

Alternating Day Emergency Medicine and Anesthesia Resident Responsibility for Management of the Trauma Airway: A Study of Laryngoscopy Performance and Intubation Success

Richard M. Levitan, MD
Boaz Rosenblatt, MD
Evan M. Meiner, MD
Patrick M. Reilly, MD
Judd E. Hollander, MD

From the Departments of Emergency Medicine (Levitan, Rosenblatt, Hollander) and Trauma Surgery and Critical Care Medicine (Reilly), University of Pennsylvania School of Medicine, Philadelphia, PA; and the Department of Emergency Medicine (Meiner), North Shore University Hospital, Manhasset, NY.

Study objective: We compare laryngoscopy performance and overall intubation success in trauma airways when primary airway management alternated between emergency medicine and anesthesia residents on an every-other-day basis.

Methods: Data on all trauma intubations during approximately 3 years were prospectively collected. Primary airway management was assigned to emergency department (ED) residents on even days and anesthesia residents on odd days. Emergency medicine residents intubated patients who arrived without notification or who needed immediate intubation before anesthesia arrived. The study was conducted in an inner-city, Level I trauma center with approximately 50,000 ED patients and 1,800 major trauma cases a year. Main outcomes were success or failure at laryngoscopy and the number of laryngoscopy attempts needed for intubation.

Results: Six hundred fifty-eight trauma patients were intubated during the study period. Laryngoscopy was successful in 654 of 656 cases. Two (0.3%) patients underwent cricothyrotomy after failed laryngoscopy, and 2 (0.3%) patients had awake nasal intubation without laryngoscopy. The specific number of laryngoscopy attempts was unknown in 6 cases (3 from each service), resulting in 650 cases for laryngoscopy performance analysis. Overall, 87% of patients were intubated on first attempt, and 3 or more attempts occurred in 2.9% of patients. Laryngoscopy performance by service (broken down by 1, 2, and B3 attempts) was as follows: emergency medicine 86.4%, 11%, and 2.6% versus anesthesia 89.7%, 6.7%, and 3.6%. Analysis by service was done by using Wilcoxon Mann-Whitney testing ($P=.225$).

Conclusion: There were no differences in laryngoscopy performance and intubation success in trauma airways managed on an every-other-day basis by emergency medicine versus anesthesia residents.

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INTRODUCTION

In the past 20 years, there has been a marked increase in the number of emergency medicine residency training programs, especially at major academic medical centers. Program accreditation in emergency medicine mandates resident experience with intubation, use of neuromuscular blocking agents, and direction of all types of major resuscitations.¹ The role for emergency medicine residents in management of trauma

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Capsule Summary***What is already known on this topic***

Who is in charge of airway management of trauma patients at academic medical centers has been a focus of debate during the past decade, with anesthesia claiming primary responsibility at many centers.

What question this study addressed

This study prospectively compared alternating-day trauma airway management by anesthesia and emergency medicine residents over a 3-year period at an inner-city teaching hospital.

What this study adds to our knowledge

There was no difference in intubation success rates between emergency medicine and anesthesia residents supervised by attending emergency physicians.

How this might change clinical practice

This study demonstrates that supervised emergency medicine residents provide primary trauma airway management that is as effective as that of anesthesia residents.

airways has been a matter of debate, however, at some trauma centers where anesthesia personnel are readily available. Anesthesiologists had primary responsibility for trauma airway management at the vast majority of academic centers, according to an anesthesiologist's survey of anesthesia residency program directors in 1997.² A recent study at a major regional trauma center involving more than 14,000 intubations asserted that having an anesthesiologist manage the airway correlated with a decreased incidence of failed airways and cricothyrotomy.³

With the growth of emergency medicine training programs, some trauma centers have transitioned completely to emergency medicine residents managing trauma airways, reportedly with minimal differences in overall success rates or the incidence of multiple laryngoscopy attempts.^{4,5} Our institution, which historically had good success rates with aggressive use of rapid sequence intubation in trauma patients, was committed to maintaining anesthesia resident involvement with trauma airways.⁶ An emergency medicine residency program was begun at our institution in 1996, and starting in 1999, senior emergency medicine residents (postgraduate years 3 and 4) began sharing trauma airway responsibility with anesthesia residents.

The goal of this study was to prospectively compare airway management results throughout a 3-year period when residents from each service had primary responsibility for trauma airways on an every-other-day basis.

METHODS**Theoretical Model of the Problem**

It was our belief that experienced laryngoscopists could achieve similar laryngoscopy performance in trauma patients, regardless of specialty. Shared responsibility of trauma airways could provide emergency medicine and anesthesia residents with the educational experience of managing trauma airways without compromising the quality of patient care. We believe that first-pass success and number of laryngoscopy attempts are potentially significant factors in patient care, as is laryngoscopy failure, and should also be assessed in any comparative performance study.

Study Design and Setting

We performed a prospective, observational study in trauma patients to compare laryngoscopy performance performed by emergency medicine residents with that of anesthesia residents by using an even-day/odd-day randomization scheme.

The study was conducted at an academic, inner-city, Level I trauma center with an emergency department (ED) census of approximately 50,000 and approximately 1,800 major trauma patients a year. The study was conducted throughout an approximately 37-month period from August 21, 1999, to September 23, 2002.

Selection of Participants

All patients who were intubated in the trauma bay were included in the study. Notification by emergency medical services ground or helicopter crews was provided in the majority of cases. In cases with notification, responsibility for intubation was provided by anesthesiology residents on odd days and emergency medicine residents (postgraduate year 3 or 4) on even days. Anesthesia residents performing intubation included senior and junior residents (clinical anesthesia year 1 to year 3), but clinical anesthesia year 1 residents never responded alone. Police units, however, commonly transport penetrating trauma cases (often without notification or with short notification) to our institution. In instances when patients needed emergency intubation and arrived without notification (or with insufficient time for anesthesia residents to respond) or in situations of multiple trauma patients, emergency medicine residents sometimes performed the intubation even though it was an assigned anes-

sia day. All airways were directly supervised by emergency medicine faculty on odd and even days.

Methods of Measurement

The following data were collected on each intubation: service that performed intubation, number of laryngoscopy attempts, success or failure at laryngoscopy, performance of cricothyrotomy, and major immediate complications. All patients were also characterized as blunt or penetrating trauma or inhalational or burn injury according to their mechanism of injury in the trauma registry. Other data, such as patient demographic characteristics and the Injury Severity Score, were obtained from the trauma registry. Each laryngoscopy blade insertion was defined to be 1 attempt. Major immediate complications were limited to those reported specifically on the data sheets by either the recording nurse or person managing the airway, including clinically evident aspiration (by observation and immediate postintubation chest radiograph), critical hypoxia causing hemodynamic instability, or cardiac arrest related to airway management.

Data Collection and Outcome Measures

Data were prospectively collected by using a dedicated emergency airway data sheet and the Trauma/Critical Care Department flow sheet. The Trauma/Critical Care Department flow sheet was completed by the assigned recording nurse for each major trauma resuscitation in accordance with policies set forth by the Pennsylvania Trauma Systems Foundation requirements for Level I trauma centers. Both of these sheets were completed prospectively at the initial evaluation. Major data points for this specific study (ie, service, number of laryngoscopy attempts, success/failure, cricothyrotomy) were included on both sheets to maximize data capture. These data points were self-reported by the laryngoscopist on the airway data sheet, although they were also objectively documented by the nurse on the Trauma/Critical Care Department flow sheet. All data were subsequently entered into Collector Trauma Registry software (Digital Innovation, Inc., Forest Hill, MD).

Primary Data Analysis

First-pass success rates and the rate of 3 or more laryngoscopy attempts are presented as percentages. An analysis of difference between services that examined the number of laryngoscopy attempts and incidence of cricothyrotomy was made with the Wilcoxon Mann-

Whitney test (StatXact, version 5.03; Cytel Software Corporation, Cambridge, MA).

The study was approved by the institutional review board.

RESULTS

Characteristics of Study Subjects

Six hundred fifty-eight patients were intubated during the study period. Of these, 460 intubations were performed by emergency medicine residents and 198 intubations were performed by anesthesia residents. Patients had a mean age of 38.4 ± 17.2 years. There were 539 (82%) male patients and 120 (18%) female patients. There were 456 (69%) black patients and 182 (28%) white patients, and 18 (0.03%) patients were either Asian or Hispanic. Race was undetermined in 2 patients. The type of traumatic injury was most often blunt (55%). Penetrating trauma occurred in 42% of patients, and the remainder were inhalational or burn injuries. Comparison of the patient composition and severity of illness among patients in the 2 study groups is shown in Table 1.

Among the 658 patients, laryngoscopy was attempted in 656 patients and was successful in 654 patients. Two patients were nasally intubated without laryngoscopy attempts (see later in this section). The actual number of intubation attempts was unknown in 6 patients, 3 who were intubated by emergency medicine residents and 3 who were intubated by anesthesia residents. In each of these cases, the nurses' notes on the Trauma Critical Care Department flow sheets were reviewed,

Table 1.
Comparison of patients treated on emergency medicine and anesthesia days.

	Emergency Medicine	Anesthesia
Age, y (range)	38.6 (37.0–40.3)	37.8 (35.6–39.9)
Male sex, %	80.8	83.8
Race, %		
Black	69	70.4
White	28.4	26.5
Other	2.6	2.1
Type of trauma, %		
Blunt	51.5	62.6
Penetrating	46.3	33.9
Inhalation	2.2	3.5
Injury Severity Score (range)	19.7 (18.0–21.4)	17.7 (15.5–19.9)

and there were no reported problems with any of the laryngoscopies, but because the specific number of attempts was not written, they were excluded from subsequent laryngoscopy performance analysis.

After excluding these 6 patients and the 2 patients who were nasally intubated without any laryngoscopy efforts, 650 cases were available for laryngoscopy performance analysis. Overall, the majority of patients were intubated on the first attempt (568/650 [87%]). Sixty-three (9.6%) patients required 2 attempts, and 19 (2.9%) patients required 3 or more attempts.

Both cricothyrotomy cases involved failed laryngoscopy, but only 1 followed rapid sequence intubation. One cricothyrotomy case involved a morbidly obese man who was brought by police in cardiac arrest after a single gunshot to the upper chest and with massive bleeding into his airway. The other cricothyrotomy case involved a blunt trauma patient who was able to be mask ventilated after rapid sequence intubation but could not be intubated by the emergency medicine resident, the emergency medicine attending physician, or an anesthesia attending physician. After multiple attempts by both services, the patient received a cricothyrotomy. For statistical purposes, this instance was counted as an emergency medicine case. Anesthesia personnel succeeded in 2 cases in which 3 or more laryngoscopy attempts had initially been made by emergency medicine residents. Conversely, emergency medicine attending physicians ultimately succeeded at laryngoscopy in 2 cases primarily managed by anesthesia residents, which involved 3 or more laryngoscopy attempts.

Awake nasal intubation was used in 2 cases, once by anesthesia (over a fiberoptic) and once by emergency medicine (blind). The fiberoptic intubation was done on a blunt trauma patient with a C4 to C5 spine fracture and evolving respiratory insufficiency approximately 90 minutes after arrival in the trauma bay. The blind intubation was done on an agitated patient with 2 closely spaced gunshot wounds in the upper occipital cranium. Immediately before planned rapid sequence intubation, he was noticed to have a wired jaw from a recent mandible fracture, and he was blindly intubated with a trigger tube (Endotrol; Nellcor Tyco Healthcare, Pleasanton, CA) on first pass. Subsequent computed tomography showed a depressed skull fracture at the gunshot wound site and an epidural hematoma.

No major immediate complications attributable to airway management were identified in any patient.

Main Results

The main outcome of the study was intubation success classified according to the number of laryngoscopy attempts required: 1, 2, or 3 or more (Table 2).

Comparison between emergency medicine and anesthesia laryngoscopy performance as defined by a 4×2 table (Table 2, emergency medicine versus anesthesia, and 4 rows: 1, 2, and B3 attempts and cricothyrotomy) was statistically assessed by using the Wilcoxon Mann-Whitney test, with a resultant P value equal to .225. The difference in the rate of 3 or more attempts between emergency medicine and anesthesia was 0.977%; the 95% confidence interval (CI) for this difference is 0% to 4.67%.

LIMITATIONS

Our study has several limitations. We did not address anything other than immediately evident major complications (ie, cardiac arrest attributable to airway management, hemodynamic instability caused by hypoxia, immediately clinically evident aspiration). According to our data about laryngoscopy performance and because we have a standardized clinical practice guideline for rapid sequence intubation, we doubt that there are any clinical differences resulting from airway man-

Table 2. Overall intubation success, methods, and direct laryngoscopy performance.

	Emergency Medicine	Anesthesia
Total intubations	460	198
Nasal intubation (no DL tried)	1	1
Total DL attempted	459	197
Number DL attempts unknown*	3	3
Total DL attempts known	456	194
Successful intubation by DL	454	194
Intubated on first DL, No. (%) [ratio]	394 (86.4) [394/456]	174 (89.7) [174/194]
Intubated on second DL, No. (%)	50 (11.0)	13 (6.7)
Intubated B3, No. (%) [95% CI]	12 (2.6) [1.4–4.6]	7 (3.6) [1.5–7.3]
Cricothyrotomy (ie, failed DL†), No. (%)	2 (0.4)	0‡

DL, Direct laryngoscopy.
*Actual DL attempts unknown, but DL intubation successful without problem according to nursing notes.
†Cricothyrotomy cases and tabulation of numbers: The 2 cricothyrotomy cases involved B3 laryngoscopy attempts and are counted in this group. The total number of emergency medicine–managed cases was 460; the 3 cases of unknown number of DL cases and the 1 nasal case were excluded from analysis of DL attempts, leaving 456 cases remaining, of which 454 patients underwent successful laryngoscopy.
‡An anesthesia attending physician attempted DL in 1 of the cricothyrotomy cases, but it began with emergency medicine residents and was listed under emergency medicine (see Discussion).

agement by emergency medicine residents versus anesthesia residents, but we did not investigate any less significant complications.

The number of laryngoscopy attempts, although defined as one blade insertion equals one attempt, may not be universally agreed on by different operators and observers, and such characterization may not completely reflect laryngoscopy difficulty. We did not, for instance, characterize duration of laryngoscopy effort or number of adjustments made with a given blade insertion. We relied on self-reporting of laryngoscopy attempts and nursing notes. A more detailed and objective means of determining laryngoscopy attempts would involve video imaging and analysis of each case. We were missing the number of laryngoscopy attempts in 3 cases from each service, although we know from nursing notes and chart review that these patients had uneventful laryngoscopies and that none of these patients received a surgical airway or had any airway-related complications. They were excluded from our laryngoscopy performance analysis.

We did not do subgroup analysis of emergency medicine intubations into those that involved patients with notification versus patients without notification. Among the 12 patients intubated by emergency medicine residents with 3 or more attempts (which includes the 2 failed laryngoscopies), only 2 of 12 had identical notification and arrival times. The 2 failed laryngoscopy cases involved notification. The small sample size of “problem” intubations does not allow meaningful analysis of what role the lack of notification may contribute to such cases.

Among patients intubated by anesthesia residents, there was a higher percentage of cervical spine-immobilized patients (62.6% versus 51.5% of emergency medicine-intubated patients). Theoretically, cervical spine immobilization could contribute to laryngoscopy difficulty. Overall, 13 of 19 patients who underwent 3 or more attempts had blunt trauma versus 6 with penetrating trauma. All of the anesthesia cases that involved 3 or more attempts had blunt trauma; among the 12 emergency medicine cases with 3 or more attempts, 6 involved blunt trauma and 6 involved penetrating trauma (2 of these patients had gunshot wounds to the neck). The small numbers of patients with failed laryngoscopy or 3 or more attempts preclude statistical analysis of laryngoscopy difficulty according to blunt or penetrating classification.

From a statistical perspective, although we evaluated our institutional strategy of alternating days with re-

sponsibility for the trauma airway, we did not compare the success rates of individual anesthesia or emergency medicine residents. Because we did not intend to perform that comparison, we did not capture data that would allow us to control for the individual performing the intubation. It is possible that the majority of airways requiring 3 or more intubations were managed by a select few individuals in the respective programs. Because we did not capture data on the individual intubator, we cannot do a performance analysis of anesthesia or emergency medicine intubations by level of training. It is possible that more junior residents from each service were responsible for a disproportionate number of problem cases.

The decision to perform a surgical airway was made by the trauma attending physician and the emergency medicine attending physician. The threshold to perform the procedure may vary among different attending physicians and, given the small number of such cases, this variable cannot be separately assessed by our data.

DISCUSSION

Our study found that alternating responsibility for trauma airways on an every-other-day basis between emergency medicine and anesthesia residents did not result in statistically different laryngoscopy results in trauma airways, whether defined by number of laryngoscopy attempts or by intubation failure resulting in cricothyrotomy. The groups were comparable in terms of demographic characteristics, although emergency medicine residents did many more intubations than anesthesia residents and had a higher percentage of penetrating trauma cases. These data reflect the fact that many penetrating trauma cases arrived without notification or with short notification. Emergency medicine residents were immediately available to intubate any patients who required intubation on presentation.

Our overall cricothyrotomy rate of 0.3% compares favorably with the cricothyrotomy rate of 0.5% reported by Jaber et al³ at a regional center where all airway management is exclusively provided by anesthesiologists. Jaber et al assert in their abstract that anesthesiologist management of the trauma airway results in a lower incidence of failed airways compared with that of previous case series involving either paramedics or emergency physicians, but they cited only 2 references for comparative purposes, and the ED study they reference was from 1989. More recent trauma airway management in emergency medicine

programs has involved increased use of rapid sequence intubation, which has correlated with a marked decrease in the incidence of cricothyrotomy.^{7,8} Two recent emergency medicine studies have reported cricothyrotomy rates after failed laryngoscopy of 0.6% to 1.1%.^{9,10}

During the period of this study, 2 other studies on laryngoscopy performance were simultaneously conducted in the operating rooms of our institution, collectively involving 8,167 intubations.^{11,12} Comparing laryngoscopy performance in our operating rooms with that of our trauma bay, our results do not support the overall assertion that "trauma" airways generally involve more laryngoscopy difficulty than operating room intubations. In the larger of the 2 studies, involving 6,419 cases, 3 or more attempts occurred in 2.8% (177/6,419).¹¹ In the other operating room study involving 1,748 patients, 3 or more laryngoscopy attempts occurred in 49 patients, also for an overall incidence of 2.8%.¹² Among the 656 patients in our study who underwent laryngoscopy (excluding the 2 nasal cases), 3 or more attempts occurred in 19, for an overall rate of 2.9%.

In retrospect, the study would have been improved if video recording had been used for data acquisition on the number and duration of laryngoscopy attempts, as well as real-time documentation of immediate adverse events (ie, hypoxia, bradycardia). Recording of laryngoscopy performance by individual would also have permitted a more sophisticated statistical comparison of performance that could have addressed the contributions of specific individuals.

In summary, our data show that alternating primary responsibility for trauma airway management between emergency medicine residents and anesthesia residents produced similar laryngoscopy results, with an overall low incidence of repeated laryngoscopy (B3 attempts=2.9%) and a low incidence of cricothyrotomy (0.3%).

Author contributions: RML, PMR, and JEH designed the study. BR, EMM, and PRM were involved in data collection, and JEH performed statistical analysis. RML drafted the manuscript, and all authors contributed to its revision. RML takes responsibility for the paper as a whole.

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Address for correspondence: Richard M. Levitan, MD, Department of Emergency Medicine, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104; 215-662-7260, fax 215-662-3953; E-mail levitanr@mail.med.upenn.edu.

REFERENCES

1. Accreditation Council for Graduate Medical Education. Program requirements for residency education in emergency medicine. Available at: <http://www.acgme.org/req/110pr101.asp>. Accessed August 8, 2002.
2. Nayyar P, Lisbon A. Non-emergency room airway management and endotracheal intubation practices: a survey of anesthesiology program directors. *Anesth Analg*. 1997;85:62-68.
3. Jaber M, Mitchell K, MacKenzie C. Cricothyrotomy: good, bad, or ugly [abstract]? *Trauma Care*. 2001;11:13.
4. Bushra JS, McNeil B, Wald D, et al. A comparison of trauma intubations managed by anesthesiologists and emergency physicians. *Acad Emerg Med*. 2002;9:404-405.
5. Omert L, Yeaney W, Mizikowski S, et al. Role of the emergency physician in airway management of the trauma patient. *J Trauma*. 2001;51:1065-1068.
6. Rotondo MF, McGonigal MD, Schwab CW, et al. Urgent paralysis and intubation of trauma patients: is it safe? *J Trauma*. 1993;34:242-246.
7. Chang RS, Hamilton RJ, Carter WA. Declining rate of cricothyrotomy in trauma patients with an emergency medicine residency: implication for skills training. *Acad Emerg Med*. 1998;5:247-251.
8. Brunette DD. Twelve years of emergency medicine at Hennepin County Medical Center: changing critical care experience. *Minnesota Med*. 1999;82:42-48.
9. Sakles JC, Laurin EG, Rantapaa AA, et al. Airway management in the emergency department: a one-year study of 610 tracheal intubations. *Ann Emerg Med*. 1998;31:325-332.
10. Bair A, Filbin M, Kulkarni R, et al. The failed intubation attempt in the emergency department: analysis of prevalence, rescue techniques, and personnel. *J Emerg Med*. 2002;23:131-140.
11. Ochroch AE, Hollander JE, Levitan RM. POGO score as a predictor of intubation difficulty and need for rescue devices [abstract]. *Ann Emerg Med*. 2000;36(Pt 2):A199.
12. Ochroch EA, Eckmann DM. Clinical application of acoustic reflectometry in predicting the difficult airway. *Anesth Analg*. 2002;95:645-649.