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Survey on the Current State of Endotracheal Intubation Among the Critically Ill: HEMAIR Investigators

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Abstract

Objectives: In the last decade, the practice of intubation in the intensive care unit (ICU) has evolved. To further examine the current intubation practice in the ICU, we administered a survey to critical care physicians. **Design:** Cross-sectional survey study design. **Setting:** Thirty-two academic/nonacademic centers nationally and internationally. **Measurements and Main Results:** The survey was developed among a core group of physicians with the assistance of the Survey Research Center at Mayo Clinic, Rochester, Minnesota. The survey was pilot tested for functionality and reliability. The response rate was 82 (51%) of 160 among the 32 centers. Although propofol was the induction drug of choice, there was a significant difference with actual ketamine use and those who indicated a preference for it (ketamine: 52% vs 61%; $P < .001$). The most common airway device used for intubation was direct laryngoscopy (Miller laryngoscope blade) at 56 (68%) followed by video laryngoscopy at 26 (32%). Most (>90%) indicated that they have a difficult airway cart, but only 55 (67%) indicated they have a documented plan to handle a difficult airway with even lower results for documented review of adverse events (49%). **Conclusion:** Although propofol was the induction drug of choice, ketamine was a medication that many preferred to use, possibly relating to the fact that the most common complication postintubation is hypotension. Direct laryngoscopy remains the primary airway device for endotracheal intubation. Finally, although the majority stated they had a difficult airway cart available, most did not have a documented plan in place when encountering a difficult airway or a documented process to review adverse events surrounding intubation.

Keywords

airway management, endotracheal intubation, hemodynamic management, intensive care unit, survey

Introduction

Endotracheal intubation carried out in the intensive care unit (ICU), as compared to other settings, is associated with increased complications.[1-3] Complications include, but are not limited to, significant hypoxemia, significant hypotension, esophageal intubation, aspiration, and cardiac arrest.[3-5] As the number of intubation attempts increases, the complication rate also increases.[6] The reasons for this alarming observation are mixed and include the urgency of the procedure and the typically poor physiologic reserve of the patient.[7] The physical environment and availability of trained staff are not optimum when compared to other anesthetizing locations (eg, operating rooms). There may also be variability in the skillsets of the primary proceduralist with limited availability of an experienced airway expert.[8,9]

In March of 2011, the Royal College of Anaesthetists and The Difficult Airway Society published the Fourth National Audit Project to characterize the major complications of airway management in the United Kingdom.[10] This was focused primarily on the operative environment but included the ICU and emergency department environments as well. For the ICUs, a number of recommendations were made to improve airway management. These include the use of capnography, use of an intubation checklist, recognition of airway difficulty with backup planning, and the availability of an airway expert. Additional recommendations include the use of a dedicated difficult airway cart with the appropriate emergency airway

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equipment (ie, fiberoptic bronchoscope) and proper training for emergency surgical procedures. When an adverse airway event occurs, a formal review process was recommended.

Following this report, it is unclear whether there have been any movement toward these practice recommendations. To further examine current intubation practice in the ICU, we administered a survey to critical care physicians both nationally and internationally with questions directed at the endotracheal intubation process.

Materials and Methods

The present study was deemed exempt from the institutional review board at Mayo Clinic, Rochester, Minnesota.

Study Population

The study population consisted of practicing critical care physicians from 32 academic and nonacademic centers in the United States, 7 centers in Canada (Alberta—4, Nova Scotia—1, and Ontario—2), and 1 center in Mexico (Instituto Nacional de Ciencias Médicas y Nutrición; Table 1). Respondents represented all regions of the Department of Health and Human Services (HHS) with the exception of region 8 (Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming) and region 10 (Arkansas, Idaho, Oregon, and Washington). The survey was open during the months of July 2015 through October 2015. Demographic data of the providers were obtained via indirect contact of a survey.

Intervention

A survey was created to investigate the process of endotracheal intubation in the ICU ranging from hemodynamic and airway management to system processes surrounding endotracheal intubation. The survey was comprised of qualitative and quantitative questions and developed with assistance from the Mayo Clinic Survey Research Center. The survey consisted of closed-ended questions utilizing a 5-point Likert scale. Functionality and validity were pilot tested prior to distribution via Research Electronic Data Capture (Redcap), a web-based data collection system. This pilot test included 10 critical care physicians who routinely practice in a mixed critical care setting (eg, surgical, medical, cardiac). Of these pilot tested surveys, 5 responses were obtained prior to distribution to the study population. Following distribution to the centers, each survey was active for the 1-month duration, with weekly completion reminders distributed via email. The providers included critical care physicians either in training or posttraining. Please refer to Appendix 1 for a copy of the survey that was utilized during the study.

Statistical Methodology

Of the approximate 160 critical care providers receiving the survey, an estimated 80 surveys were expected to be completed. This estimated percentage of critical care providers provides a precision of $\pm 11\%$ based on the half width of the 95% confidence interval. The survey was descriptive in nature with questions focused on medications administered during endotracheal intubation to devices used for airway management and systematic processes in place during the intubation to provide a safe outcome for the patient. Categorical variables are reported as counts and percentages. For categorical variables, a χ^2 test was used for parametric distributions and Fisher exact test, when applicable, for nonparametric distributions. Statistical comparisons are reported for some but not all components of the survey as this is a descriptive study by nature. All reported P values are 2 tailed, and a P value $\leq .05$ was considered statistically significant. JMP Statistical Package 9.0 (SAS Institute Inc, Cary, North Carolina) was used for all calculations.

Results

Population Background

Eighty-two completed surveys from a total of 160 surveys sent to the 32 centers were received. The centers were comprised of both academic and nonacademic institutions with 7 centers in Canada and 3 in Mexico. Within the United States, participants were from all HHS regions, except regions 8 and 10, with the majority coming from region 5 at 42 (51%). Canada had the second highest participation rate at 11 (13%). All surveys were completed by physicians. Seventy-six (93%) respondents practice in an ICU with at least 11 or more beds and most indicated they practice in a medical and/or surgical/trauma ICU as compared to other ICU types (73% vs 56%, P value <.001).

Hemodynamic Management

Of the available induction agents used for endotracheal intubation, propofol was used by 69 (84%) followed by fentanyl at 65 (79%), midazolam 60 (73%), etomidate 54 (66%), and ketamine 43 (52%). Succinylcholine and high-dose rocuronium ($\geq$1 mg/kg) were used by 66 (80%) of the respondents. Given the potential variability of available medications within the diverse cohort, we asked participants which induction medications they preferred to use. Propofol was listed as the induction drug of choice, with 53 (64%) indicating they preferred this medication. Although fentanyl was preferred by 50 (61%), ketamine was also preferred as the second agent of choice in 50 (61%). This was followed by etomidate at 44 (54%) and midazolam at 40 (49%). There was a significant difference with ketamine and midazolam use between those who used it and those who would prefer to use it (ketamine: 52% vs 61%, P value <.001; midazolam: 73% vs 49%, P value <.001; Table 2). Succinylcholine and high-dose rocuronium were preferred by 66 (80%) respondents. Although 54 (66%) indicated they experience postintubation hypotension in less than 21% of intubated patients, 60 (73%) indicated that 20% or less of patients require vasoactive agents 30 minutes after intubation (66% vs 73%, P value <.001). Fifty-two (63%) indicated vital signs are recorded at intervals of 5 minutes or less 30 minutes after intubation. When asked what is the most common complication

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Table 1. Demographic of Participating ICUs.[a]

Name of Institution	State, Country	Patient Population Demographic Comprises the ICU	Number of ICU Beds	Number of Weekly Tracheal Intubations Performed in ICU
Akron General Hospital	Ohio, United States	Medical	11-20	> 15
Aurora Health Care	Wisconsin, United States	Combined, medical, surgical, cardiac, transplant, and neurological	> 21	5-10
Aurora Medical Center at Grafton	Wisconsin, United States	Combined	11-20	5-10
Berkshire Medical Center	Massachusetts, United States	Combined, medical, surgical, cardiac, and neurological	11-20	0-5
Bridgeport Hospital	Connecticut, United States	Medical	11-20	> 15
Colquitt Regional Medical Center	Georgia, United States	Combined, medical, surgical, and transplant	11-20	0-5
Creighton University Medical Center	Nebraska, United States	Medical	> 21	5-10
Dalhousie University	Nova Scotia, Canada	Combined, medical, surgical, transplant, and neurological	> 21	0-5
Dartmouth Hitchcock Medical Center	New Hampshire, United States	Combined, medical, surgical, transplant, and neurological	> 21	> 15
Geisinger Medical Center	Pennsylvania, United States	Combined, medical, surgical, cardiac, transplant, and neurological	> 21	0-5
Grey Nuns Hospital	Alberta, Canada	Combined, medical, surgical, and neurological	0-10	5-10
Instituto Nacional de Ciencias Médicas y Nutrición	Distrito Federal, Mexico	Combined	11-20	5-10
LAC+USC Medical Center	California, United States	Medical	> 21	0-5
LSU Health Sciences Center New Orleans	Louisiana, United States	Combined, medical, cardiac, and neurological	> 21	5-10
Marshfield Clinic	Wisconsin, United States	Combined, medical, surgical, cardiac, transplant, and neurological	> 21	5-10
Mayo Clinic	Minnesota, United States	Medical, surgical, cardiac, transplant, and neurological	> 21	> 15
Mayo Clinic	Florida, United States	Combined, medical, surgical, and neurological	> 21	> 15
Mayo Clinic	Arizona, United States	Medical, surgical, cardiac, and neurological	11-20	5-10
Memorial Hospital of Rhode Island	Rhode Island, United States	Combined, medical, surgical, cardiac, and neurological	11-20	> 15
Mercy Hospital	Missouri, United States	Combined, cardiac, transplant, and neurological	> 21	5-10
Royal Alexandra Hospital	Alberta, Canada	Combined, medical, surgical, and neurological	> 21	0-5
Sturgeon Community Hospital	Alberta, Canada	Combined	0-10	> 15
Sunnybrook	Ontario, Canada	Combined, medical, surgical, and cardiac	> 21	0-5
SUNY Upstate Medical University	New York, United States	Combined, medical, and cardiac	> 21	0-5
Sutter Health Memorial Medical Center	California, United States	Combined, medical, surgical, cardiac, and neurological	> 21	5-10
University of Alberta	Alberta, Canada	Medical, surgical, cardiac, transplant, and neurological	> 21	5-10
University of Madison	Wisconsin, United States	Medical, surgical, and transplant	> 21	0-5
University of North Carolina	North Carolina, United States	Surgical/trauma	> 21	0-5

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Table 1. (continued)

Name of Institution	State, Country	Patient Population Demographic Comprises the ICU	Number of ICU Beds	Number of Weekly Tracheal Intubations Performed in ICU
University of Oklahoma Health Sciences Center	Oklahoma, United States	Medical, surgical, cardiac, and neurological	> 21	0-5
University of Toronto	Ontario, Canada	Combined, medical, surgical, cardiac, and neurological	> 21	> 15
UPMC at Hamot	Pennsylvania, United States	Combined	0-10	0-5
Yale—New Haven Hospital	Connecticut, United States	Medical, surgical, cardiac, and neurological	> 21	5-10

Abbreviation: ICU, intensive care unit.
[a] Combined indicates medical–surgical unit.

Table 2. Induction Agent Use (Hemodynamic Management).

	Number (%) of Centers
Induction agents used for endotracheal intubation	
Propofol	69 (84)
Fentanyl	65 (79)
Midazolam	60 (73)
Etomidate	54 (66)
Ketamine	43 (52)
Induction agents preferred for endotracheal intubation	
Propofol	53 (64)
Fentanyl	50 (61)
Ketamine	50 (61)
Etomidate	44 (54)
Midazolam	40 (49)

Table 3. Airway Management.

	Device Used	Number (%) of Centers
Most common airway device used for endotracheal intubation	Direct laryngoscopy (Miller laryngoscope blade)	56 (68)
	Video laryngoscopy	26 (32)
Most common backup device when primary device fails	Video laryngoscopy	51 (62)
	Fiberoptic intubation	10 (12)
	Direct laryngoscopy	9 (11)

experienced within 30 minutes of intubation, 71 (86%) indicated postintubation hypotension followed by hypoxia at 6 (7%).

Airway Management

The most common reason for endotracheal intubation was acute respiratory failure (73 [89%]) followed by airway protection (5 [6%]), with 60 (73%) participants performing between 1 and 9 endotracheal intubations per week. Interestingly, 15 (18%) respondents indicated that they perform more than 15 endotracheal intubations per week. The proceduralist was most often an ICU physician or nurse practitioner, with 21 (26%) indicating anesthetist and 8 (10%) indicating respiratory therapists, who routinely performs the procedure. Sixty-six (80%) indicated that it is standard practice to have senior physician staff present for intubation, regardless of the intubating provider. The most common airway device used for endotracheal intubation was direct laryngoscopy (Miller laryngoscope blade) at 56 (68%) followed by video laryngoscopy at 26 (32%). The most common backup device when the primary device failed was video laryngoscopy (51 [62%]) followed by fiberoptic intubation (10 [12%]) and then direct laryngoscopy (9 [11%]; Table 3).

Intubation Process

Preoxygenation was nearly universal among the respondents with only one indicating they do not routinely preoxygenate. Interestingly, only 68 (83%) routinely use capnography for confirmation of endotracheal tube placement. Although evidence is mounting regarding checklists used in the clinical environment, only 43 (52%) routinely use checklists during intubation. When asked if the participants have a plan for difficult airway encounter, 55 (19%) indicated they have a documented plan to handle a difficult airway with over 90% of respondents indicating their institution has a difficult airway cart available. Only 15 (19%) of the participants routinely practiced cricothyroidotomies, with 78 (95%) indicating that the frequency of cricothyroidotomies is less than 2%. When an intubation complication occurs, only 40 (49%) have a documented method to review the event.

Discussion

In a multicenter survey conducted among national and international centers with a focus on the peri-intubation period, preoxygenation was nearly universal among participants, however, the use of capnography to confirm placement was not. This is alarming as the most sensitive and specific way to confirm placement is capnography.[11-16] In contrast, other signs of confirmation such as chest wall movement, breath sounds, and tube condensation are notoriously inaccurate.[17-19]

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Regarding the choice of the induction drug, the majority of critical care physicians use propofol with fentanyl and midazolam as second and third choices, respectively. When compared to propofol, etomidate and ketamine use are at a distance with etomidate seeing a greater use over ketamine. When asked what induction medication they preferred to use, the respondents chose ketamine almost as often as propofol. This discordance between what is used (propofol) and what is preferred (propofol and ketamine) may be the result of drug shortages or the development of a greater appreciation of postintubation hypotension with a lag in the actual practice.[20,21] Postintubation hypotension has recently gained attention due to its adverse effects on patient outcomes.[22,23] In the past, etomidate was the induction drug of choice for patients with hypotension or patients with the potential for postintubation hypotension because of its stable hemodynamic profile. With a potential for increased mortality with its use in the septic population, etomidate has fallen out of favor. The next best drug with a similar favorable hemodynamic profile is ketamine.[24] Given most respondents prefer to use both propofol and ketamine, it seems reasonable that the admixture, so-named "ketofol," is a possible option.[25,26]

Although the majority of respondents stated that postintubation hypotension was the most common complication, few respondents indicated the use of vasoactive medications in the immediate postintubation period. This finding may be influenced by the frequency of vital sign recording, which was not as universal as thought. Roughly 40% of our cohort record vital signs at intervals more than 5 minutes surrounding endotracheal intubation. Given the available evidence on postintubation hypotension, an increased frequency of vital sign recording may be appropriate.[22,23]

Paralysis was used by the majority of respondents, consistent with evidence indicating an increase in the first-attempt success of endotracheal intubation.[27]

Although video laryngoscopy was indicated as the backup device, it was not the primary device chosen to secure the airway. This is surprising given the mounting evidence suggesting reduced complications and shorter time to endotracheal intubation with the use of video versus direct laryngoscopy.[28-33] A recent systematic review and meta-analysis of video laryngoscopy versus direct laryngoscopy demonstrated that video laryngoscopy reduced the risk of difficult endotracheal intubation, Cormack 3/4 grades, and esophageal intubation and increased the first-attempt success rate. No statistically significant difference was found for severe hypoxemia, severe cardiovascular collapse, or airway injury.[33] However, not all providers who practice in a critical care setting utilize the newer modalities, possibly due to lack of experience and familiarity with the newer techniques or evidence suggesting no benefit.[8,34] As an example, a recent survey among Canadian resuscitation physicians (intensive care and emergency medicine physicians) demonstrated that the majority utilize direct laryngoscopy with a MacIntosh laryngoscope blade as a primary device for emergent endotracheal intubations.[35] Our findings may be related to inexperience with the relatively new video laryngoscope devices and/or financial reasons.[8,34]

The endotracheal intubating provider at most institutions was a critical care physician or a midlevel provider (nurse practitioner or physician assistant). Some centers had anesthetist as the primary provider but a few allowed respiratory therapists to intubate. Despite evidence to show that having a senior-level staff clinician presence during the procedure decreased complications, surprisingly, only 80% of the respondents indicated a senior-level staff clinician was present.[36]

Studies suggest that the use of a systematic approach or protocol for airway management can reduce intubation complications.[37-39] This was recently demonstrated in a prospective trial utilizing an intubation management protocol whereby immediate severe life-threatening complications associated with intubation of ICU patients were reduced.[40] Despite this evidence, our cohort demonstrated it is underutilized. It is unclear why, although one could speculate that the effort to organize these protocols may be a barrier to their development and implementation.

The American Society of Anesthesiologists has developed an algorithm to follow when encountering a patient with a difficult airway.[41] However, only 67% of respondents indicated they have a plan for when they encounter a difficult airway. Thus, this seems to be another area for improvement. Unfortunately, if an adverse event occurs, only 49% have a documented process in place to review the event and make improvements in care delivered.

Limitations to this study include nonrespondent bias with a response rate of 51%, limited sample size, and the use of a survey that had not been previously validated from prior literature. However, the strength of this survey study is that the participants were from diverse geographical regions, and thus, this adds external validity to the results. In addition, the functionality of the survey was pilot tested among a random group of critical care physicians prior to implementation, which adds to the internal validity. Finally, these efforts have helped us plan and conduct a prospective multicenter observational study named "HEModynamic instability and AIRway management study (HEMAIR)"—Clinictrials.gov ID: NCT02508948 (reference—www.hemairregistry.org)

Conclusion

The results represent critical care physicians from a broad range of geographical practice settings. Although propofol was the induction drug of choice, ketamine was a medication that many indicated a desire to use, possibly relating to its hemodynamic profile. The most common complication following endotracheal intubation was hypotension. Direct laryngoscopy remains the primary airway technique for endotracheal intubation, despite mounting evidence demonstrating superior results with video laryngoscopy. Despite recommendations for its use to confirm endotracheal tube placement, capnography is underutilized. Similar results were obtained with the use of checklists. Finally, although the majority stated they had a difficult

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airway cart available, most did not have a documented plan in place when encountering a difficult airway or a documented process to review adverse events surrounding endotracheal intubations.

Authors' Note

The original research presented in this manuscript has not been published elsewhere. All authors had access to the data and participated in manuscript preparation. All ethical standards at Mayo Clinic, Rochester, Minnesota, were adhered. Reprint of any figures or tables is granted to Nathan Smischney. A portion of this work was submitted to SCCM 45th Critical Care Congress in abstract form.

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Supplemental Material

The online appendix is available at http://jic.sagepub.com/supplemental

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