Incidence of Airway Interventions in the Setting of Serious Facial Trauma

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ABSTRACT

Background: Airway obstruction is the second leading cause of preventable death on the battlefield. Most airway obstruction occurs secondary to traumatic disruptions of the airway anatomical structures. Facial trauma is frequently cited as rationale for maintaining cricothyrotomy in the medics' skill set over the supraglottic airways more commonly used in the civilian setting. **Methods:** We used a series of emergency department procedure codes to identify patients within the Department of Defense Trauma Registry (DoDTR) from January 2007 to August 2016. This is a sub-group analysis of casualties with documented serious facial trauma based on an abbreviated injury scale of 3 or greater for the facial body region. **Results:** Our predefined search codes captured 28,222 DoDTR casualties, of which we identified 136 (0.5%) casualties with serious facial trauma, of which 19 of the 136 had documentation of an airway intervention (13.9%). No casualties with serious facial trauma underwent nasopharyngeal airway (NPA) placement, 0.04% underwent cricothyrotomy (n = 10), 0.03% underwent intubation (n = 9), and a single subject underwent supraglottic airway (SGA) placement (<0.01%). We only identified four casualties (0.01% of total dataset) with an isolated injury to the face. **Conclusions:** Serious injury to the face rarely occurred among trauma casualties within the DoDTR. In this subgroup analysis of casualties with serious facial trauma, the incidence of airway interventions to include cricothyrotomy was exceedingly low. However, within this small subset the mortality rate is high and thus better methods for airway management need to be developed.

KEYWORDS: *prehospital; airway; facial; trauma; military*

Background

Airway obstruction is the second leading cause of potentially preventable death on the battlefield.[1,2] Tactical Combat Casualty Care (TCCC) guidelines recommend the use of positional maneuvers followed by NPA placement followed by the placement of SGA or cricothyrotomy if SGA placement is not feasible (e.g., casualty is not obtunded, etc.).[3] Endotracheal intubation (ETI) is usually performed only by medical officers or Special Operations medics later once the casualty reaches a more controlled setting. Civilian medics commonly utilize SGA devices in lieu of ET as it requires less experience for successful placement. It is also often faster to place and sufficient for the shorter transport times in the civilian setting.[4–6] However, the signature mechanism of injury of the recent conflicts in Iraq and Afghanistan – explosive trauma – creates injury patterns not seen in the civilian setting.

Casualties with facial trauma requiring airway intervention have high mortality.[7] Previous reports on US military prehospital airway intervention among battlefield casualties, including those without serious facial trauma, describe a combined total of 348 cricothyrotomies with a procedure incidence rate of 0.25–2.4%. Mortality rates were reported from 45% to 90%.[8–15] As such, the cricothyrotomy remains in the medics' skill set of airway management options for this specific population. A previous report from the combat setting demonstrated a 33% failure rate with medic performed cricothyrotomy.[16] Additionally, complications reported mirrored that of the civilian literature – misplacement, excessive bleeding, failure to cannulate, etc.

Cricothyrotomy is a technically challenging and rarely performed procedure even for physicians. Maintaining currency with this procedure is a particular challenge for medics who have infrequent training and opportunities for skill maintenance.[17] It remains unclear whether the military should continue to promote this method of airway management, especially outside of the Special Operations community in which their medics have more advanced training, more frequent sustainment, and more combat trauma experience with airway management.[8]

Goal of This Investigation

We seek to build on previously published data and determine the incidence of prehospital cricothyrotomy among casualties with serious facial trauma.[10,18]

Methods

Ethics

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.

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Data Acquisition

We conducted a retrospective review of prospectively collected data within the DoDTR. We queried the DoDTR using a series of emergency department (ED) procedure codes to acquire the subjects which is previously described.[19] We then searched for all casualties with an abbreviated injury scale (AIS) score of 3 (serious) or greater to the face to define the baseline population (Table 1).[20] Within that population, we searched for all airway interventions.

TABLE 1 *Description of the Abbreviated Injury Scale (AIS) Scoring System*[25–27]

AIS Score	Categorization	Example	Estimated Mortalit, %
1	Minor	Superficial laceration	0
2	Moderate	Fractured sternum	1–2
3	Serious	Open fracture of the humerus	8–10
4	Severe	Perforated trachea	5–50
5	Critical	Ruptured liver with tissue loss	5–50
6	Maximum	Total severance of aorta	100

DoDTR Description

The DoDTR, formerly known as the Joint Theater Trauma Registry (JTTR), is the data repository for DoD trauma-related injuries.[19,21–24] The DoDTR includes documentation regarding demographics, injury-producing incidents, diagnoses, treatments, and outcomes of injuries sustained by US military and US civilian personnel in wartime and peacetime from the point of injury to final disposition. Short-term outcome data are available for non-US casualties. The DoDTR comprises all patients admitted to a Role 3 (fixed-facility) or forward surgical team (FST) with an injury diagnosis using the *International Classification of Diseases 9th 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 injury. The registry defines the prehospital setting as any location prior to reaching a location with surgical capabilities or a combat support hospital (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).[10,19,23,24] The Joint Trauma System (JTS) has trained staff that perform the scoring of the abbreviated injury scale and the composite injury score to ensure standardization.

Analysis

We performed all statistical analysis using Microsoft Excel version 10 (Microsoft, www.microsoft.com/en-us/microsoft-365/excel) and JMP Statistical Discovery version 13 (SAS, https://www.jmp.com/en_us/home.html). We reported categorical variables as numbers with percentages, ordinal variables as medians with interquartile ranges, and continuous variables as means with standard deviation. We defined an isolated injury to the face as an AIS of 3 or greater for the facial body region and AIS of 0 for all other body regions (Table 1).

Results

From January 2007 to August 2016, there were a total of 38,769 encounters in the DoDTR. Our predefined search codes captured 28,222 (72.8%) of those subjects. Within that group of 28,222 subjects, we identified 136 (0.5%) casualties with serious or worse facial trauma, of whom 4 (0.01% of total dataset) had isolated injury to the face. Of note, there were no casualties with an AIS of 5 or 6 for the facial body region (Figure 1). Of subjects with serious facial trauma, the median age was 25 (IQR 21–30), the median injury severity score (ISS) was 27 (IQR 19–35), most were male (99.2%). Additionally, the US military made up the greatest proportion (37.5%), most were injured by explosives (59.5%), most were in Afghanistan (65.4%), and most survived to hospital discharge (87.5%).

FIGURE 1 *Breakdown of abbreviated injury scales values for the facial body region for entire dataset.**

AIS Score	Percentage	n
0	74.0	20,897
1	12.3	3,459
2	13.2	3,730
3	<0.5	120
4	<0.01	16
5	0	0
6	0	0
Total	100	

*For the facial body region, there were no casualties with an AIS of 5 or 6.

Of this serious facial trauma cohort, 19 had documentation of an airway intervention (13.9%). The median age was 26 (IQR 21–29), the median ISS was 34 (IQR 27-41), all were male, the US military made up the greatest proportion (36.8%), most were injured by explosive (63.1%), most were in Afghanistan (84.2%), and most survived to hospital discharge (57.8%, Table 2). Within the overall dataset (n= 28,222), no casualties with serious facial trauma underwent NPA placement, 0.04% underwent cricothyrotomy (n = 10), 0.03% underwent intubation (n = 9), and a single subject underwent SGA placement (<0.01%). Among subjects with serious injury to the face, the incidence of NPA placement was 0%, cricothyrotomy was 7.3%, intubation was 6.6%, and SGA was 0.7% (Table 3).

Discussion

In our study, we present the incidence of airway interventions in a unique subset of the population with serious facial trauma. Overall, we found that the incidence of serious injury to face was rare (0.5%; 136 of 28,222). Correspondingly, we also found that the incidence of serious facial injury with airway intervention was rare (0.07%; 19 of 28,222). Cricothyrotomy was rarely performed in the prehospital setting in patients with serious facial trauma (0.04%; 10 of 28,222). As our original dataset was aimed at describing ED interventions performed in casualties, we used a very broad set of procedure codes to capture casualties that required any level of trauma-relevant interventions.[29] With the broad search criteria used for the original dataset, it is unlikely that we missed few, if any, trauma-relevant interventions among the 38,769 total casualties in the DoDTR during our search period. Extrapolating the data to the entire DoDTR population within the time span that we searched using the procedure codes (e.g., including casualties not captured by our search criteria, airway interventions in casualties with serious facial injuries would have an incidence of 0.05%). Put another way, for every 10,000 casualty encounters, only five would have an airway intervention performed in the setting of serious injury to the face.

TABLE 2 *Description of Casualties With Serious Facial Trauma*

		Serious Facial Trauma Population (n = 136)	Serious Facial Trauma + Airway Intervention (n = 19)
Demographics	Age*	25 (21–30)	26 (21–29)
	Male	99.2% (135)	100% (19)
Patient category	US military	37.5% (51)	36.8% (7)
	Coalition	4.4% (6)	5.2% (1)
	Host nation force	33.1% (45)	31.5% (6)
	Humanitarian	22.7% (31)	26.3% (5)
	Other	2.2% (3)	0% (0)
Mechanism of injury	Explosive	59.5% (81)	63.1% (12)
	Gunshot wound	20.5% (28)	10.5% (2)
	MVC	13.2% (18)	15.7% (3)
	Other	6.6% (9)	10.5% (2)
Country	Afghanistan	65.4% (89)	84.2% (16)
	Iraq	34.5% (47)	15.7% (3)
Injury severity score	Composite	27 (19–35)	34 (27–41)
Serious injuries by body region	Head/neck	69.1% (94)	94.7% (18)
	Thorax	19.8% (27)	42.1% (8)
	Abdomen	5.1% (7)	5.2% (1)
	Extremities	22.0% (30)	21.0% (4)
	Skin/superficial	2.9% (4)	0% (0)
Outcome	Survival to discharge	87.5% (119)	57.8% (11)

*Reported as median and interquartile ranges.
**Defined as an AIS by body region scale of 3 or greater.[20,28]
MVC = motor vehicle collision.

Other studies, even beyond those with facial injuries also note that cricothyroidotomy is rarely performed, with varying degrees of success and impact on survival. One study on prehospital airway interventions including cricothyrotomy, SGA, and bag valve mask (BVM).[30] There was no difference in outcome between cricothyrotomy and BVM. It should be noted, these were not specific airway injuries. Barnard et al. demonstrated a significantly small number of cricothyroidotomies performed in Operation Enduring Freedom (OEF) over a 4-year period.[31] Of the 34 (1.8%) cricothyroidotomies, only six were performed at the point of injury (POI). The success rate was 82% but failed to delineate the breakdown of success by setting. It is likely that the more formally trained medical evacuation medics were more successful.

Cricothyrotomies are not without risk. Mabry reported that nearly one in three had a complication related to the cricothyrotomy when performed by a medic, and just under one in six when performed by a physician or physician assistant.[16] It is likely the complication rate would be even higher in the setting of serious facial injury as the airway anatomy is harder to identify. Given the very low incidence of this procedure in the combat setting juxtaposed with the limited initial and sustainment training by non-SOF medics, it does not appear that we can continue to justify the opportunity cost of diverting training and resources away from other higher-yield interventions. With a limited time to train for most medics in the US Army, often limited to their annual Table VIII training (1 week), sinking significant time into training the cricothyrotomy will detract from other life-saving skills.

TABLE 3 *Incidence of Airway Interventions Prehospital of Those With Serious Facial Trauma or Worse*

	Overall Dataset (n = 28,222)	Serious Facial Trauma Only (n = 136)	Survival to Discharge
NPA (n = 0)	0%	0%	N/A
Cricothyrotomy (n = 10)	0.04%	7.3%	40.0% (4)
Intubation (n = 9)	0.03%	6.6%	44.4% (4)
SGA (n = 1)	<0.01%	0.7%	0% (0)

NPA = nasopharyngeal airway; SGA = supraglottic airway.

Our study has several important limitations. We relied on the AIS to identify those with serious facial trauma. It is possible that a casualty may have had a clinically significant airway obstruction that, when scored after-the-fact, did not meet the registry threshold of 3 or greater. Moreover, it is possible that more minor injuries could have led to airway obstruction in the right setting that may not be captured by the AIS threshold we used. Aside from using AIS, we would have to rely on individual injury codes for documented injuries which are far more challenging to interpret across a large population. However, given the very low incidence within the population, it would likely have had no effect on our overall findings. For inclusion into the DoDTR, patients must have arrived at a location with surgical capabilities with signs of life or with ongoing interventions (e.g., cardiopulmonary resuscitation in progress). Therefore, our analysis does not incorporate casualties that expired in the prehospital setting. It is unclear what effect that would have on our dataset as those casualties were either mortally wounded from other etiologies or the airway intervention was insufficient to keep them alive until reaching such a location. However, we must clearly note that we cannot characterize those casualties that died on the battlefield. Thus, our findings are limited to those that survived to generate an encounter in the registry. The latter would further support the need for major changes to our current protocols. We also lack the data granularity to determine the type and level of training of the medical provider who performed the airway intervention. This may have effects on outcomes and survival after interventions. While the DoDTR carries limitations with data capture quality, it is by far the largest data capture system in the deployed setting. Without a major overhaul by the Department of Defense (DoD), this stands to be the most robust, widespread data capture system available for targeting improvements. Lastly, previous studies have demonstrated that US military prehospital documentation rates are poor, which limits data quality in the registry.[32]

Conclusion

Serious injury to the face rarely occurred among trauma casualties within the DoDTR. In this subgroup analysis of casualties with serious facial trauma, the incidence of airway interventions to include cricothyrotomy was exceedingly low. However, within this small subset, the mortality rate is high and thus better methods for airway management need to be developed.

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Disclaimer
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Disclosure

We have no relevant disclosures to report.

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