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The Airway Lead and the Creation of a Comprehensive Emergency Airway Quality Program

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☐ **Abstract—Background: Emergency Department (ED) Intubation is one of the most critical times during a patient's hospital course. Ideal performance requires training, equipment, and mindset to overcome the barriers of anatomy, physiology, and human factors. Objectives: We believe that EDs should use the same model of quality improvement and leadership for intubation as other critical procedures such as ED ultrasound. Discussion: This paper delineates one program's creation of a comprehensive airway quality improvement (QI) program and will hopefully serve as a roadmap for other centers. Conclusions: The creation of an airway QI program headed by a designated airway lead has the potential to improve patient care and procedural success in the ED. © 2024 Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.**

☐ **Keywords—Laryngoscopy; airway; resuscitation; critical care; quality improvement**

Introduction

Emergency Department (ED) Intubation is one of the most critical times during a patient's hospital course. Almost one in 3 critically ill patients intubated in the ED or Intensive Care Unit (ICU) experience a peri–intubation major adverse event (1). Ideal performance of intubation requires proper training, equipment, and mindset to overcome the barriers of anatomy, physiology, and human factors. Unless attention is devoted to continuous quality improvement of ED airway management, it is easy to fall into complacency and to blame failures on patient factors rather than systemic issues. Conversely, it is possible to perform well above national benchmarks when efforts towards quality improvement are implemented and sustained.

Published studies have shown only mediocre systemic airway performance when specific effort to optimize performance is not present. One large, international study of critically ill patient intubations showed a 79.8% first pass success (FPS) rate (2). Another meta-analysis evaluating >40,000 intubations showed FPS in the ED at 84.1% (3). This is in contradistinction to high-performance organizations that have prioritized airway quality yielding FPS rates in the high 90′s (4–6).

Other centers have studied a set of interventions for Airway Quality Improvement. Groombridge et al.

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achieved a FPS rate of 94.6% with a bundle of airway data collection, monthly airway audits, and the use of a rapid sequence intubation (RSI) checklist (6). Fogg et al. demonstrated that a bundle of staff training, equipment and practice standardization resulted in a significant increase in FPS (7). Louka et al. showed a dramatic improvement in FPS after making video laryngoscopy mandatory in a prehospital airway program (8). After the implementation of a bundle comprising mandatory use of the bougie and video laryngoscopy, checklists, and apneic oxygenation; Grant et al. demonstrated improvements in FPS and a reduction of airway complications (9). Mosier et al. developed a comprehensive airway quality improvement program and demonstrated improvements in FPS in an intensive care program (10).

Our emergency airway program at a busy level-1 trauma center and quaternary referral center had an 84% FPS rate before the initiation of an airway quality improvement (QI) program. After the initiation of several improvement steps, safe first pass success was consistently ≥95%. This paper outlines the sequential steps taken to achieve this improvement and may provide a framework to other programs wishing to create a durable improvement in intubation performance for other programs.

Interventions

Our program took the following steps to improve airway performance in our emergency department. The steps are listed in the order of their initiation over a 13-month period. These steps need to be evaluated as a complete bundle, because we cannot discern the effects of any individual intervention on first pass success as each intervention likely bled into those following.

Assign an Airway Lead

Many EDs have already assigned an ultrasound director to enact sonographic teaching and quality improvement measures, but comparatively few have a similar designation for airway management. While this role has been implemented in the anesthesia and prehospital medicine realms, it has not yet become commonly incorporated into Emergency Medicine or Critical Care (8,11). The airway lead can optimize equipment, provide training, track performance, and investigate adverse events. In our department, an airway lead was assigned and given a small amount of protected time to offset the workload of airway quality improvement (QI) and education.

Creation of an Airway Quality Improvement Program

Our program involves the emergency medicine (EM) residents in all QI initiatives. Once the airway QI program was approved, residents began abstracting data from every endotracheal intubation (ETI) performed in the ED setting, including by operators from other departments intubating in the ED. In addition to consolidating data from the patient chart and airway debrief forms (Figure 1), residents participated in the QI interviews with the participants of ETIs that were significant. In this setting, significance is defined as any adverse event or ETI otherwise flagged as interesting/noteworthy in the comments of the airway debrief form. Such QI interviews delineate the events of the ETI procedure, with the intention of identifying a cause of any adverse event or noteworthy incident.

A crucial piece of the development of the program was to involve the ED's clinical nurse specialist and nurse educators in every step of the process. Many nascent programs ignore this vital step to the detriment of the initiative and the teamwork dynamics of the ED in general.

Determination of the Trackable Goal for the Airway Quality Improvement Program

Creating a quantitative goal allows measurement of effectiveness for an airway QI program. The goal chosen for our group and many high-efficiency organizations is Safe First Pass Success (sFPS) (12). We defined sFPS as placement of the endotracheal tube with only a single entrance and exit of the laryngoscope blade without new hypoxemia (oxygen saturation < 90%), hypotension (mean arterial pressure [MAP] <65 if not already hypotensive), or cardiac arrest during or immediately after intubation. Importantly, many publications demonstrating the safety of intubation feature a threshold for hypoxemia with an oxygen saturation less than 80%; however, oxygen saturations at this level are potentially life threatening, particularly in the critically ill patient. We feel that the higher threshold confers an increased degree of safety and is thus in line with our goal of "safe" first pass success. Balancing FPS with clinical safety markers prevents a false optimization of FPS at the expense of patient decompensation.

Multiple intubation attempts have been associated with adverse outcomes including cardiac arrest and death in several ED and ICU studies (13–15). Taking a second attempt on a hemodynamically stable, well oxygenated patient will not necessarily lead to a bad outcome; however, it can be life-threatening in a critically ill patient. Moreover, only a high-performance airway program can consistently achieve sFPS rates in the high 90′s. All aspects of the program must be functional to generate consistency, maximize all participant choices, and de-

Airway Debrief

Pt Name:
MRN:
Date:

Instructions: Fill this form out after intubation and stabilization. Discuss with all members involved in the intubation. This process should take < 2 minutes.

List Each ***Laryngoscopy Attempt*** *by Name and Service*					
#	**Name**	**Service**	**#**	**Name**	**Service**
1			***4***		
2			***5***		
3			***6***		

	Yes	No
Was this patient suspected or confirmed **COVID19**?		
Did the team feel like this was a difficult airway?		
If yes, why?		
Was there a DESAT <80% with good waveform (**Cardiac Arrests Excluded**)?		
Was there any VOMITING after the administration of RSI Drugs?		
Was there a CARDIAC ARREST after pushing meds till 10 minutes Post-Tube?		
Was this a Delayed Sequence Intubation (DSI) [Document Why Below]?		
Was this an AWAKE intubation [Document Why Below]?		
Write Down ED Attending Name Here:	⬅	
Was Anesthesia Called (**except for <u>Code T</u>**)?		
If yes, why?		
Was a supraglottic airway placed to **rescue** a failed airway?		
Was a cricothyrotomy performed?		
If a cric is performed, please **<u>immediately</u>** email [**email removed**] with MRN and patient location		

In the opinion of the team, was there anything that could have been done better? If multiple attempts required, please indicate why

Place in Mailbox Next to ED Docs' Desk

Figure 1. Airway debrief form—filled out by the lead nurse after every intubation using input from the team. [Used with permission from emcrit.org].

velop participant skill sets to achieve this goal. We set our threshold goal (the level below which prompts immediate reevaluation and overhaul of an established program and above which is a sign of success for a nascent program) at $\geq$ 90% sFPS. Our target goal (the goal a program should strive towards month-to-month) was $\geq$95% sFPS. The latter goal was achievable at our program for 12 of 13 months after sequentially enacting the steps included in this paper.

Additional performance metrics were tracked by the airway QI program. It can be useful to record the intubation team's qualitative impression of whether the airway was difficult and the reasons why. This both allows stratification of the sFPS as well as offering insights into educational and equipment interventions. Delayed sequence technique, severe desaturation (SpO_2 < 80%), vomiting after intubation medications, hypotension, and peri–intubation cardiac arrest (during or within 10 min of the intubation) were also captured as additional physiologic and clinical data. Awake intubations were tracked and appropriately removed from the safe first pass success model, as multiple attempts are acceptable and better tolerated during this specific procedure. Difficult airway modalities, such as extraglottic airway placement or the performance of front-of-neck/surgical access were other features prompting immediate review of the intubation by the airway lead, though not considered as adverse events.

Additionally, anesthesia consults were tracked by the ED airway team. A planned consult for a multispecialty approach to a perceived difficult airway prior to beginning intubation is a mark of a skilled and experienced airway team. A crash consult for a failed airway with a desaturating patient is often a sign of either poor airway planning, a lack of familiarity with rescue techniques, or an unwillingness to perform surgical airway. It is imperative that cases requiring the aid of another service be debriefed and analyzed for opportunities for performance improvement.

Development of an Airway Database

Quality Improvement data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools. REDCap is a secure, web-based software platform designed to support data capture for research studies. This database is Health Insurance Portability and Accountability Act (HIPAA) compliant and allows access by multiple team members. Further we submitted this quality project to the institutional review board (IRB) to allow monitoring and act as the springboard for further IRB submissions to use the data for publications and studies.

Development of a Debrief Form

We created a form to be filled out by the bedside nurse immediately after intubation. The nurse would query the team and fill in the answers. The form (Figure 1) was designed to be filled out in less than 60 s. The debrief form facilitated multiple beneficial actions. It forced a procedural debrief, which has been shown to benefit the learning and cognitive status of the team involved (16). Also, it allowed for an immediate flagging of potentially problematic intubations to facilitate prompt airway lead review prior to hearing about it through other channels in the hospital. It functioned as a target for information that the clinicians wanted the QI committee to know about, but did not want placed in the chart, e.g. a conflict with another service. Finally, involving nursing in the filling out of the form bolstered ED team dynamics by focusing on a multidisciplinary debrief. The forms were placed in a lock-box in the resuscitation area and collected every 2 days by the airway lead.

Preoxygenation and Preintubation Optimization

Optimizing preoxygenation (preox) allows longer safe apnea time and therefore improves sFPS (17). We changed allowable preox methods to include only: non-rebreather mask at flush rate (> 50 lpm), bag-valve-mask with positive end-expiratory pressure (PEEP) valve with nasal cannula underneath at 15–20 lpm, ventilator, or non-invasive machine; all of which will provide near 1.0 fiO_2. End-tidal oxygen monitoring was subsequently added to verify adequate denitrogenation, but this yielded little change in clinical interventions and was eventually made optional (18).

Positioning of the patient for intubation was standardized to head-of-the-bed at $\geq 20^\circ$ with a specific sniffing position (face-plane parallel to the ceiling, external auditory meatus above the level of the sternal line) (19).

Call and Response Checklist

A call-and-response checklist was used for all non-crash intubations. The nurse-leader of the resuscitation would read through each item of the checklist (Figure 2) and a member of the intubating team would affirm or stop to remedy the missed item. Residents were given a miniature version of the checklist as a plastic card that could be placed behind their identification badges. The checklist added minimal time to the intubation if everything required was already present and done. Any additional time added was because a crucial item or step had been missed.

While the literature vacillates on the utility of airway checklists it is conceivable that these studies have failed to

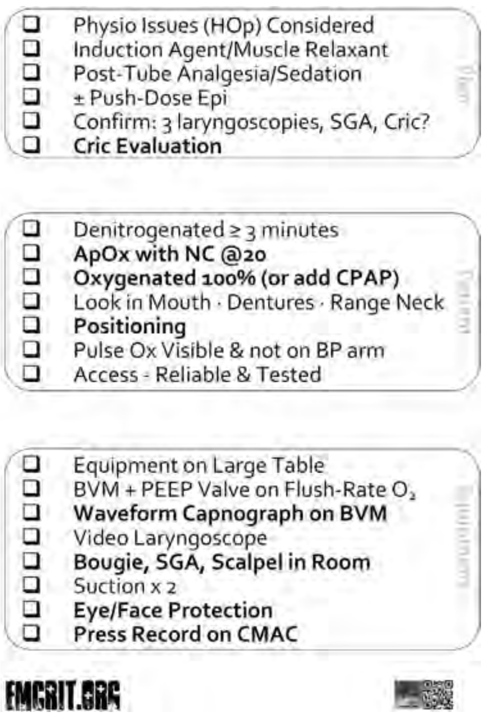

Figure 2. Airway checklist—run before every noncrash intubation as a call/response, with the lead nurse announcing each item and the airway team responding. [Used with permission from emcrit.org].

capture a meaningful number of cases in which the use of a checklist would have conveyed benefit (e.g., exceptionally challenging airways). The use of an airway checklist mentally prepares the operator and the supporting members of the airway team for multiple levels of difficulty that are only encountered in a fraction of ETI attempts. Such preparation with a checklist establishes a shared mental model for preintubation preparation and difficult airway management among the airway team, allowing for anticipatory rather than reactionary responses in high stress circumstances (e.g., can't oxygenate/can't ventilate scenarios, poor Cormack-Lehane views, etc.) Further, the use of a checklist trains the providers to the point that obviates its necessity when the use of the checklist is not feasible, e.g. crash intubation scenarios or out-of-ED intubations.

Use of a Validated Failed Airway Algorithm

A 3-pass maximum airway algorithm (Figure 3) was adopted as standard practice. This algorithm was adapted from the only study-validated airway algorithm, the Shock Trauma Center algorithm (20,21). It was only applicable for rapid sequence or delayed sequence intubations, as multiple attempts beyond 3 were acceptable with an awake intubation strategy.

Video Laryngoscopy for all First Passes

At the beginning of the interventions, there was a wide variance of techniques and choice of intubating equipment between the faculty of our department. Based on current literature, this was viewed as a primary source of poor first-pass performance and decreased the teaching potential for residents (22). Video laryngoscopy (VL) allows for real-time teaching during airway management and allows salvage of poor performance during the first pass. Direct laryngoscopy prevents any useful feedback from being given to learners as the attending cannot see their technique to provide immediate corrective feedback for performance errors. This is especially dangerous with intubations that were successful, but performed with less-than-ideal technique as it cognitively reinforces the bad technique. The recent DEVICE trial shows that direct laryngoscopy is inferior to video even in the hands of skilled practitioners (23).

Eventually, the only way to enact this measure was by fiat from the ED leadership. Attending physicians that wished to continue to teach direct techniques to the residents were able to do so simply by using standard geometry video laryngoscope blades and turning the video screen so that they, but not the learner could visualize the video portion of the intubation.

Recordings and Videographic Review of All Intubations

Once the switch was made to video laryngoscopy for all intubations, mandatory recording of the intubations was added as a requirement. This allowed a video review by the airway lead of every intubation in the department (24). Feedback was offered to the intubator and supervising attending for any intubations that demonstrated particularly excellent technique or needed improvement in technique. Teams were also encouraged to watch the recording immediately after the intubation together as often subtle details of technique can be missed in the heat of the resuscitation.

Standard Geometry Video Laryngoscopy as Standard

Unless intubating a patient with cervical spinal precautions, a CMAC (Karl Storz, Germany) Macintosh standard geometry blade was made the standard for all first-pass intubation attempts. This was based on the available literature as well as a desire to instill perfect standard geometry technique in our learners (22). Based on anatomical impediments noted on the first laryngoscopy, in some cases, a switch to a hyper-angulated blade was indicated for subsequent passes.

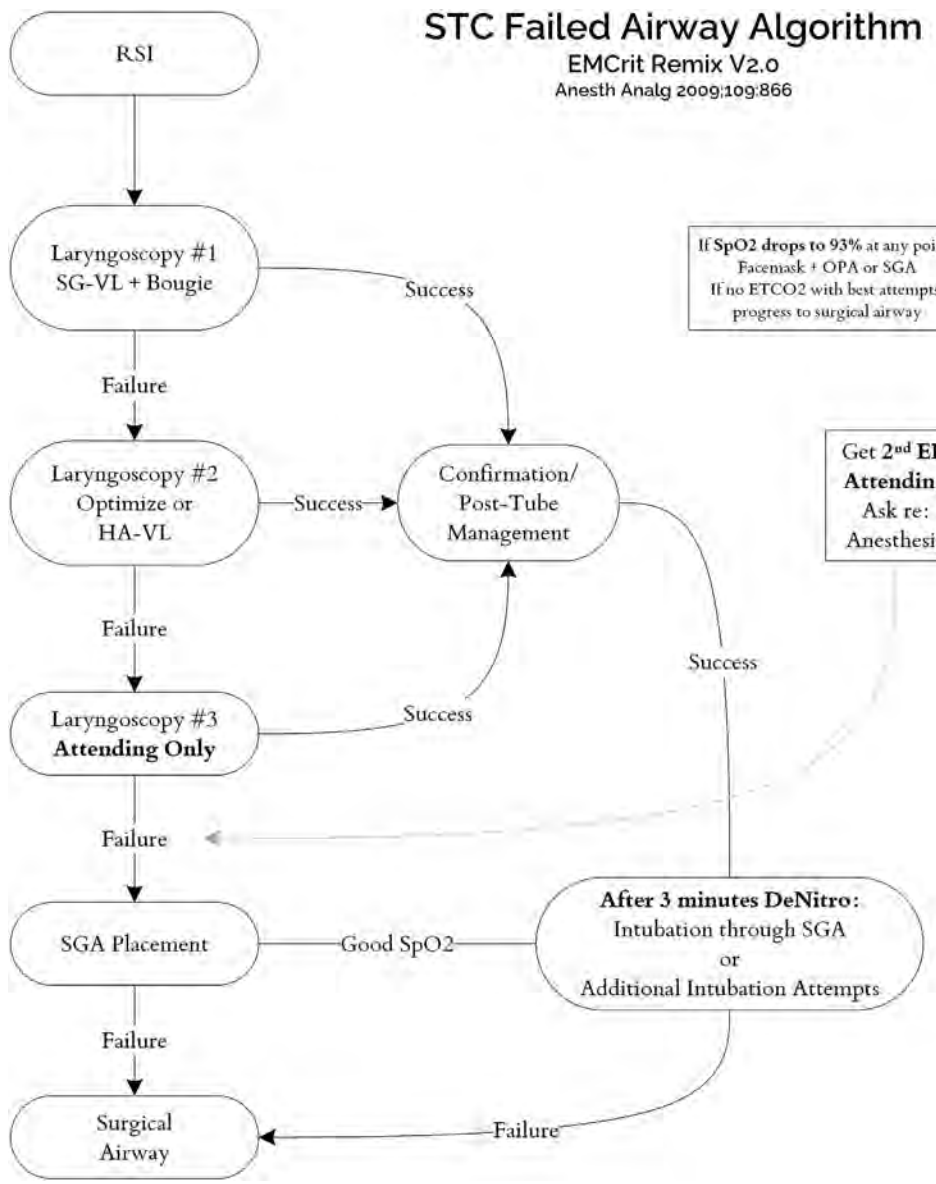

Figure 3. Airway algorithm—adapted from Stephens et al. [17]. [Used with permission from emcrit.org].
RSI = Rapid Sequence Intubation, SG-VL = Standard Geometry Video Laryngoscopy, HA-VL = Hyperangulated Video Laryngoscopy, SGA = Supraglottic Airway DeNitro Denitrogenation, SpO2 = Pulse Oximeter Oxygen Saturation, OPA = Orophrayngeal Airway, ETCO2 = End-Tidal Carbon Dioxide, STC = Shock Trauma Center.

Bougie for All First Pass Except Hyperangulated Blade Intubations

After the publication of 2 studies documenting high FPS (≥98%) rates, both using bougies, we switched to requiring the use of a bougie on the first pass for every standard geometry blade intubation (4,5). Driver et al.'s subsequent paper demonstrating a lower FPS rate in intubators lacking significant bougie experience (though not worse than the stylet group) bolstered our belief that unless you train extensively with bougies, they will not offer the same benefit as in systems where bougies are used regularly (25). Since we were not aware of any published literature that achieved the same high FPS rates with styletted tubes as with the bougie in trained hands, we made the decision to utilize bougies on every first pass of intubation.

Midline Approach

Some faculty were teaching a right-sided mouth entry with deliberate tongue sweep, a holdover from standard anesthesia practice. Video review demonstrated that often with this approach, key structures were missed and the esophagus was entered (24). A switch to mandatory midline approach with progressive visualization of uvula and epiglottis avoided this issue. Tongue sweeping is unnecessary with video intubation devices, but even with direct laryngoscopy it is obviated by proper insertion technique of the laryngoscope (26).

Change to an Articulable Bougie Allowed Use in All Intubations

A switch to an articulable tip, prebent bougie [Flexible Tip Bougie, Sharn Anesthesia] allowed the use of this airway adjunct even with hyperangulated blades. It also allowed easy placement into the glottis in patients with an anterior glottic opening. We adopted this manipulable bougie for all our standard intubations, allowing us to teach 1 technique for all video intubations regardless of blade geometry. This allowed us to deemphasize bedside teaching of the clinically distinct skill of hyperangulated-stylet tube placement, which requires an application of separate micro-skills, though this technique was still taught extensively in simulation.

Single Technique Mastery With Proactive Initiation of Airway Adjuncts

While many programs have argued that allowing each attending to teach their own preferences for airway management allows residents to be exposed to a wider variety of techniques, the problem becomes potentially limited opportunity to gain true mastery of a single intubation technique. One study demonstrated 29 intubations per resident/year, but even this low number seems optimistic in 2024 given the increased number of EM programs, the influence of noninvasive positive pressure to decrease intubation rates, and the increased capabilities of prehospital services (27). Attendings are infrequently exposed to intubation opportunities, with 1 study demonstrating only 3 intubations per annum (28). After the manipulable tip bougie was available, our group switched to 1-technique mastery: use of video and bougie for every intubation. We felt that given the limited number of intubations that emergency medicine residents were exposed to, this guaranteed the highest level of expertise for our trainees after graduation.

Airway Corner Session in Resident Conference

Key laryngoscopy recordings demonstrating performance errors or difficult, rare conditions were shown in a monthly 20-min session at resident conference. This allowed the entire program to benefit from rarely seen airway situations and consistently noted errors in technique. We shared well performed intubations to celebrate performance and provide a demonstration of ideal technique. Videos were anonymized to protect both patient and intubator confidentiality.

Teaching and Encouragement to Use Awake Intubation Techniques

Training sessions and continuous education were provided on the performance of awake intubation. This enabled attendings to feel more comfortable performing an intubation while maintaining spontaneous ventilation. Awake intubation was urged for both anatomic and physiologic reasons. This protected the patient from hypoxemia and hypotension as well as avoiding the need for airway rescue and potential peri–intubation cardiac arrest. Both the traditional topicalization awake approaches as well as ketamine-facilitated laryngoscopy were utilized (29).

While the steps were presented in the order they were initiated in our program, other centers may wish to adopt an entirely different stepwise progression. The key is to enact a change, receive feedback, observe obstacles, and track success.

Conclusion

A high-performance airway program may save lives and reduce morbidity by increasing endotracheal intubation safe first-pass success. Given the low cost and potential benefits, it makes sense for all emergency departments to consider starting an airway program. Once an airway lead is designated, goals can be determined, and a means of tracking these goals can be established. Once data on trackable goals are available, iterative improvements can be made and then studied for incremental increases in success. While each program will have to determine which airway interventions are most appropriate for their center, we hope delineating our process can be a helpful reference for a nascent program.

Prior Presentations

This paper has not been presented.

Author contributions

SDW conceived of and drafted the original manuscript. All of other authors participated in the airway program and reviewed and edited the manuscript.

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