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Original Article

Adherence to Evidence-Base Endotracheal Intubation Practice Patterns by Intensivists and Emergency Department Physicians

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Background: Endotracheal intubation outside the operating room (OR) is mainly performed by intensive care (IC) physicians and emergency department (ED) physicians. We hypothesized that difference in practice patterns exists between these two groups of physicians.
Methods: A retrospective chart review was performed on all endotracheal intubations that were performed out of OR over a five year period at our health care facility. Practice patterns of IC and ED physicians were compared regarding use of (a) video laryngoscopy, (b) paralytic agents, (c) waveform capnography, and (d) use of larger size of endotracheal tube (internal diameter ≥ 8 mm).
Results: A total of 201 patients underwent out of OR intubations over a 5 year period. IC physicians used more often than ED physicians video laryngoscopy (67% vs. 49%; $p = 0.008$), waveform capnography (99% vs. 86%; $p = 0.001$) and larger size endotracheal tubes (95% vs. 60%; $p < 0.001$). Conversely, paralytic agents were used less frequently by IC than ED physicians (12% vs. 51%; $p < 0.001$). The success of first intubation attempt was higher by IC than ED physicians (82% vs. 67%; $p = 0.018$).
Conclusions: IC physicians more often adhered to currently considered preferable practices for endotracheal intubation than ED physicians in this single center retrospective study. Although larger scale studies are needed to unveil the effects of different practice patterns on short and long term outcomes, the present study identifies opportunity to bridge practice gaps that could lead to improved outcomes.

Key words: *airway management, endotracheal intubation, practice patterns*

Background

Airway management outside the operating room (OR) is particularly challenging as it is often performed in life-threatening situations. Achieving airway control and establishing effective ventilation and oxygenation can be lifesaving in critically ill patients.[1,2] The incidence of acute respiratory failure is estimated to be 137 hospitalizations per 100,000 US residents ≥ 5 years of age with 31-day hospital mortality of 31.4%.[3] Between 13 and 20 million intubations are performed annually in the United States.[4] Tracheal intubation is frequently performed outside the operating room, often during resuscitation of physiologically unstable patients or in an emergency to secure the airway. Difficult or failed intubations are associated with significant morbidity and mortality.[2,5-7]

In recent years, video laryngoscopy has been increasingly studied and employed for endotracheal tube placement. A recent meta-analysis of 17 trials

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comparing video laryngoscopy to direct laryngoscopy reported that the former was associated with improved glottic visualization, especially in patients with potential difficult airways.[8] Tracheal intubation success rates have been reported to be approximately 93% using video laryngoscopy compared to 84% with direct laryngoscopy.[8,9] Despite compelling data suggesting superiority of video laryngoscopy in airway management, its use in clinical practice has been scarce. Choi et al. reported that emergency physicians did not use video laryngoscopy frequently during the initial two years after introduction.[10] In another emergency room study, video laryngoscopy was used for initial intubation in 22% of the cases while direct laryngoscopy was used in 78% of cases.[11]

It is also well known that complications associated with airway management can be serious. Failure to recognize esophageal intubation can have disastrous effects.[5] Waveform capnography is a method used to confirm tracheal intubation. Birmingham et al. reported that other than direct visualization with laryngoscopy, waveform capnography is consistently more reliable than any other method.[12] Roberts et al. found that waveform capnography can more quickly and accurately determine tracheal intubation than other clinical assessments in a neonatal intensive care setting. In this study, waveform capnography identified errant tube placements in 98% of instances in 1.6 ± 2.4 seconds.[13] Despite its superiority the use of waveform capnography has been scarce.[14,15] A national survey of emergency physicians in 2005 reported that among those physicians who had waveform capnography available, only 14% "always" used it and 57% "rarely" or "never" used it.[16]

In clinical practice, Intensive Care (IC) physicians and Emergency Department (ED) physicians routinely perform out of OR endotracheal intubations. A paucity of studies has examined the use of videolaryngoscopy and waveform capnography by ED physicians.[8-11,14] However, to the best of our knowledge, there have been no studies comparing the practice patterns of IC physicians with those of ED physicians.

We conducted the present study to compare practice patterns by these two groups of physicians with focus on use of video laryngoscopy, waveform capnography, paralytic agents, and endotracheal tube size.

Methods

The study was a retrospective chart review examining adult patients who had out of OR endotracheal intubations between January 1, 2008 and December 31, 2012 at the Captain James A. Lovell Federal Health Care Center (FHCC). Our health care facility is a teaching hospital affiliated with Rosalind Franklin University of Medicine and Science. FHCC is the first in the nation fully integrated facility between a VA and a military hospital and serves veterans along with active duty navy personnel and their dependents. At FHCC, data on all out of OR intubations are kept by the department of education. This data is presented monthly to the critical care committee for aggregate and provider specific analysis. At FHCC, out of OR airway management is provided by ED and IC physicians based on schedule. During business hours on weekdays (Monday-Friday, 8 am-5 pm) IC physicians provide coverage for out of OR airway management anywhere in acute care areas excluding ED. During off business hours on weekdays (Monday-Friday, 5 pm-8 am), weekends (Friday evening-Monday morning, 5 pm-8 am) and holidays, ED physicians provide coverage for out of OR airway management anywhere in acute care areas including ED. At FHCC, airway equipment including video laryngoscopes and waveform capnographs are readily available in all acute care areas. The protocol was approved by our Institutional Review Board. Patients who were younger than 18 years of age, patients with pre-existing endotracheal tubes or tracheostomy tubes, and those who were transferred from outside the health care center were excluded. Intubations performed inside the OR were also excluded.

The practice parameters investigated were evidence-based and included use of video laryngoscopy, use of waveform capnography, use of paralytic agents, and use of an endotracheal tube of diameter ≥ 8.0 mm. Additional data captured included number of attempts during intubation, use of sedation including number of agents and their total dose, and complications such as esophageal intubation, cardiac arrest as direct result of airway management, and post-intubation hypotension. Potential confounding factors were also recorded including the presence of difficult airway and history of known upper airway disease or structural abnormality.

Statistical Analysis

Statistical analysis was performed by IBM SPSS Statistical program (version 22, IBM Corporation,

Pittsburgh, PA). Statistical analysis consisted of computation of means and standard deviations for continuous variables and frequencies for categorical variables. Differences in continuous variables between the two study groups were analyzed by independent sample t test. Differences in categorical variables were analyzed by chi-square test or Fisher's exact tests as appropriate. A two-sided alpha error of $p \leq 0.05$ was considered statistically significant.

Results

Over the 5 year period, 201 patients had endotracheal intubations and met inclusion criteria. Of the 201 patients, 94 were intubated by IC physicians and 107 by ED physicians. There were no significant differences in age, gender, body mass index, known upper airway disease, or presence of difficult airway (Table 1).

The practice patterns are summarized in Table 2. IC physician more often used video laryngoscopy and waveform capnography and less often used paralytic agents. The preferred paralytic agent by ED physicians was succinylcholine. Sedative agents were used with similar frequency among providers but IC physicians more often combined agents. Regarding specific agents, IC physicians favored propofol whereas ED physicians favored midazolam and rarely used fentanyl.

IC physicians placed larger size endotracheal tube more often than ED physicians. The success rate of the first intubation attempt was higher by IC than ED physicians; however, the rate of esophageal intubations was comparable. Cardiac arrest as a direct result of airway management occurred more often with ED than with IC physicians. Post-intubation hypotension was not statistically significant between groups.

The clinical indications which prompted endotracheal intubations are summarized in Table 3. There were six major indications for endotracheal intubation without significant differences between IC and ED physicians.

Due to significant differences in practice patterns of these two groups of physicians. We analyzed the practice patterns of ED physicians according to location (i.e., ED, ICU, and other acute care areas) as shown in Table 4. Use of Video laryngoscopy, larger size endotracheal tube, and paralytic agents was comparable in ED, ICU, and other acute care areas. However, waveform capnography was more often used when intubating patients in the ICU and other acute care areas.

Discussion

Airway management outside of the operating room has not been well studied.[17] A survey of the Department of Veterans Affairs Medical Centers by the National Center for Patient Safety showed that emergent airway management is often required outside of the OR. It is thereby critical that only well-trained and qualified individuals be responsible for airway management. Competency in airway management must be demonstrated and not assumed based on job description.[18] It is also imperative to use adjunctive devices to facilitate airway management and verify proper endotracheal tube placement. The use of video laryngoscopy -- as noted earlier -- has been shown to decrease the number of attempted intubations and reduced the number of esophageal tube placements. The use of waveform capnography is strongly recommended by various professional organizations, including the International Liaison Committee on Resuscitation (ILCOR), for its high sensitive and specificity for identifying tracheal tube placement.

Table 1. Demographic data

	IC	ED	*p* value
N	94	107	
Age (years)	66.1 ± 16.4	64.5 ± 17.3	0.495
Male (n/%)	93 (98.9%)	104 (97.2%)	0.378
BMI (kg/m^2)	28.4 ± 9.1	28.4 ± 8.0	0.986
Known upper airway disease (n/%)	0 (0%)	2 (1.9%)	0.183
Presence of difficult airway (n/%)	12 (12.8%)	20 (18.7%)	0.252

Data are shown as number of patients with corresponding percentage, or mean ± SD.
IC: patients intubated by Intensive Care (IC) Physicians, ED: Patients intubated by Emergency Department (ED) physicians, BMI: body mass index (BMI).

Emergent airway management in critically ill patients rates high among stressful situations for primary care physicians and airway specialists alike. Achieving airway control and establishing effective ventilation and oxygenation can be lifesaving.[1,2]

Our single center retrospective chart review showed significant differences in practice patterns between IC and ED physicians. Among key differences, video-laryngoscopy was more often used by IC than ED physicians. In recent years, video laryngoscopy has been increasingly studied and employed for endotracheal tube placement. Studies show better success and ease of use especially when used on patients with potential difficult airways.[8] Studies have shown

Table 2. Adherence to evidence-base endotracheal intubation practice patterns by intensivists and emergency department physicians

	IC	ED	*p* value
Patients per group (n)	94	107	
Use of video laryngoscopy (n/%)	63 (67%)	52 (49%)	0.008
Use of waveform capnography (n/%)	93 (99%)	92 (86%)	0.001
Endotracheal tube diameter > 8 mm (n/%)	89 (95%)	64 (60%)	< 0.001
Use of paralytic agent (n/%)	11 (12%)	54 (51%)	< 0.001
Use of succinylcholine (n/%)	5 (5%)	48 (45%)	< 0.001
Attempts (n)	1.27 ± 0.63	1.42 ± 0.67	0.095
Success with 1st attempt (n/%)	77 (82%)	72 (67%)	0.018
Use of sedation (n/%)	78 (83%)	84 (79%)	0.424
Number of sedative agents (n/%)	1.4 ± 0.9	1 ± 0.7	0.002
Propofol use (n/%)	56 (60%)	24 (22%)	< 0.001
Propofol dose (mg)	57 ± 35	81 ± 61	0.095
Etomidate use (n/%)	38 (40%)	35 (33%)	0.256
Etomidate dose (mg)	20 ± 0	21 ± 6	0.330
Midazolam use (n/%)	14 (15%)	44 (41%)	< 0.001
Midazolam dose (mg)	2.8 ± 2.4	4.4 ± 2.8	0.098
Fentanyl use (n/%)	19 (20%)	1 (1%)	< 0.001
Fentanyl dose (mcg)	86 ± 23	50 ± 0	0.146
Esophageal intubation (n/%)	7 (7%)	9 (8%)	0.801
Cardiac arrest (n/%)	1 (1%)	7 (7%)	0.047
Post-intubation hypotension (n/%)	7 (7%)	11 (10%)	0.483

Data are shown as number of patients with corresponding percentage, or mean ± SD. Abbreviations: See Table 1.

Table 3. Clinical indications for endotracheal intubation between ED and IC physicians

Clinical indications	IC	ED	*p* value
n	94	107	
Acute hypoxic respiratory failure, n (%)	28 (29.8)	42 (39.3)	0.209
Acute hypercarbic respiratory failure, n (%)	18 (19.1)	16 (14.9)	0.546
Acute respiratory failure (mixed), n (%)	2 (2.1)	4 (3.7)	0.799
Airway protection, n (%)	10 (10.6)	8 (7.5)	0.592
Increase work of breathing/impending respiratory failure, n (%)	33 (35.1)	28 (26.2)	0.222
Cardiac arrest, n (%)	3 (3.2)	9 (8.4)	0.208

Data are shown as number of patients with corresponding percentage.

Table 4. Intubations done by emergency department physicians based on location

	Intubated in ED	Intubated in ICU	Intubated elsewhere except operating room	*p* value
n	45	52	10	
Video laryngoscopy, n (%)	19 (42.2)	30 (57.7)	3 (30.0)	0.147
Wave form capnography, n (%)	30 (66.6)	52 (100.0)	10 (100.0)	0.001
Use of larger size tube ≥ 8.0, n (%)	24 (53.3)	32 (61.5)	08 (80.0)	0.280
Use of paralytic agent, n (%)	25 (55.6)	25 (48.1)	04 (40.0)	0.600

Data are shown as number of patients with corresponding percentage.

a marked increase in success rate by emergency physicians when using video laryngoscopy (70 to 80%) compared with direct laryngoscopy (20-50%).[10,19,20] At our facility, video-laryngoscopes are available in the intensive care unit, emergency department, and operating room; yet, its use was more prevalent by IC physicians.

Our study showed that IC physicians more often used waveform capnography to verify proper endotracheal tube placement. Our study also showed that ED physicians more often used waveform capnography when they intubated patients in ICU and other acute care areas. As mentioned earlier, the waveform capnographs are readily available in all acute care areas including ED. IC nursing staff has been trained to confirm all endotracheal intubations with waveform capnography in ICU and other acute care areas. The IC nurses assisted ED physicians in airway management in ICU and other acute care areas excluding ED. This could be one of the reasons for significantly increase use of waveform capnography by ED physicians in these areas. The medical literature and root cause analyses confirm that brain damage or death may occur because of unrecognized esophageal intubation or other failures to intubate the trachea.[5,7,21] Several studies have documented improved outcomes with use of waveform capnography. When compared with auscultation and colorimetric CO_2 detection, waveform capnography was found to be the most reliable method for confirming correct endotracheal tube placement by emergency physicians.[22] Knapp et al. reported that the reliability of waveform capnography, unlike other methods including auscultation, was independent of clinician experience in critical care setting.[22]

Our study also showed that IC physicians favored larger endotracheal tubes (internal diameter ≥ 8.0 mm). It is a well-established that work of breathing and airway pressures are inversely proportional to the diameter of endotracheal tube. Fiastro et al. showed that net added inspiratory work increased progressively with decreasing diameter of the endotracheal tubes.[23] Bolder et al. showed that every 1 mm decrease in endotracheal tube diameter increased work of breathing by 34-154%, depending on tidal volume and respiratory rate.[24] These studies underline the importance of using larger diameter endotracheal tube in critically ill patients. Because IC physicians manage patients on mechanical ventilation for longer period of time than ED physicians, IC physicians are more likely to be mindful of the importance of endotracheal tube size.

ED may be confronted with more urgent situations having to act with less preparation and use of rapid sequence intubation protocols, all favoring use of smaller tube sizes to rapidly stabilize a critical patient without concerns of longer term management.

The use of neuromuscular blocking agents is common practice during endotracheal intubation. Schwartz et al. reported that these agents were used to facilitate intubations in 80 % of critically ill patients.[6] In a study performed by Jaber et al. neuromuscular blocking agents were used in 62% of all intubations performed in critically ill patients.[25] Our study showed less use of paralytic agents by IC physicians. The overall use of paralytic agent was less frequent in our study than in the abovementioned studies.

IC physicians, at our institution, avoid paralytic agents during intubation out of concern that failure to intubate in a patient with suppressed ventilatory capability may lead to critical situation with failure to oxygenate and ventilate. IC physician feel comfortable using sedatives and providing bag-valve-ventilation while managing the airway.

In our study, there were no significant differences between the two physician groups in esophageal intubation or post-intubation hypotension, although the success of intubation on first attempt was higher with IC physicians. Cardiac arrest, as direct consequence of intubation, occurred more often in patients who were intubated by ED physicians. There were differences between the two practice groups in use of sedative agents. It is currently unknown that the type and dose of sedatives employed during intubation in out of OR affects short or long term outcomes.

With regard to intubations, we believe there is sufficient scientific data (and consensus among experts) that video laryngoscopy and waveform capnography have a positive effect by increasing the success of first attempt endotracheal intubation and by virtually eliminates the risk of inadvertent esophageal intubation. From this perspective, monitoring practice and striving to increase the usage of these two technologies has the potential to improve outcome. In fact, the Veterans Health Administration directive 2012-032 has recommended the use of these technologies based on safety and quality concerns for all out of operating room endotracheal intubations at all VA hospitals. In our study we found that Intensivists use these technologies more often that ED physicians. We have in fact developed programs at our institution to encourage and facilitate their use regardless of the provider or hospital location.

In our study there were no significant differences in clinical indications which led clinician to perform endotracheal intubation. We categorized clinical indications in six separate categories. However due to retrospective nature of study it was not possible to confirm underlying disease process or severity of illness with reasonable certainty. Another limitation of this study was lack of data on pre-intubation airway risk assessment. The data could not be generalized due to fact that it was single center study. These were some of the limitations which we encountered in this study with retrospective chart review.

Conclusions

IC physicians more often adhered to practices considered preferable practices for endotracheal intubation than ED physicians in this single center retrospective study. Although larger scale studies are needed to unveil the effects of different practice patterns on short and long term outcomes, the present study identifies opportunity to bridge practice gaps that could lead to improved outcomes.

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