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ORIGINAL RESEARCH

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Predictive value of difficult airway identifiers for intubation-related complications in the emergency department

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Abstract

Objectives: The Airway Alert banner at our institution alerts physicians to patients with the potential for a difficult intubation. Difficult airway guidelines can reduce intubation complications in the operating room, but little research has been done in the emergency department (ED). We hypothesize that patients meeting criteria for the banner will have a more difficult intubation and increased complications.

Methods: Patients greater than 18 years old who presented to the ED for any complaint and required intubation were reviewed from January 2015 to January 2020 and divided into those meeting criteria for a difficult airway ("criteria cohort") and those who did not ("non-criteria cohort"). Past medical history and details of the intubation were collected.

Results: The mean number of attempts for intubation was 1.60 in the criteria cohort and 1.36 in the non-criteria cohort ($P > .05$). The mean grade of view was 1.73 and 1.39, respectively ($P < .05$). The average size of endotracheal tube was 7.50 and 7.74 in the criteria and non-criteria cohorts ($P < .05$). The use of adjuncts was 28.6% and 12.5%, respectively ($P < .01$). The average number of intubation attempts and complication rate did not differ significantly.

Conclusions: Intubations in patients meeting criteria for the banner are associated with a more difficult view, use of smaller endotracheal tube, and increased use of adjuncts, but not with a significantly higher rate of complications or attempts. Physicians should prepare with additional endotracheal tube sizes, adjuncts, and a plan for secondary strategies in these patients.

Level of Evidence: 2b.

KEYWORDS
adjuncts, difficult airway, emergency department, intubation, intubation complications

1 | INTRODUCTION

Endotracheal intubation is a commonly used method of airway management in patients requiring increased respiratory support beyond less-invasive measures (eg, bag-valve mask or nasal cannula). In emergency departments (ED) worldwide, clinicians are trained to intubate patients who decompensate in respiratory status and those who present in respiratory distress refractory to other measures.[1,2] A variety

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of methods for intubation, medications for paralysis and sedation, and associated adverse events with ED intubation have been characterized in the literature.[3] With such a variety of options available to ED physicians, patient factors such as medical history and presenting symptoms can help guide the techniques utilized. However, patients may present with no medical information or little indication of their ability to be intubated beyond immediately assessable anatomic factors, and clinicians are forced to evaluate candidacy for intubation rapidly and without knowledge of, for instance, a history of cervical fusion or previous difficult intubations. This can lead to failed intubation, the need for multiple attempts, and other complications while in the ED.[4,5] The ability to recognize patients with difficult airways is acknowledged to be a key part in the management of these patients prior to intubation, to ensure that proper equipment and personnel (eg, respiratory therapists or otolaryngologists) are present.[6,7]

The implementation of an Airway Alert banner at a tertiary academic medical center was designed to alert providers throughout the hospital, including the ED, of patients who may require additional support or personnel in the course of airway management. For patients with a previous medical history at our institution who present to the ED for care, providers can use this Airway Alert banner to guide preprocedural preparation for these patients. This banner is automatically generated based on predetermined diagnoses and has gradually been implemented since March 2018. To our knowledge, no study has evaluated whether the criteria used to determine this designation are actually associated with more difficult intubations in the ED setting, or whether the presence of the notation itself changes the approach to such intubations in the ED.

Thus, the primary objective in our study is to determine whether the rate of difficult intubation (as assessed by number of intubation attempts, size of tube required, quality of view, use of adjuncts, and intubation-associated complications) varies between those patients who meet criteria to be considered a difficult airway vs those who do not. Patients in the criteria group either had an Airway Alert banner at the time of their ED visit or would have received the banner based on current institutional guidelines. The secondary objective of our study, focused on those within the criteria cohort, is to determine whether there are any differences between those with an Airway Alert banner on their chart and those who met criteria but did not yet carry the banner.

2 | MATERIALS AND METHODS

Approval for this work was granted by the Biomedical Sciences Institutional Review Board. A retrospective chart review was performed of all patients ≥18 years of age who presented to the ED of a single academic tertiary care center for any complaint that required intubation during the course of their ED visit. Data was collected from January 2015 through January 2020. Exclusion criteria included patients <18 years of age, non-oral intubation (eg, via a tracheostoma), or those not intubated in the ED (eg, intubation occurring after the patient was admitted).

A description of the Airway Alert banner is necessary to predicate the remainder of the study design. The banner was instituted in March 2018 at this institution. ED intubations from before and after this date were analyzed; we thus based our analysis on the presence of *criteria* that would have triggered the banner, rather than the presence of the banner itself. Those criteria included any of the following diagnoses: History of difficult intubation, history of prolonged ventilation, bilateral vocal fold paralysis, malignant hyperthermia, subglottic/glottic stenosis, total laryngectomy, angioedema or hematoma affecting the airway, tracheostomy with complications, tracheal stenosis, anomalies of trachea or respiratory system, oral or facial burns, mediastinal mass, cancer of the mouth or neck affecting the airway, or Guillain-Barre or other neuromuscular disorders compromising respiratory status. We used the presence of criteria that would have triggered the banner rather than the banner itself for our analysis because the medical diagnoses in these patients were similar regardless of the presence of the banner and thus any difficulties related to intubation should theoretically be similar as well. We also planned for a subanalysis of this cohort stratified by presence of banner or not to determine whether either group was driving any overall differences that were found.

Patient records were reviewed and the following was documented from the patient's chart: date of presentation, reason for presentation, age, gender, race, past medical history, history of prior intubation, reason for current intubation, number of attempts, difficulty of intubation as assessed by grade of view, method utilized, any complications during the intubation or while in the ED, tube size, diagnosis meeting criteria for an Airway Alert banner, and actual presence of the Airway Alert banner at the time of presentation. The method of intubation was defined as the technique used for the first attempt. Adjuncts were defined as additional modifying strategies beyond the technique of the first attempt.

Patients were divided into two cohorts based on whether or not they met criteria for an Airway Alert banner (as described above) at time of presentation to the ED; these were called the "criteria cohort" and the "non-criteria cohort." The criteria cohort included both (a) patients meeting criteria for the Airway Alert banner and (b) patients actually carrying the banner on their chart.

The primary outcome was the rate of difficult intubation for each cohort, as indicated by number of attempts, size of tube required, grade of view, adjuncts required, and intubation-associated complications. We also compared the rate of first pass attempt with direct laryngoscopy (DL) or video laryngoscopy (VL) (the two most common methods of intubation in the ED) to other methods. "Adjuncts" included use of a bougie or introducer, a tube downsize, change to a video-assisted method after initial attempt with another method, need for the assistance of another specialty team, or use of other airway management devices such as flexible endoscopic laryngoscopy or laryngeal mask airway (LMA). We documented all complications found in the intubation procedure note. Statistical analysis was performed to determine whether there was a significant difference in demographic data, number of attempts, grade of view, tube size, use of adjuncts, or rate of complications between the two cohorts. The secondary outcome was a subanalysis of patients within the criteria cohort, comparing those with the Airway Alert banner to those who had diagnoses

that would currently trigger the banner but received care prior to the banner implementation. This analysis sought to determine if either group was driving any results seen in the overall criteria cohort and whether the presence of the banner altered the behavior of the intubating physicians. The average rate for each of the above indices was calculated and compared between cohorts using *z*-test and Student's *t*-test. A *P*-value <.05 was considered significant.

3 | RESULTS

We identified 35 patients in the criteria cohort and 536 patients in the non-criteria cohort. Details regarding age, gender, race, prior intubations, reason for intubation, and prior respiratory history can be found in Table 1. Ten patients in the criteria cohort had an Airway Alert banner in place at the time of the study, and details regarding

TABLE 1 Cohort demographics

	Criteria	Non-criteria	*P*-value
Number of patients	35[a]	536	
Age	58.97	55.61	.260
Gender			
Male	22 (62.9%)	307 (57.3%)	.516
Female	13(37.1%)	229 (42.7%)	.516
Race			
White	19 (54.3%)	314 (58.6%)	.617
Black	13 (37.1%)	198 (36.9%)	.984
Hispanic	0	2 (0.4%)	.719
Asian	0	8 (1.5%)	.465
Other	3 (8.6%)	4 (0.7%)	<.001
Unknown	0	10 (1.9%)	.412
Prior intubations	1.51	0.63	<.001
Reason for intubation[b]			
Hypercapnia	7 (20.0%)	55 (10.3%)	.073
Respiratory failure or distress	22 (62.9%)	265 (49.4%)	.124
Airway protection	17 (48.6%)	350 (65.3%)	.046
General anesthesia	1 (2.9%)	7 (1.3%)	.447
Time with Airway Alert banner (years)	1.7	–	
Reason for meeting criteria[b]		–	
Prior difficult airway	9	–	
Airway stenosis	3	–	
History of Tracheostomy	11	–	
Airway-compromising mass[c]	8	–	
Neuromuscular disease[c]	5	–	
Vocal cord paralysis	1	–	
Prior medical history			
Obesity	16 (45.7%)	140 (26.1%)	.012
Obstructive lung disease	16 (45.7%)	155 (28.9%)	.036
Other lung disease[d]	5 (14.3%)	26 (4.9%)	.017
Obstructive airway disorder[e]	11 (31.4%)	79 (14.7%)	.009
Heart failure or CAD	13 (37.1%)	110 (20.5%)	.020
Esophageal disorder[f]	3 (8.6%)	5 (0.9%)	.001

Note: All percentages listed are of that specific cohort, not the entire study population.
Abbreviation: CAD, coronary artery disease.
[a]Ten patients had the airway banner in their chart. Twenty-five had diagnoses consistent with placement of the banner but had an ED encounter prior to the implementation of the banner (see Table 3).
[b]Patients can have more than one reason for meeting criteria or requiring intubation.
[c]Airway-compromising mass included head and neck cancer, angioedema, and mediastinal masses. Neuromuscular diseases included myasthenia gravis and Guillain Barre.
[d]This includes lung cancer, interstitial lung disease, pulmonary hypertension, and lung transplant.
[e]This includes obstructive sleep apnea, oropharyngeal dysphagia, and airway clearance issues.
[f]This includes esophageal stricture, aspiration, esophageal diverticulum, and Barrett esophagus.

TABLE 2 Intubation details

	Criteria	Non-criteria	*P*-value
Number of intubation attempts	1.60	1.36	.142
Cormack-Lehane grade			
Grade 1	7 (41.2%)	176 (56.2%)	.222
Grade 2	5 (29.4%)	77 (24.6%)	.653
Grade 3	3 (17.6%)	11 (3.5%)	.005
Grade 4	0	1 (0.3%)	.818
Cords visualized	2 (11.8%)	48 (15.3%)	.689
Average grade	1.73	1.39	.029
Endotracheal tube size	7.50	7.74	.013
Method of intubation			
Direct laryngoscopy	22 (62.9%)	367 (68.5%)	.490
Video laryngoscopy	9 (25.7%)	138 (25.7%)	.999
Bronchoscopy or flexible fiberoptic	2 (5.7%)	15 (2.8%)	.327
Non-ED team intubation	1 (2.9%)	0	<.001
Not stated	1 (2.9%)	16 (3.0%)	.968
Direct laryngoscopy or video laryngoscopy	31 (88.6%)	505 (94.2%)	.177
Patients requiring adjuncts[a]	10 (34.3%)	67 (12.5%)	.007
Bougie	4	22	
Switch to video-assisted	4	32	
Required another team	2	1	
Required tube downsize	1	2	
LMA	0	6	
Unspecified	1	4	
Complications	5 (14.3%)	60 (11.2%)	.575
Bleeding	2	13	
Emesis	0	7	
Hypotension	0	4	
Death in ED	3	36	

Abbreviations: ED, emergency department; LMA, laryngeal mask airway.
[a]Patients that required greater than one adjunct were counted only once to determine the rate of adjunct use in the cohort. However, all adjuncts were recorded here in their respective categories.

the banner can also be found in Table 1. Data on the details of the intubations can be found in Table 2.

There was no significant difference in age, gender, or race between our two cohorts. Regarding patient-centered factors, the criteria cohort had a greater average number of prior medical diagnoses (in all categories) and of prior intubations; the non-criteria cohort was more likely to be intubated for airway protection. Regarding intubation details, the criteria cohort had a significantly higher grade of view and rate of adjunct use, and a significantly smaller size endotracheal tube placed.

There were no significant differences between the two cohorts in number of intubation attempts, use of DL or VL as opposed to other methods on first attempt, or rate of complications. The most common complications in both groups were bleeding or death in the ED. Death in the ED occurred in 8.6% of the criteria cohort and 6.7% of the non-criteria cohort ($P > .05$).

The subanalysis of the criteria cohort identified 10 patients with the Airway Alert banner at the time of ED presentation and 25 patients with diagnoses matching current Airway Alert banner guidelines but who presented prior to its implementation. Data on this subanalysis can be found in Table 3. There were no significant differences between the two groups in any factor except the average size tube placed and the rate of use of DL or VL as opposed to other methods of intubation. The average tube size was 7.15 in the banner cohort and 7.65 in the non-banner cohort ($P < .05$). The rate of use of DL or VL was 70.0% in the banner cohort and 96.0% in the non-banner cohort ($P < .05$). With only 10 patients in the banner group, we were only powered to detect major differences between the groups.

4 | DISCUSSION

Unrecognized comorbidities or patient factors indicating a difficult airway can lead to poor outcomes and complications associated with

TABLE 3 Criteria cohort subanalysis

	Banner	No banner	*P*-value
Number of patients	10	25	
Reason for meeting criteria			
Prior difficult airway	9	0	
Airway stenosis	2	2	
Tracheostomy	1	9	
Airway-compromising mass	0	8	
Neuromuscular disease	0	5	
Vocal cord paralysis	0	1	
Number of intubation attempts	1.83	1.53	.555
Average grade of view	1.00	1.85	.171
Average endotracheal tube size	7.15	7.65	.035
Method of intubation			
Direct laryngoscopy	4 (40.0%)	18 (72.0%)	.077
Video laryngoscopy	3 (20.0%)	6 (16.0%)	.711
Bronchoscopy or flexible fiberoptic	2 (20.0%)	0	.021
Non-ED team intubation	1 (10.0%)	0	.110
Not stated	0	1 (4.0%)	.522
Direct laryngoscopy or video laryngoscopy	7 (70.0%)	24 (96.0%)	.030
Patients requiring adjuncts	5 (50.0%)	5 (20.0%)	.077
Complications	2 (20.0%)	3 (12.0%)	.542
Bleeding	1	1	
Death in ED	1	2	

intubation in the ED.[6] As such, many institutions have implemented a difficult airway banner to allow physicians to rapidly identify patients who could pose a problem during intubation. At our institution, this banner is automatically triggered by a range of diagnoses and can also be added manually by providers. The primary concern with implementation of banners like this are whether they are an accurate indication of the actual difficulty encountered in airway management in these patients.

Prior literature has established the need for adequate preintubation risk stratification. A bedside airway assessment score (based on Mallampati score, neck mobility, and thyromental distance) is associated with a poor Cormack-Lehane score (grade 3 or 4), but these criteria can be difficult to assess during urgent or emergent intubation in the ED.[6,8] A prospective study on the predictors of complications postintubation identified three or more attempts and a Grade 3 or 4 view as predictors, further reinforcing the need to identify patients who may require additional attempts or have poor visualization.[9] Research on the use of DL vs VL found VL to be superior in difficult airways involving blood, a small mandible, or a large tongue, but less effective in patients with neck masses or radiation.[10,11]

A desire to reduce airway management complications has also led to interventions at the institutional level. Berkow et al found that the need for emergent surgical airways in the operating room was reduced after the implementation of a comprehensive difficult airway program.[12] The Difficult Airway Society created flow charts for operating room providers to manage patients who fail to respond to initial airway interventions and gave recommendations for when to proceed to more invasive maneuvers.[13] A study by Ideker et al found that lawsuits following intubation complications primarily found either a failure to follow standards of care or a breakdown in communication.[14]

In our study, multiple intubation-related metrics were compared between the criteria cohort and the non-criteria cohort. Results show that the criteria cohort had a worse view during intubation and tended to require a smaller-caliber endotracheal tube. In addition, these patients more often required the use of adjuncts such as a bougie, assistance from another team, or attempt with a different intubation method (Table 2). This study's hypothesis that the criteria used to identify a difficult airway and elicit an airway banner would accurately identify those with increased difficulty of intubation is supported by these findings. The use of a bougie or switch from DL to VL were the most common adjuncts reported in both cohorts. This indicates that ED physicians should prepare for difficult airway intubations with additional endotracheal tubes (ie, having a size 6.0 present in addition to a 7.0 or 8.0), a bougie, LMAs, and availability of video-assisted intubation methods. Predicting this need and mentally planning backup strategies may prevent the need for surgical airways and other drastic measures.

Importantly, the average number of attempts for successful intubation and the rate of complications did not differ significantly between the two cohorts. Complications following intubation in the ED have been reported at a rate of 10% to 29% or more in prior studies, and a primary goal of Airway Alert banners is to reduce this rate as well as improve first-pass success.[9] Our findings could suggest that a difficult airway is not a factor in number of intubation attempts or

rate of complications, or that our institution's criteria for the Airway Alert banner was not predictive of the risk for multiple attempts or complications. More likely, our findings suggest that ED physicians were already properly identifying difficult airway patients and using a more tailored approach for them, thus reducing the number of attempts required and mitigating potential complications.

We performed a subanalysis within the criteria cohort, comparing those with the banner in place to those only meeting criteria for it, in part because we questioned whether patients with a banner might require fewer intubation attempts than those without a banner because of the additional preparation it would trigger. Table 3 shows results from this analysis. Not surprisingly, there was no difference in grade of view or number of previous intubations, or in demographic or other medical factors between the groups. More interesting is that there was also no significant difference in the rate of adjunct use, complications, or number of intubation attempts between the two groups, which was contrary to our hypothesis. This could simply be because our analysis was underpowered, given that only 10 patients were in the banner group. However, if larger studies showed similar results, this could again suggest that ED physicians already successfully identify and prepare for difficult airway patients even without a banner. Our subanalysis did indicate that the presence of the banner was associated with a decreased rate of use of first-line intubation methods (DL or VL) and smaller tube size as compared with the non-banner group. This may indicate that the presence of the banner triggered ED physicians to start with more advanced intubation methods and smaller tube sizes, but our subanalysis was likely underpowered to determine which advanced methods in particular were utilized more frequently in the banner group.

There are several important limitations to our study. Our subanalysis within the criteria cohort was underpowered. In addition, missing data was common during the chart review. Intubation procedure notes frequently omitted details of the intubation, including tube size, grade of view, and specific adjuncts. Finally, as noted in the results, the cohorts differed in the number of prior intubations and prior medical diagnoses. It is reasonable to assume that patients in the criteria cohort would have more prior intubations, and that they would also have more prior respiratory-related medical diagnoses. However, the overall sicker patient population in the criteria cohort could be contributing to some of the outcomes seen with intubations in the ED.

Future directions for this area of research include a need to further identify specific risk factors for difficult intubation to make a difficult airway banner as helpful as possible for ED physicians. Future studies should include a larger patient population, with analysis comparing specific risk factors and their correlation with difficult intubation and poor outcomes. In addition, more research is needed to determine whether EDs should utilize smaller endotracheal tubes in these patients to increase first-pass success and decrease complication rates.

5 | CONCLUSION

Patients meeting criteria for the Airway Alert banner had significantly more difficult intubations in the ED, as measured by higher-grade views, need for smaller endotracheal tubes, and increased use of adjuncts to facilitate successful intubation. This indicates that the difficult airway criteria used in this study are useful for the prediction of difficult intubations in the ED setting. Our study also suggests that ED physicians already identify and prepare for difficult airways appropriately, in that there were not a significantly higher number of intubation attempts or complications in the group meeting criteria for the airway banner. A subanalysis of those with a banner in place upon presentation to the ED indicates that banners may be effective in prompting ED physicians to start intubation attempts with smaller tubes and more advanced methods in these patients.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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