by anesthesiologists to have a difficult airway. The sonographic measurement of anterior neck soft tissue thickness was greater in patients with difficult airways at both measured locations. At the level of the hyoid bone difficult airways had significantly increased thickness (1.69, 95% CI = 1.19 to 2.19) compared with easy laryngoscopy (1.37, 95% CI = 1.27 to 1.46). A similar increased thickness at the thyrohyoid membrane was found in difficult (3.47, 95% CI = 2.88 to 4.07) compared with easy airways (2.37, 95% CI = 2.29 to 2.44). There was no significant correlation found between sonographic measurements and clinical screening tests.

Bedside ultrasound measurements may prove to be helpful in assessment of the difficult airway. This pilot study was conducted in patients undergoing elective surgical procedures, which gives the study poor external validity. There is time pressure in the emergency setting which may influence the ability to measure neck soft tissues and may contribute to inaccurate measurement of these structures. If validated in the emergency setting, ultrasound could be used as an adjunct to or in lieu of other clinical predictors of difficult airways.

Take Home Points:

• Video laryngoscopy may be helpful in difficult airway scenarios, but direct laryngoscopy is still useful, especially in rescue attempts.
• There is no difference between succinylcholine and rocuronium in first-attempt intubation success when appropriate doses are used.
• Track-based or channel-based video laryngoscopes may provide faster intubation times with less trauma than video laryngoscopes utilizing rigid stylet-guided intubation.
• When using video laryngoscopy, greater success is achieved when using the appropriate stylet.
• Future studies may help identify whether soft tissue measurements of the neck with ultrasound may predict difficult emergency intubations.

Additional References: