



Evaluation of a Difficult Airway Educational Intervention on Residents' Performance of Endotracheal Intubation in the Emergency Department

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Authors' contributions

This work was carried out in collaboration between all authors. Author JLA developed and taught the educational intervention, developed the Difficult Airway Assessment (DAA) tool, designed the study, and wrote portions of the first draft of the manuscript. Author JFE abstracted data, managed data, and wrote portions of the first draft of the manuscript. Author LM performed the statistical analysis, managed the statistical analysis, and wrote portions of the first draft of the manuscript. Author LMW managed the literature search, wrote the protocol, supervised the data extrapolation and data management and verified the accuracy of data submitted for analysis, wrote portions of the first draft of the manuscript, and wrote the final manuscript. All authors have reviewed and approve the final manuscript.

Research Article

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ABSTRACT

Aims: To evaluate the effectiveness of a brief educational intervention and a predictive difficult airway (DA) checklist on performance of emergency endotracheal intubation by residents.

Place and Duration of Study: The Emergency Department (ED) of Interim Louisiana State University Public Hospital, the level one trauma center in New Orleans, from September 2006 to June 2010.

Methodology: We performed a retrospective chart review of patients intubated in the ED

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during the study period. Demographic, physiologic and procedural data had been previously recorded on a worksheet immediately following each intubation. In July 2008, residents received a lecture on management strategies for the DA and participated in simulation exercises based on DA scenarios. A detailed checklist of DA predictors was added to the standard intubation form, and completed by the resident prior to each intubation. Procedural outcomes were compared for number of attempts, time to successful intubation, faculty involvement and use of adjunct devices for the pre-and post-intervention periods using generalized estimating equations and z statistics.

Results: There were 266 intubations in the pre-intervention period and 373 in the post-intervention period. 50.3% of post-intervention intubations met criteria for DA. Time to successful intubation did not vary between the two groups (11.6 minutes pre; 10.8 post, $P=0.30$). There was no significant difference in the number of attempts (1.4 pre; 1.3 post, $P=0.44$) or faculty interventions (1.5 v. 3.75%) or the number of successful intubations that were assisted by adjuncts ($P=0.22$). Success on the second attempt was more likely if an adjunct was used ($P=0.24$).

Conclusion: A brief DA educational module and the application of a standard pre-intubation checklist resulted in few appreciable changes in EM resident intubations. Further research is needed to more clearly define the relationship between DA education and resident intubation performance.

Keywords: Emergency endotracheal intubation; post-graduate education; difficult airway.

1. INTRODUCTION

Successful emergency airway management is a core component of Emergency Medicine (EM) residency training. This critical skill includes several key elements: recognition of impending respiratory failure, prediction of effective bag-valve-mask ventilation with oxygen, preparation for tracheal intubation, and anticipation of and preparation for potential complications requiring airway adjuncts or surgical interventions.

Previous studies report that emergency physicians perform 87% of emergency department intubations [1], and that EM residency training leads to timelier intubation of patients in the ED [2]. The frequency of successful initial intubation attempts tends to increase over the first 3 years of residency training [3]. However, difficult airways can complicate as many as 1 out of 4 intubations [4].

The exact definition of a difficult airway has not been standardized; however, the concept of "difficult tracheal intubation" is generally described as intubation requiring multiple attempts, regardless of intrinsic tracheal pathology [5]. There are many factors which are currently used to predict whether or not an intubation will be difficult: These include certain phenotypical features, Mallampati Score, physical landmark distances, and body mass index (BMI). Previous research has shown that management of difficult airways was more successful when operators are adequately prepared [6].

No study has evaluated whether the introduction of an educational intervention specifically focused on difficult airway management improves certain characteristics of EM resident intubation, such as the number of intubation attempts, time to successful intubation, need for faculty intervention, and use of adjunct devices. Our study examines the effect of such an intervention – a didactics module, skills practice, and predictive difficult airway assessment worksheet - on EM resident endotracheal intubation in the ED. Using the description of

difficult intubation above, we hypothesized that a difficult airway educational intervention should decrease the number of attempts and operators, as well as the overall time to successful intubation. We also hypothesized that the frequency of use of airway adjuncts would be increased post-intervention, reflecting increased skill at recognizing the DA and a pre-emptive approach to it.

2. METHODS

2.1 Setting

We performed a retrospective review of the ED medical records of all patients intubated in the Interim Louisiana State University Public Hospital (ILSUPH) ED from September 2006 through June 2010 for whom an intubation worksheet was completed. ILSUPH is a certified Level I trauma center and urban teaching hospital affiliated with a fully accredited EM residency training program. The institution maintains a policy protocol for ED airway management. Intubations are performed by resident physicians (years 2-4) at the discretion of and under the supervision of board certified EM attending physicians, with 24-hour Anesthesia backup in-house, if needed.

2.2 Educational Intervention

In July 2008, a difficult airway education module was presented to all EM residents. This module consisted of:

- Didactic lectures on identification and management of the difficult airway using standardized, internationally recognized algorithms and mnemonics [7].
- A skills lab with faculty teaching and hands-on simulator, cadaveric, and mannequin practice using traditional direct laryngoscopy (DL), video laryngoscopy (VL), fiberoptic laryngoscopy, airway adjuncts, and rescue devices.
- Development and maintenance of a difficult airway cart, available in the ED all days on all shifts.
- Regular case scenario and simulator practice sessions scheduled intermittently, about three times throughout the year, for maintenance of skills on difficult and basic airway management topics.

During the study period, intubating residents completed worksheets with basic demographic and procedure characteristics on all patients who required endotracheal intubation while in the ED. Intubations prior to July 2008 were recorded using a worksheet which was completed immediately following the procedure. Following the educational module in July 2008, all intubations were documented using the Difficult Airway Assessment (DAA) worksheet, which required that an evaluation of the airway be made prior to intubation and the remaining data be recorded post-intubation.

Both versions of the worksheet recorded patients' age, medical record number, vital signs, indication for intubation, technique of airway management, names and dosages of all medications administered, time elapsed from decision to intubate to time of successful tube placement, time elapsed from drug administration to intubation time, number of attempts, name of physician performing subsequent attempts, tube size used, number of and types of adjuncts used, success or failure, and adverse events. In addition, the post-intervention DAA

worksheet required the intubating resident to predict whether an airway would or would not be a difficult intubation based on the patient's external appearance (restricted mouth opening, Mallampati Score, obesity, neck immobility, facial trauma, poor dentition, and anatomic abnormalities). This revised worksheet also recorded which, if any, adjunct devices were prepared prior to the procedure.

Both prior to the study period and during the study period, our ED intubations were routinely performed using a rapid sequence intubation protocol (7). By definition, this protocol employs the use of sedation and a neuromuscular blocking agent to render an awake patient unconscious, flaccid and paralyzed to facilitate emergency intubation. Our residents are encouraged to use the rapid sequence intubation protocol that was developed by Ron Walls, MD and has been described in the *Manual of Emergency Airway Management* (citation: Manual of Emergency Airway Management, Edition 4; edited by Michael F. Murphy; Lippencott Williams and Wilkins, 2012; ISBN 1451144911). The procedure we use includes:

1. Preparation- assessment of the need for airway intervention and the patient's airway; continuous cardiac monitoring, continuous pulse oximetry; preparation of the equipment needed to perform the intubation;
2. Pre-oxygenation- using a properly fitting face mask to deliver 100% oxygen. Almost always, we pre-oxygenate the patient to a pulse oximetry reading of 100%;
3. Pre-treatment- routine drug of choice is etomidate;
4. Paralysis- routine drug of choice is succinylcholine. It is rare that a patient comes into the ED with a contraindication to this drug;
5. Position- consideration is given to the possibility of c-spine instability in trauma patients or patients who were found unresponsive;
6. Placement with proof- at the time of the study, placement was being done by direct laryngoscopy; proof of placement- through visualization of thoracic movement, auscultation of both the left and the right hemithoraces and the stomach, and the visualization of color change on an end tidal carbon dioxide detector;
7. Post intubation management- details of which did not have any impact on the results of this study.

2.3 Data Collection and Study Design

All airway worksheets filled out during the study period were filled out and collected by ED Nursing Supervisors and filed securely. Study investigators entered data into an excel spreadsheet for both pre- and post-educational intervention. Data were summarized with standard descriptive statistics (means, standard deviations, medians, and frequencies). There were 266 ED intubations performed by 79 residents over the course of the study, so there were multiple procedures from individuals. To control for correlation among procedures performed by the same individual, intubation data were analyzed using generalized estimating equations regression methods. SAS (version 9.2) was used for all analyses. Statistical significance was defined using a criterion of $P < 0.05$.

3. RESULTS

For all intubations, the need for adjuncts, faculty involvement, or multiple attempts is illustrated in Fig. 1. There were 266 attempted intubations pre-intervention and 373 post-intervention. Of those, 18 required intubation by the faculty physician: 4 pre-educational intervention and 14 post- intervention (1.5% vs. 3.75%, $P = 0.09$). A total of 621 procedures

did not require intubation by faculty. These procedures were performed by 79 residents. Of these, 262 were pre- and 359 were post-intervention.

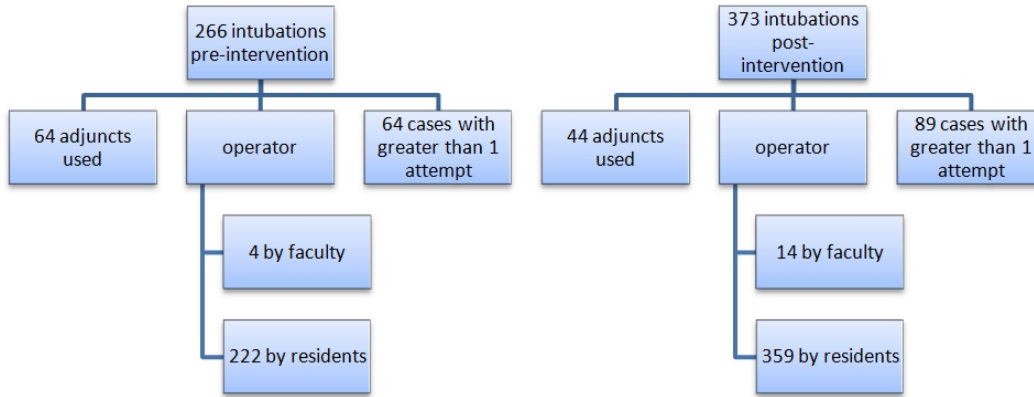


Fig. 1. Flowsheet

Of the 79 residents, 24 performed intubations in the pre-intervention period, 27 in the post-intervention period, and 28 in both periods. The minimum number of ED intubations per resident was 1 and the maximum was 21 (median 4).

Characteristics of the intubations are shown in Table 1. Characteristics of the patients are shown in Table 2. There were no significant differences between pre- and post-intervention endotracheal intubations in number of attempts required, percent of intubations which were successful on the initial attempt, time from procedure start to successful tube placement, time from RSI drug administration to successful intubation, or percent of procedures employing an adjunct device.

Table 1. Characteristics of ED intubations performed by residents before and after an educational intervention

Characteristic	Pre-intervention	Post-intervention	P-value
Number of attempts mean + SD, median	1.4 + 0.9 1.0	1.3 + 0.7 1.0	0.44
% successful on 1 st attempt	75.6	75.0	0.87
Time to successful intubation (mins) mean + SD, median	11.6 + 7 9.5	10.8 + 10.1 9.0	0.30
Time from drug administration to intubation (mins) Mean +SD, median	3.3 + 3.4 2.0	3.1 + 3.75 2.0	0.49
% Adjunct device used	9.2	12.3	0.22
% with DA predictor	---	50.3	

Table 2. Patient characteristics

Variable	Pre-Intervention				Post-Intervention			
	N	Mean	SD	Median	N	Mean	SD	Median
Age	74	48.70	17.48	51.5	135	45.46	16.03	47
Systolic BP	251	141.88	39.00	135	331	138.53	43.43	135
Diastolic BP	244	92.23	25.91	91	320	89.73	28.89	90
MAP	251	107.07	31.04	106.33	331	103.77	33.09	104.33
HR	253	104.34	27.03	103	335	107.41	28.11	108
O2%sat*	243	95.36	9.83	99	315	96.88	6.27	100
RR	225	21.97	9.32	20	309	22.69	9.64	22
% Hypertensive	61.9				58.7			
% Trauma**	58.3				35.1			

4. LIMITATIONS

This study was limited by the relatively small sample size in a single site training facility. The data record sheets were transcribed by different scribe nurses and residents, which could have led to inconsistent data recording. While it would have been impossible to have a single data recorder present in the ED 24 hours a day, seven days a week, results may have been more reliable had we performed double data entry and calculated a kappa coefficient. One study limitation is the possibility of missed intubation data due to a form not being filled out. All intubations are required to have the standard form filled out by the RN supervisor, but it may be that occasionally this is not done, and this missing data might affect the results. Each month, the Airway Quality Assurance committee reviews and compares all forms and intubations, and consistently less than 5% of ED intubations do not have a completed form, so the missing number is likely very small. The major strength of this study is the large percentage of completely filled out data sheets, which allowed for maximal data entry for all categories. Future aims would be to include other facilities with the same study methods to increase the number of data points and to compare with different teaching institutions which will invariably have different teaching modalities and personnel teaching intubation. We would predict that our findings would be generalizable to other academic urban teaching hospitals, given that our resident and faculty demographics are fairly typical.

5. DISCUSSION

Managing the airway is one of the most important responsibilities of the EM physician, and so it is of paramount importance that the EM resident masters this skill [8]. Endotracheal intubation requires specific training and technique [8]. The ability to rapidly predict a difficult airway is vital to the learning process of airway management. Graduate medical educators are consistently working to develop effective and engaging methods to facilitate mastery and retention of these fundamental EM skills.

Our educational intervention employed mechanical simulation, a method that has been shown to increase successful intubations in real world settings [9]. Airway assessment data record sheets were utilized pre and post-educational intervention to record pertinent airway management information. Post-educational intervention, DA predictor worksheets were filled out by the resident attempting intubation prior to the procedure. According to the American Society of Anesthesiology 2013 update, a difficult airway is defined as the clinical situation in

which a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway or with tracheal intubation, or both [10]. Predictors of a difficult intubation included: restricted mouth opening, Mallampati Socroe, obesity, neck immobility, facial trauma, poor dentition, and anatomic abnormalities. Predictors of DA in our study included obesity, poor dentition, increased age, c-collar, restricted mouth opening, occlusion of the airway, trauma to the oropharynx or neck, previous radiation, previous neck surgical procedure, and stiff neck. Adjunctive devices are known to improve rates of successful intubations in patients with difficult airways [11]. Since our educational intervention provided practical cadaveric and simulation experience for the mastery of adjuncts, it was our expectation that predicted DA's would prompt the preparation of adjuncts such as smaller endotracheal tubes, Eschmann, laryngeal mask airways, and alternative blades.

Unexpectedly, the use of adjuncts did not increase following the introduction of the DAA tool and the educational intervention, nor did the number of attempts to successful tube placement, the time to successful tube placement, or the need for a faculty physician to perform the intubation. And, despite the fact that the literature contends that physicians with higher levels of training have higher first attempt success rates [12], the percent of successful first attempts also remained stable both before and after the educational intervention. The 75% first-pass intubation success rate found in our study is comparable to what has been shown in other studies [13,14], as is the use of adjunct devices [15].

6. CONCLUSIONS

No previous studies have evaluated whether the introduction of an educational intervention focused on improving airway management for physicians during residency training has an impact on the number of intubation attempts, the time to successful endotracheal intubation, or the successful use of airway adjuncts. Previous studies have validated the positive impact of simulation training on enhancement of intubation skills [9] and demonstrated that higher levels of training result in an increased percentage of successful tube placements on initial attempt [12]. Our study failed to demonstrate a positive impact of a combined didactic and practical educational intervention combined with the introduction of a DAA tool. It should be noted that we evaluated the combined impact and not the impact of each intervention individually. Furthermore, a washout effect could have accounted for the failure of a remote simulation intervention to evidence continued impact on practice. However these study findings strongly suggest that, rather than continue with current teaching methods for the development of critical endotracheal intubation skills, post-graduate medical educators need to develop and validate alternative methods of teaching these skills.

CONSENT

This is a retrospective review of documents. This study received a waiver of consent from the Institutional Review Board of the Louisiana State University Health Sciences Center-New Orleans.

ETHICAL APPROVAL

This study was approved by the Institutional Review Board of the Louisiana State University Health Sciences Center- New Orleans.

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COMPETING INTERESTS

None of the authors have professional, financial or personal conflicts of interest.

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