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En route Care Research Center

SCIENTIFIC AND TECHNICAL REPORT

National Emergency Airway Registry (NEAR)

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NOTICE AND SIGNATURE PAGE

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14. ABSTRACT

In 2016, the SAMMC ED initiated research-based surveillance of its intubation practices as part of the National Emergency Airway Registry (NEAR), a multicenter, observational intubation registry coordinated through Brigham and Women's Hospital in Boston, Massachusetts. This protocol expands on the research of the previous NEAR studies by continuing surveillance of emergency intubation practices. The goal of this descriptive study was to evaluate various elements of endotracheal intubations, including demographics, intubation techniques, adverse events, success rates, and patient disposition. Data collection included vital sign measurements, post-intubation management and attempt-level intubation characteristics for all intubations in the San Antonio Military Medical Center (SAMMC) Emergency Department (ED). Data was entered into an

updated, web-based data collection tool (StudyTRAX) managed by the central site at Brigham and Women's Hospital, Boston, MA effective from the "go-live" date of 27 March 2016. All data collected prior this date to include data collected as part of the San Antonio Emergency Airway Registry (SEAR) internal PI initiative were entered into a locally maintained de-identified, password-protected Excel database for separate analysis. No personnel outside of SAMMC had access to protected health information (PHI) for the patients included at this site. The registry characterizes intubation practices in an effort to ultimately enhance patient safety.

For this study, we collected data from 503 patients who were intubated in the SAMMC ED as part of the NEAR study, of which 84.7% were successful upon first attempt. Most intubations were done using a video laryngoscope (57.3%). The most commonly used sedative was ketamine (58.3%) and most common paralytic agent was rocuronium (64.8%). Emergency medicine residents in their 2nd post-graduate year performed 62.0% of the intubations; 1st and 3rd year residents performed 17.5% and 14.7% of the intubations, respectively. Our findings suggest that SAMMC, together with off-service rotations at outside civilian hospitals, provide the emergency medicine trainees managing the majority of emergency airways at SAMMC with adequate procedure volume to maintain airway management competence. Multiple publications are ongoing as a result from data collected through this registry, with authors being those who contributed to this collaborative research effort. The specific topic of immediate interest for the SAMMC site investigators addressed with this data include, but is not limited to, the impact of intubation sedative agent on peri-procedural survival and hypotension.

15. SUBJECT TERMS

Airway management, endotracheal intubation, emergency medicine

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1.0 SUMMARY

Endotracheal intubation is a critical skill for emergency physicians. While anesthesiologists have historically taken ownership of the procedure, emergency physicians are increasingly responsible for performing this intervention. Studies over the past 2 decades estimate the proportion of emergency department (ED) intubations performed by emergency physicians ranges from 89% to 95%.[1-3] This procedure is of particular importance to the military emergency physician as airway emergencies account for 9% of preventable deaths on the battlefield.[4] Adequate experience with this procedure in-garrison helps to ensure physician readiness in executing this life-saving intervention in the deployed environment.

As the military's largest hospital and only level 1 trauma center, San Antonio Military Medical Center (SAMMC) is an ideal training platform that offers physicians such experience with intubation procedures. This facility is responsible for the care of active duty and retired military personnel, military beneficiaries, and shares emergency medical care responsibilities with area civilian hospitals for care of non-military trauma patients received from surrounding communities.

In 2016, the SAMMC ED initiated research-based surveillance of its intubation practices as part of the National Emergency Airway Registry (NEAR), a multicenter, observational intubation registry coordinated through Brigham and Women's Hospital in Boston, Massachusetts.[3,5] The goal of this descriptive study was to evaluate various elements of endotracheal intubations, including demographics, intubation techniques, adverse events, success rates, and patient disposition. We collected data from 503 patients who were intubated in the SAMMC ED as part of the NEAR study, of which 84.7% were successful upon first attempt. Most intubations were done using a video laryngoscope (57.3%). The most commonly used sedative was ketamine (58.3%) and most common paralytic agent was rocuronium (64.8%). Emergency medicine residents in their 2nd post-graduate year performed 62.0% of the intubations; 1st and 3rd year residents performed 17.5% and 14.7% of the intubations, respectively. Our findings suggest that SAMMC, together with off-service rotations at outside civilian hospitals, provide the emergency medicine trainees managing the majority of emergency airways at SAMMC with adequate procedure volume to maintain airway management competence.

2.0 INTRODUCTION

2.1 Background

Successful resuscitation of critically ill or injured patients requires effective ventilation and oxygenation. Airway failure can have dire hypoxic consequences for emergency patients. Approximately one million endotracheal intubations are performed per year in emergency departments in the United States alone[3] yet relatively little is known about variability in practice, success rates and outcomes from ED intubations.

The National Emergency Airway Registry is a multi-center prospective intubation registry. Prior to implementation of NEAR, intubations performed in emergency departments were explored primarily through the use of single-center studies.[6] The implementation of NEAR in 1996 provided investigators with the opportunity to examine intubation practices through the use of a multi-center emergency airway management registry, with the coordinating center in the Department of Emergency Medicine at Brigham and Women's Hospital in Boston, MA. To date, over thirty abstracts and manuscripts have resulted from NEAR and information from NEAR studies have been the focus of regional, national and international seminars. Airway registries focusing on emergency department patients are crucial. While much is known about airway management in the operating room, patients requiring emergency department airway management are different: they are unselected, more often high risk, critically ill or injured patients with a higher proportion of airway difficulty. In addition, intubation is mandatory and there is not an option to delay or avoid airway management. All of these factors can contribute to airway difficulty, repeated intubation attempts, peri-intubation adverse events and patient morbidity/mortality.

2.2 Importance

NEAR continues to provide an opportunity for investigators to explore the many factors that contribute to intubation events and the impact on patient safety. Previous NEAR studies have shed light on trainee intubation practices,[2] expected intubation success rates in ED patients,[7] drugs selected,[8] and the influence newer video devices have on intubation view.[9] There remain many unanswered questions regarding vital sign stability during rapid sequence intubation (RSI), the integration of newer video devices, the utility of pre-hospital intubation, emergency airway management by non-physicians, and the safety of select induction agents. Through the use of the NEAR registry data, investigators are able to resolve concerns with conflicting research reported in the literature. One such example is the use of etomidate and the increased risk of mortality. Tran et al. (2015) found that a bolus dose of etomidate is linked with an increased risk of death in a population of patients with septic shock.[10] A previous multi-center report in 2011 had also noted an associated increased rate of mortality among septic patients with the use of etomidate..[5] However, other randomized controlled trials did not find an increased risk of mortality associated with etomidate use in critically ill patients.[11] NEAR

registry data has provided investigators with the opportunity to better understand the effects of etomidate on intubated patient outcomes and explore many additional aspects of intubation practices related to any unforeseen risk of mortality. This large, robust airway registry continues to refine our understanding of key practices that help to mitigate patient safety issues.

2.3 Goals of This Investigation

The goal of this descriptive study was to evaluate various elements of endotracheal intubations, including demographics, intubation techniques, adverse events, success rates, and patient disposition.

3.0 METHODS

3.1 Study Design and Setting

We conducted a descriptive analysis of the SAMMC ED NEAR database and analyzed data from intubations performed in the SAMMC ED as part of the National Emergency Airway Registry (NEAR), a prospective registry of ED intubations performed at an international network of academic hospitals.

3.2 Selection of Participants

We included all data from patients who were entered into the NEAR database at the SAMMC ED from March 2016 to March 2018. These data were collected as part of the larger NEAR study.

3.3 Measurements

Healthcare providers performing endotracheal intubations in the BAMC ED completed data collection forms for each intubation event. These forms solicited information on patient demographics, intubation techniques, and intubation outcomes, including success or failure, adverse events, and patient disposition. We cross-referenced these forms against the numbers of intubation events reported in the ED nursing daily reports to ensure capture of all intubations. Providers completed forms for every intubation within 6 weeks of the procedure.

3.4 Outcomes

The primary outcome was first-pass intubation success. Secondary outcomes included incidence of any adverse event. We defined an adverse event as the occurrence of any of the following events captured by the NEAR data collection forms: cardiac arrest (loss of pulses during or immediately after intubation), dental trauma, direct airway injury, dysrhythmias, epistaxis, esophageal intubation (per clinical diagnosis, visualization, or capnography), hypotension (systolic blood pressure <100 mmHg), hypoxia (oxygen saturation <90%), iatrogenic bleeding, laryngoscope failure, laryngospasm, lip laceration, main-stem bronchus intubation (as diagnosed clinically or by chest radiograph), malignant hyperthermia, medication error, pharyngeal laceration, pneumothorax (diagnosed clinically or by chest radiograph), endotracheal tube cuff failure, or vomiting (forceful expulsion of gastric contents). Other outcomes examined included best Cormack-Lehane view[11] and lowest peri-intubation oxygenation saturation.

3.5 Analysis

We conducted a descriptive analysis of the SAMMC ED NEAR database. Nominal variables are presented as percentages (with 95% confidence interval [CI]), non-normal continuous variables as medians (with interquartile range [IQR]), and normally-distributed continuous variables as means (with standard deviation [SD]).

4.0 RESULTS

4.1 Characteristics of Study Subjects

We collected data from 503 patients who were intubated in the SAMMC ED as part of the NEAR study. The majority of patients were male (74.6%) and the average age was 45.8 (SD 21.9). The average weight was 82.3 kg (SD 22.0) and almost half (46.7%) of patients had a BMI in the normal range. About 31% of patients were either obese or morbidly obese, whereas 21.7% were considered thin or very thin.

The most common indication was traumatic (68.6%), followed by medical (31.4%). Over half of the patients had a difficult airway as judged by the provider (51.3%) and reduced neck mobility (55.1%).

Most intubations were done using a video laryngoscope (57.3%). The most commonly used sedative was ketamine (58.3%) and most common paralytic agent was rocuronium (64.8%).

Emergency medicine residents in their 2nd post-graduate year performed 62.0% of the intubations; 1st and 3rd year residents performed 17.5% and 14.7% of the intubations, respectively.

These patient characteristics are summarized in Table 1.

4.2 Main Results

The first-pass success rate for intubations in the SAMMC ED was 84.7%. The overall success rate (over multiple attempts) was 99.0%. Approximately 15% of patients experienced peri-intubation desaturation; the average oxygen saturation nadir for those patients was 68% (see Table 2).

About a quarter of patients experienced an adverse event; these events included hypoxia (14.1%), hypotension (7.4%), cardiac arrest (2.2%), and vomiting (1.6%). Most patients who experienced an adverse event experienced more than one (see Table 3).

Table 1. Patient characteristics

Variable	All patients (n=503)
Mean age (SD), y	45.8 (21.9)
Sex (female), % (95% CI)	25.4 (21.6-29.2)
Mean weight (SD), kg	82.3 (22.0)
Body Habitus, % (95% CI)	
Very thin	3.8 (2.1-5.5)
Thin	17.9 (14.5-21.3)
Normal	46.7 (42.3-51.1)
Obese	25.2 (21.4-29.0)
Morbidly obese (BMI >40 kg/m2)	6.0 (3.9-8.1)
Starting oxygen saturation (SD), %	92.9 (20.3)
Pre-intubation hypotension (SBP <100), % (95% CI)	19.1 (15.7-22.5)
Indication, % (95% CI)	
Medical	31.4 (27.3-35.5)
Traumatic	68.6 (64.5-72.7)
Initial impression of difficult airway, % (95% CI)	51.3 (46.9-55.7)
Reduced neck mobility, % (95% CI)	55.1 (50.8-59.4)
Median Mallampati score (IQR)	3 (2-3)
Reduced mouth opening, % (95% CI)	25.8 (22.0-29.6)
Airway obstruction, % (95% CI)	8.9 (6.4-11.4)
Facial trauma, % (95% CI)	34.2 (30.1-38.3)
Blood or vomit in airway, % (95% CI)	39.4 (35.1-43.7)
Device, % (95% CI)	
Laryngoscope	42.3 (38.0-46.6)
Video laryngoscope	57.3 (53.0-61.6)
Sedation agent, % (95% CI)	
Etomidate	21.7 (18.1-25.3)
Ketamine	58.3 (54.0-62.6)
Propofol	3.2 (1.7-4.7)
Midazolam	0.6 (0.0-1.3)
None	16.3 (13.1-19.5)
Paralytic agent, % (95% CI)	
Rocuronium	64.8 (60.6-69.0)
Succinylcholine	20.5 (17.0-24.0)
Vecuronium	0.2 (0.0-0.6)
None	14.5 (11.4-17.6)
Intubator characteristics, % (95% CI)	
Emergency medicine PGY1	17.5 (14.2-20.8)
Emergency medicine PGY2	62.0 (57.8-66.2)
Emergency medicine PGY3	14.7 (11.6-17.8)
Emergency medicine PGY4	0
Emergency medicine fellow	0
Emergency medicine attending physician	3.0 (1.5-4.5)
Other (nonemergency medicine)	2.8 (1.4-4.2)

Table 2. First-pass intubation outcomes

Variable	All patients (n=503)
First-pass intubation success, % (95% CI)	84.7 (81.6-87.8)
Overall intubation success, % (95% CI)	99.0 (98.1-99.9)
Cormack-Lehane view grade 1–2, % (95% CI)	87.1 (84.2-90.0)
Median best first-attempt glottic view (IQR)	1 (1-2)
Peri-intubation desaturation, % (95% CI)	15.1 (12.0-18.2)
Mean oxygen saturation nadir (SD)*	68.0 (22.8)

* Mean oxygen saturation nadir only reported for those who experienced peri-intubation hypotension (n=75).

Table 3. Adverse events

Variable	All patients (n=503)
Adverse events (% of encounters)	
Any adverse event	24.3 (20.6-28.0)
Hypoxia	14.1 (11.1-17.1)
Hypotension	7.4 (5.1-9.7)
Cardiac arrest	2.2 (0.9-3.5)
Vomiting	1.6 (0.5-2.7)
Esophageal intubation	1.4 (0.4-2.4)
Dysrhythmias	1.2 (0.2-2.2)
Main-stem intubation	1.2 (0.2-2.2)
Lip laceration	0.6 (0.0-1.3)
Laryngoscope failure	0.2 (0.0-0.6)
Endotracheal tube failure	0.2 (0.0-0.6)
Iatrogenic bleeding	0.2 (0.0-0.6)
Dental trauma	0.0 (0.0-0.0)
Laryngospasm	0.0 (0.0-0.0)
Epistaxis	0.0 (0.0-0.0)
Pneumothorax	0.0 (0.0-0.0)
Direct airway injury	0.0 (0.0-0.0)
Malignant hypertension	0.0 (0.0-0.0)
Medical error	0.0 (0.0-0.0)
Pharyngeal laceration	0.0 (0.0-0.0)
Number of adverse events (% of encounters)	
0	75.7 (72.0-79.4)
1	0.2 (0.0-0.6)
2	19.1 (15.7-22.5)
3	4.0 (2.3-5.7)
4	1.0 (0.1-1.9)

5.0 DISCUSSION

5.1 Conclusions

Endotracheal intubation is a critical skill for military healthcare providers as part of combat casualty care in the deployed environment.[12-14] In total, we reported 503 intubations, of which 84.7% were successful upon first attempt. These data provide an overview of the stateside emergency airway management experience at the military's largest hospital and only level 1 trauma center. The indications for a majority (68.6%) of intubations were related to trauma. This reflects the SAMMC trauma program's treatment of civilian trauma patients.[15] Our results highlight the substantial proportion of our procedural experience arising from our participation in this program. By extension, these results highlight the importance of our participation in this program in maintaining the medical readiness of our force.

Our first-pass success percentage of 84.7% is identical to that reported for ED centers nationwide as part of the NEAR registry during 2002-2012.[3] This suggests a comparable level of skill between the military practitioners in our hospital compared to civilian counterparts. This finding is noteworthy given recognition of the importance of experience and patient volume for procedural competence.[16] Indeed, authors have voiced concerns regarding the potential lack of adequate exposure to sufficient procedure volume in domestic military treatment facilities for military healthcare providers to achieve and maintain clinical skills.[17-18] Our findings suggest that SAMMC, together with off-service rotations at outside civilian hospitals, provide the emergency medicine trainees managing the majority of emergency airways at SAMMC with adequate procedure volume to maintain airway management competence.

5.2 Limitations

This study has several limitations. As a descriptive study, we are unable to ascertain whether the apparent trends we observed (e.g., higher first-pass success with video as compared to direct laryngoscopy) reflect correlation or causation. Moreover, given that it is a single-center study, we had an inadequate sample size to perform inferential analyses comparing first-pass success across alternative RSI regimens or intubation devices while controlling for potential confounders (e.g., regression models, propensity matching). Moreover, given our reliance upon self-reported data, it is possible that biased responses skewed our results towards more favorable outcomes. Reporting of some adverse events, in particular, is more subjective than others and could result in under-reporting due to reporting bias. Another important limitation is that our results may have limited generalizability. The environment of SAMMC is unique. As a military hospital, its experience may not be representative of the experience at civilian hospitals. Simultaneously, as the military's largest academic hospital and an urban tertiary care

center, our data may not reflect the emergency airway management experience at smaller military treatment facilities or in the deployed environment. Nevertheless, generalizability was not our intent. Rather, we sought to describe the in-garrison experience for stateside military healthcare professionals at the epicenter of military medicine. In so doing, our intention was to provide military trainees, educators, and leaders alike with a better understanding of the context in which military physicians practice and maintain readiness with regards to emergency airway management, a skill known to be critical for saving lives on the battlefield.[4]

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APPENDIX: Publications and Presentations

A.1 Publications

1. April MD, Arana A, Pallin DJ, Schauer SG, Fantegrossi A, Fernandez J, Maddry JK, Summers SM, Antonacci MA, Brown III CA, NEAR Investigators. Emergency Department Intubation Success with Succinylcholine Versus Rocuronium: A National Emergency Airway Registry Study. *Ann Emerg Med.* 2018 Dec;72(6):645-653.
   https://www.ncbi.nlm.nih.gov/pubmed/29747958
2. April MD, Schauer SG, Brown Rd CA, Ng PC, Fernandez J, Fantegrossi AE, Maddry JK, Summers S, Sessions DJ, Barnwell RM, Antonacci M. A 12-month descriptive analysis of emergency intubations at Brooke Army Medical Center: a National Emergency Airway Registry study. *US Army Med Dep J.* 2017 Oct-Dec;(3-17):98-104.
   https://www.ncbi.nlm.nih.gov/pubmed/29214627

A.2 Presentations

1. April MD, Schauer SG, Fernandez JD, Maddry JK, Medellin K, Summers SM, Sessions D, Barnwell RM, Antonacci MA. Emergency airway management at San Antonio Military Medical Center: A 12- month descriptive analysis. San Antonio Military and Universities Research Forum, San Antonio, TX, June 2017 (Oral)

2. April MD, Schauer SG, Fernandez JD, Maddry JK, Medellin K, Summers SM, Sessions D, Barnwell RM, Antonacci MA. Emergency airway management at San Antonio Military Medical Center: A 12- month descriptive analysis. Military Health System Research Symposium (MHSRS), Orlando, FL, August 2017 (Poster)

3. Shults N, April M, Schauer S, Fernandez J, Maddry J, Medellin K, Summers S, et. al. Emergency Airway Management at Brooke Army Medical Center: a 24-month Descriptive Analysis, San Antonio Military Health System and Universities Research Forum (SURF), San Antonio, TX, June 2018 (Poster)

4. Arana AA, Shults N, April MD, Schauer SG, Fernandez JD, Maddry JK, Medellin K, Summers S, Sessions D, Barnwell R, Antonacci M. Emergency Airway Management at Brooke Army Medical Center: A 24-month Descriptive Analysis. Military Health Science Research Symposium. Orlando, FL, August 2018 (Poster)

LIST OF SYMBOLS, ABBREVIATIONS, AND ACRONYMS

NEAR, National Emergency Airway Registry

SEAR, San Antonio Emergency Airway Registry

SAMMC, San Antonio Military Medical Center

ED, emergency department

RSI, rapid sequence intubation

mmHg, millimeters of mercury

SD, standard deviation

CI, confidence interval

y, years

kg, kilograms

SBP, systolic blood pressure

IQR, interquartile range

PGY, post-graduate year