A Comparison of Prehospital Versus Emergency Department Intubations in Iraq and Afghanistan

Steven G. Schauer, DO, MS[1]; Michael D. April, MD, DPhil[2]; Lloyd I. Tannenbaum, MD[3]; Joseph K. Maddry, MD[4]; Cord W. Cunningham, MD, MPH[5]; Megan B. Blackburn, PhD[6]; Allyson A. Arana, PhD[7]; Stacy A. Shackelford, MD[8]*

ABSTRACT

Background: Airway obstruction is the second most common cause of potentially preventable death on the battlefield. We compared survival in the combat setting among patients undergoing prehospital versus emergency department (ED) intubation. **Methods:** Patients were identified from the Department of Defense Trauma Registry (DODTR) from January 2007 to August 2016. We defined the prehospital cohort as subjects undergoing intubation prior to arrival to a forward surgical team (FST) or combat support hospital (CSH), and the ED cohort as subjects undergoing intubation at an FST or CSH. We compared study variables between these cohorts; survival was our primary outcome. **Results:** There were 4341 intubations documented in the DODTR during the study period: 1117 (25.7%) patients were intubated prehospital and 3224 (74.3%) were intubated in the ED. Patients intubated prehospital had a lower median age (24 versus 25 years, $p < .001$), composed a higher proportion of host nation forces (36.1% versus 29.1%, $p < .001$), had a lower proportion of injuries from explosives (57.6% versus 61.0%, $p = .030$), and had higher median injury severity scores (20 versus 18, $p = .045$). A lower proportion of the prehospital cohort survived to hospital discharge (76.4% versus 84.3%, $p < .001$). The prehospital cohort had lower odds of survival to hospital discharge in both univariable (odds ratio [OR] 0.60, 95% confidence interval [CI] 0.51–0.71) and multivariable analyses controlling for confounders (OR 0.70, 95% CI 0.58–0.85). In a subgroup analysis of patients with a head injury, the lower odds of survival persisted in the multivariable analysis (OR 0.49, 95% CI 0.49–0.82). **Conclusions:** Patients intubated in the prehospital setting had a lower survival than those intubated in the ED. This finding persisted after controlling for measurable confounders.

KEYWORDS: *airway; intubation; prehospital; military; emergency*

Introduction

Background

Airway obstruction is the second leading cause of potentially preventable death on the battlefield.[1,2] The current iteration of the Tactical Combat Casualty Care guidelines do not recommend endotracheal intubation until the tactical evacuation phase; however, intubations remain the leading airway intervention in the prehospital setting.[3,4]

Civilian-based studies show high rates of endotracheal intubation complications.[5–8] Prehospital endotracheal intubation (ETI) is significantly more challenging than ETI performed in the well-controlled setting of a hospital for many reasons. Intubation on the battlefield is complicated by the dangerous environment, poor lighting, and confined spaces. Conversely, a recent subanalysis from a larger head injury study noted no worse outcomes, and possibly improved outcomes, in traumatic brain injury patients intubated in the prehospital setting.[9] A recent systematic review and meta-analysis comparing prehospital intubations performed by physicians versus nonphysicians found that physicians had higher overall success rates and higher first-pass success rates.[10] The rates of complications appear to be lower when performed by emergency physicians, even in the prehospital setting.[11–15]

However, these studies all took place in developed countries among civilian trauma patients. It is unclear whether these results are applicable to the combat setting. Moreover, the prehospital combat setting, which includes Role 1 and Role 2 facilities, are frequently staffed by physicians and physician assistants that lack significant airway training. This contrasts with the FSTs and CSHs, which have emergency medicine physicians, anesthesiologists, and anesthetists on staff. The impact of medical personnel and facility airway capabilities on patient outcomes remains unclear.

Study Goal

We sought to compare the outcomes of combat casualties intubated in the prehospital setting (Role 1 and Role 2 without FST augmentation) versus the ED (FST or CSH).

Methods

Data Acquisition

We identified subjects as part of a larger descriptive study of ED interventions for trauma patients in Iraq and Afghanistan using

*Correspondence to Steven G. Schauer, 3698 Chambers Pass, JBSA Fort Sam Houston, TX 78234; *or* steven.g.schauer.mil@mail.mil
[1]**MAJ Schauer** is affiliated with the US Army Institute of Surgical Research, JBSA Fort Sam Houston, TX; 59th Medical Wing, JBSA Lackland Air Force Base, TX; and San Antonio Military Medical Center, JBSA Fort Sam Houston, TX. [2]**MAJ April** is affiliated with the San Antonio Military Medical Center, JBSA Fort Sam Houston, TX. [3]**CPT Tannenbaum** is affiliated with San Antonio Military Medical Center, JBSA Fort Sam Houston, TX. [4]**Lt Col Maddry** is affiliated with 59th Medical Wing, JBSA Lackland Air Force Base, TX; and San Antonio Military Medical Center, JBSA Fort Sam Houston, TX. [5]**LTC Cunningham** and [6]**Dr Blackburn** are affiliated with the US Army Institute of Surgical Research, JBSA Fort Sam Houston, TX. [7]**Dr Arana** is affiliated with 59th Medical Wing, JBSA Lackland Air Force Base, TX. [8]**Col Shackelford** is affiliated with the US Army Institute of Surgical Research, JBSA Fort Sam Houston, TX; San Antonio Military Medical Center, JBSA Fort Sam Houston, TX; and the Joint Trauma System, JBSA Fort Sam Houston, TX.

predefined search codes.[12] This is a retrospective review of prospectively collected data within the registry. We searched our data set for all subjects with a documented prehospital or ED intubation for inclusion into this analysis. We placed subjects with documentation of both a prehospital and ED intubation into the prehospital category as they were likely intubated (or status post attempted intubation) in the prehospital setting and redundant coding in the registry occurred. The US Army Institute of Surgical Research regulatory office reviewed protocol H-16-005 and determined it was exempt from institutional review board oversight. We obtained only deidentified data.

Department of Defense Trauma Registry Description

The Department of Defense Trauma Registry (DODTR), formerly known as the Joint Theater Trauma Registry (JTTR), is the data repository for DoD trauma-related injuries.[16,17] The DODTR includes documentation regarding demographics, injury-producing incidents, diagnoses, treatments, and outcomes of injuries sustained by US/non-US military and US/non-US civilian personnel in wartime and peacetime from the point of injury to final disposition. The DODTR comprises all patients admitted to a Role 3 (fixed facility) or FST with an injury diagnosis using the *International Classification of Disease, Ninth Edition* (ICD-9) between 800-959.9, near-drowning/drowning with associated injury (ICD-9 994.1) or inhalational injury (ICD-9 987.9) and trauma occurring within 72 hours from presentation. We defined the prehospital setting as any location prior to reaching an FST or a CSH to include the Role 1 (point of injury, casualty collection point, battalion aid station) and Role 2 (temporary limited-capability forward-positioned hospital inside combat zone without surgical support). The registry categorization scheme considers a Role 2+ (or variant with surgical support) to be the ED.

Analysis

We performed all statistical analyses by using Microsoft Excel (version 10, Redmond, WA) and JMP Statistical Discovery from SAS (version 13, Cary, NC). We compared study variables between the subjects intubated in the prehospital setting versus the ED setting using a Student *t*-test for continuous variables expressed as means with standard deviations, Wilcoxon rank sum test for ordinal variables expressed as medians and interquartile ranges (IQRs), and χ^2 test for nominal variables expressed as numbers and percentages. For binary outcomes, we used a logistic regression analysis to report ORs.

We performed a subgroup analysis of patients with significant head injuries.[9] To operationalize the Abbreviated Injury Scale (AIS) by body region (AISBR) as a binary variable, we dichotomized these data as either serious (≥3) or not serious (<3).[18,19]

Results

Overall Analysis

During the study period, there were a total of 38,769 encounters in the DODTR. Our predefined search codes captured 28,222 (72.8%) of those subjects with our datas et. Within this data set, there was documentation of 4341 intubations: 1117 in the prehospital cohort and 3224 in the ED cohort.

The prehospital cohort had a lower median age, comprised a higher proportion of local forces, had a lower proportion of injuries sustained from explosives but higher proportion of gunshot wounds (GSWs), and were more likely to have sustained injuries as part of Operation Enduring Freedom (Table 1). The prehospital cohort had higher composite injury severity scores but lower abbreviated scores for the thorax region (Table 2). Overall, a lower proportion of the prehospital cohort survived to hospital discharge (76.4% versus 84.3%, $p < .001$).

On univariable logistic regression analysis, the prehospital cohort had lower odds of survival to hospital discharge (OR 0.60, 95% CI 0.51–0.71). On multivariable analysis, controlling for injury severity score, military operation, patient category (US military, coalition, etc.), mechanism of injury, sex, and age, the lower odds of survival to hospital discharge persisted (OR 0.59, 95% CI 0.50–0.71).

Head Injury Subgroup (AISBR1)

There were 1486 patients with a head AIS ≥3, 449 of whom were intubated prehospital and 1037 were intubated in the ED. Of patients intubated prehospital, 278 (61.9%) survived to hospital discharge versus 783 (75.5%, $p < .001$) of those intubated in the ED. On univariable analysis, those intubated prehospital had lower odds of survival to hospital discharge (OR 0.63, 95% CI 0.49–0.82). In multivariable analysis controlling for age, sex, mechanism of injury, theater of operation and AIS face, chest, abdomen, extremities, and external, the lower odds of survival persisted for patients intubated prehospital (adjusted OR 0.49, 95% CI 0.49–0.82).

Discussion

To the best of our knowledge, this is the first comparison of adult trauma patients undergoing intubation in the prehospital versus ED setting in the combat environment. In this data set, we found that those undergoing prehospital intubation had worse outcomes than those intubated in the ED, even after controlling for confounders. This suggests that patients in need of emergency airway intervention may derive benefit from intubation delay until reaching the ED. The reasons for this are likely multifactorial.

Unfortunately, the prehospital data do not have sufficient granularity to determine indications for intubation, which is a limiting factor. In that regard, a frequent indication for intubation in the prehospital setting is failure of airway protection due to depressed mental state.[20] Given this, we assessed the impact of intubation specifically among those patients with head injury as defined by an AIS ≥3 for the head body region.[19] We still found lower survival to hospital discharge rates among those patients intubated in the prehospital setting (61.9% versus 75.5% $p < .001$). Furthermore, the lower odds of survival persisted in multivariable analysis controlling for potential confounders. This suggests that the association between prehospital intubation and decreased survival applies in this brittle subgroup of patients with severe head injuries who are especially sensitive to hypoxia that may occur in the setting of airway intubation complications.[21] Conversely, after intubation a more rapid bag-tube rate may occur in which detriment from hyperoxia can occur.

The Role 1 and Role 2 (without FST attachment) settings where the prehospital intubations took place are generally

TABLE 1 *Comparison of the Prehospital Cohort With the ED Cohort*

		Prehospital (n = 1117)		Emergency Department (n = 3224)		*p* Value
Demographics	Age (median, IQR)	24	(21–30)	25	(21–30)	<.001
	Male	97.7%	*(1091)	96.9%	(3122)	.183
Affiliation	US military	21.6%	(241)	30.8%	(993)	<.001
	Coalition	9.9%	(111)	6.0%	(194)	
	Host nation forces	36.1%	(403)	29.1%	(939)	
	Humanitarian	29.8%	(333)	28.9%	(932)	
	Other	2.6%	(29)	5.2%	(166)	
Mechanism of injury	Explosive	57.6%	(643)	61.0%	(1965)	.030
	GSW	28.3%	(316)	25.6%	(825)	
	MVC	9.1%	(102)	7.4%	(237)	
	Other	5.0%	(56)	6.1%	(197)	
Military operation	OEF	77.0%	(860)	69.5%	(2241)	<001
	OFS	1.4%	(16)	1.9%	(62)	
	OIF	21.0%	(234)	27.8%	(897)	
	OND	0.6%	(7)	0.7%	(24)	
Outcome	Survival rate	76.4%	(853)	84.3%	(2717)	<.001

GSW, gunshot wound; IQR, interquartile range; MVC, motor vehicle collision; OEF, Operation Enduring Freedom; OFS, Operation Freedoms Sentinel; OIF, Operation Iraqi Freedom; OND, Operation New Dawn.

TABLE 2 *Comparison of Injury Severity Scores Between the Two Cohorts*

	Prehospital (n = 1117)	Emergency Department (n = 3224)	*p* Value
Injury Severity Score	20 (12–27)	18 (11–27)	.045
AIS head/neck	1 (0–4)	1 (0–3)	<.001
AIS face	0 (0–1)	0 (0–1)	.286
AIS thorax	0 (0–2)	0 (0–3)	.006
AIS abdomen	0 (0–2)	0 (0–2)	.396
AIS extremity	2 (0–3)	2 (0–3)	.033
AIS external	1 (0–1)	1 (1–1)	<.001

AIS, Abbreviated Injury Score.
Values reported as medians with interquartile ranges.

staffed with physicians and physician assistants who have limited airway management training. Even for physicians that have airway training as part of their residency curriculum, challenges to maintaining skills readiness persist after completion of training. It is possible that medical personnel who are not in clinical positions experience challenges maintaining airway skills.[22] Medical personnel with more extensive airway training are less likely to have airway complications.[15] In addition to the training challenges noted, the prehospital Role 1/2 settings often lack advanced airway equipment including assistive devices, such as video laryngoscopy, that are almost ubiquitous at the fixed facilities or the forward surgical teams (internal communication, Operation Inherent Resolve logistical chain). In the developed setting, these devices have led to a drastic decrease in the need for surgical airway management.[23,24]

Given these findings, casualties may benefit from prehospital airway management via bag-mask ventilation without intubation for which there is some support from the civilian literature.[254] Such ventilation may be facilitated by bag-mask devices with alterations designed to facilitate downward pressure to optimize mask seal.[26,27] Ventilation of casualties with extensive facial trauma may further benefit from the use of novel intraoral mask devices.[28] Conversely, moving medical staff with advanced skills to more forward areas may carry benefit.

There are several limitations of this study. First, the observational nature of our investigation means that we can only demonstrate correlation and not causation given the potential for confounding. We used logistic regression to control for those potential confounders for which we had data, but we cannot control for unmeasured confounders. Second, for an encounter to be generated within the DODTR, subjects must arrive at the FST or fixed facility alive or with ongoing interventions. However, we do not believe including these cases would have a material impact on our findings. None of these excluded subjects would have undergone ED intubation without ongoing interventions. To the extent that any of these subjects underwent prehospital intubation, their inclusion in the study would likely have resulted in even higher observed mortality among these patients. That said, it is possible that a gravely injured patient subset exists among whom survival to fixed facility depends on prehospital advanced airway management. As our database excludes all subjects not surviving to fixed facility unless undergoing interventions, we are unable to characterize subjects who died on the battlefield. Third, we do not have sufficient data to determine transport times. It is possible that prehospital intubation subjects had longer times from injury to arrival at the FST or fixed facility. If true, these longer transport times would potentially increase the need for airway protection with concomitant higher mortality rates from delays to surgical intervention. A final limitation of note is that the registry includes patients even if their data are incomplete.[29]

Conclusions

Patients intubated in the prehospital setting had lower survival than those intubated in the ED. This finding persisted after controlling for measurable confounders.

Acknowledgments

We would like to thank the Joint Trauma System Data Analysis Branch for their efforts with data acquisition.

Disclaimer

Opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Air Force, the Department of the Army, or the Department of Defense.

Conflicts

We have no conflicts to report.

Funding

We received no funding for this study.

Author Contributions

SGS is the principal investigator and was involved in all aspects of this study. MDA was involved in the conceptualization, data interpretation, manuscript development, and manuscript revisions. JKM, CWC, LIT, and MBB were involved in data interpretation, manuscript development, and manuscript revisions. AAA was involved in data analysis, data interpretation, and manuscript development. SAS was involved in the conceptualization, data interpretation, manuscript development, and manuscript revisions. All authors contributed substantially to this study.

References

1. **Eastridge BJ, et al.** Died of wounds on the battlefield: causation and implications for improving combat casualty care. *J Trauma*. 2011;71(1 Suppl):S4–S8.
2. **Eastridge BJ, et al**. Death on the battlefield (2001–2011): implications for the future of combat casualty care. *J Trauma Acute Care Surg*. 2012;73(6 Suppl 5):S431–S437.
3. Tactical Combat Casualty Care Guidelines for medical personnel. http://www.usaisr.amedd.army.mil/pdfs/TCCCGuidelinesforMedicalPersonnel170131Final.pdf, Accessed 15 September 2017.
4. **Adams BD, et al.** Registry of emergency airways arriving at combat hospitals. *J Trauma*. 2008;64(6):1548–1554.
5. **Gaither JB, et al.** Prevalence of difficult airway predictors in cases of failed prehospital endotracheal intubation. *J Emerg Med*. 2014;47(3):294–300.
6. **Pepe PE, et al.** Prehospital endotracheal intubation: elemental or detrimental? *Crit Care*. 2015;19:121.
7. **Wang HE, et al.** Multivariate predictors of failed prehospital endotracheal intubation. *Acad Emerg Med*. 2003;10(7):717–724.
8. **Carlson JN, et al.** Derivation and validation of the Prehospital Difficult Airway IdentificationTool (PreDAIT): a predictive model for difficult intubation. *West J Emerg Med*. 2017;18(4):662–672.
9. **Denninghoff KR, et al.** Prehospital intubation is associated with favorable outcomes and lower mortality in ProTECT III. *Prehosp Emerg Care*. 2017;21(5):539–544.
10. **Fouche PF, et al.** Nonphysician out-of-hospital rapid sequence intubation success and adverse events: a systematic review and meta-analysis. *Ann Emerg Med*. 2017;70(4):449–459 e20.
11. **Kamiutsuri K, et al.** Analysis of prehospital endotracheal intubation performed by emergency physicians: retrospective survey of a single emergency medical center in Japan. *J Anesth*. 2013;27(3):374–379.
12. **Schauer SG, Naylor JF, Oliver JJ, et al.** An analysis of casualties presenting to military emergency departments in Iraq and Afghanistan. *Am J Emerg Med*. 2019;37(1):94–99. doi:10.1016/j.ajem.2018.04.068. Epub 2018 May 2. https://www.ncbi.nlm.nih.gov/pubmed/29753547#
13. **Thoeni N, et al.** Incidence of difficult airway situations during prehospital airway management by emergency physicians—a retrospective analysis of 692 consecutive patients. *Resuscitation*. 2015;90:42–45.
14. **Lecky F, et al.** Emergency intubation for acutely ill and injured patients. *Cochrane Database Syst Rev*. 2008(2):CD001429.
15. **Lockey D, et al.** Observational study of the success rates of intubation and failed intubation airway rescue techniques in 7256 attempted intubations of trauma patients by pre-hospital physicians. *Br J Anaesth*. 2014;113(2):220–225.
16. **Glenn MA, et al.** Implementation of a combat casualty trauma registry. *J Trauma Nurs*. 2008;15(4):181–184.
17. **O'Connell KM, et al.** Evaluating the Joint Theater Trauma Registry as a data source to benchmark casualty care. *Mil Med*. 2012;177(5):546–552.
18. **Haasper C, et al.** [The Abbreviated Injury Scale (AIS). Options and problems in application]. *Unfallchirurg*. 2010;113(5):366–372.
19. **Foreman BP, et al.** Usefulness of the Abbreviated Injury Score and the Injury Severity Score in comparison to the Glasgow Coma Scale in predicting outcome after traumatic brain injury. *J Trauma*. 2007;62(4):946–950.
20. **American College of Surgeons Committee.** Advanced Trauma Life Support (ATLS(R)): The Ninth Edition. *J Trauma Acute Care Surg*. 2013;74(5):1363–1366.
21. **Chesnut RM, et al.** The role of secondary brain injury in determining outcome from severe head injury. *J Trauma*. 1993;34(2):216–222.
22. **Connick RM, et al.** Procedural confidence in hospital based practitioners: implications for the training and practice of doctors at all grades. *BMC Med Educ*. 2009;9:2.
23. **Mosier J, et al.** A comparison of the GlideScope video laryngoscope to the C-MAC video laryngoscope for intubation in the emergency department. *Ann Emerg Med*. 2013;61(4):414–420 e1.
24. **Chang RS, et al.** Declining rate of cricothyrotomy in trauma patients with an emergency medicine residency: implications for skills training. *Acad Emerg Med*. 1998;5(3):247–251.
25. **Cobas MA, et al.** Prehospital intubations and mortality: a level 1 trauma center perspective. *Anesth Analg*. 2009;109(2):489–493.
26. **Reed P, et al.** Single rescuer ventilation using a bag valve mask with removable external handle: a randomized crossover trial. *Prehosp Disaster Med*. 2017:1–6.
27. **Zobrist B, et al.** Single rescuer ventilation using a bag-valve mask with internal handle: a randomized crossover trial. *Am J Emerg Med*. 2016;34(10):1991–1996.
28. **Amack AJ, et al.** Comparison of ventilation with one-handed mask seal with an intraoral mask versus conventional cuffed face mask in a cadaver model: a randomized crossover trial. *Ann Emerg Med*. 2017;69(1):12–17.
29. **Robinson JB, et al.** Battlefield documentation of Tactical Combat Casualty Care in Afghanistan. *US Army Med Dep J*. 2016(2–16):87–94.

The Special Operations Medical Association's Official Journal

JSOM

JOURNAL *of* SPECIAL OPERATIONS MEDICINE™

Summer 2019
Volume 19, Edition 2

THE JOURNAL FOR OPERATIONAL MEDICINE AND TACTICAL CASUALTY CARE

Inside this Issue:

- CASE REPORTS: Skin Changes After Aggressive Diving
- A Case of Fright or a Deadly Bite? › TXA in Difficult-to-Treat Epistaxis
- TCCC CRITICAL DECISION CASE STUDIES
- SPECIAL ARTICLE: Assessment of Trainer Skill
- FEATURE ARTICLES: Tourniquets on Simulated Infants
- Tourniquet Strap Technique
- Resilience and Suicide in SOF
- AAJT vs Combat Gauze in Porcine Hemicorporectomy Model
- Field-Expedient Vascular Trauma Simulator
- Ketamine Infusion in Burn ICU Patients
- Sulfur Mustard Exposure
- Prehospital vs ED Intubations in Iraq and Afghanistan
- Prehospital Supraglottic Airway Placement vs Cricothyrotomy
- Ongoing Series: Canine Medicine, Human Performance Optimization, Infectious Diseases, Injury Prevention, NATO SOC Research, Prolonged Field Care, SOFsono Ultrasound, Special Talk, Book Reviews, TCCC Updates, *and more!*

Dedicated to the Indomitable Spirit and Sacrifices of the SOF Medic

A Peer-Reviewed Journal That Brings Together the Global Interests of Special Operations' First Responders