Prehospital Battlefield Casualty Intervention Decision Cognitive Study

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ABSTRACT Introduction: Airway compromise is the third most common cause of preventable battlefield death. Surgical cricothyroidotomy (SC) is recommended by Tactical Combat Casualty Care (TCCC) guidelines when basic airway maneuvers fail. This is a descriptive analysis of the decision-making process of prehospital emergency providers to perform certain airway interventions. Methods: We conducted a scenario-based survey using two sequential video clips of an explosive injury event. The answers were used to conduct descriptive analyses and multivariable logistic regression models to estimate the association between the choice of intervention and training factors. Results: There were 254 respondents in the survey, 176 (69%) of them were civilians and 78 (31%) were military personnel. Military providers were more likely to complete TCCC certification (odds ratio [OR]: 13.1; confidence interval [CI]: 6.4–26.6; *P*-value < 0.001). The SC was the most frequently chosen intervention after each clip (29.92% and 22.10%, respectively). TCCC-certified providers were more likely to choose SC after viewing the two clips (OR: 1.9; CI: 1.2–3.2; *P*-value: 0.009), even after controlling for relevant factors (OR: 2.3; CI: 1.1–4.8; *P*-value: 0.033). Conclusions: Military providers had a greater propensity to be certified in TCCC, which was found to increase their likelihood to choose the SC in early prehospital emergency airway management.

INTRODUCTION

Airway compromise is the third most common cause of battlefield preventable death.[1] Correction of airway compromise and placement of a definitive airway is widely recognized as a mainstay in preventing hypoxia. Hypoxia contributes to acidosis in the lethal triad as well as immediate and long-term brain injury. The lethal triad is composed of acidosis, hypothermia, and coagulopathy, which interact with each other to create a deadly cycle in trauma patients. Endotracheal intubation (ETI) has been the preferred definitive airway in civilian trauma, but it requires significantly more training to reach and maintain competency.[2] Optimal visualization of the vocal cords and ETI often requires skilled airway manipulation and positioning that might not be attainable in the tactical setting. The austere setting further prohibits the reliance on the comforts of hospital settings, which typically provides more available medical personnel, an ample suction, an adequate lighting, a temperature-controlled environment, and multiple modalities of preoxygenation to forestall precipitous desaturations.

Surgical cricothyroidotomy (SC) has been recommended because of its relative simplicity compared with ETI when done in the right circumstances and is recommended in the Tactical Combat Casualty Care (TCCC) airway management algorithm if other airway maneuvers (ie, jaw thrust, nasopharyngeal airway, and recovery position) are contraindicated or fail in impending airway obstruction. Supraglottic airways have proven to be efficacious in a variety of settings but require intact oropharyngeal anatomy not affected by trauma.[3] Moreover, the use of some supraglottic airways on porcine models was found to be associated with a significant reduction in carotid blood flow when compared with an endotracheal tube.[4]

Many articles describe the success rate of SC in the civilian and battlefield environments in well-trained hands,[5] as well as study its success with reliable equipment and techniques.[6,7] Nevertheless, the literature is lacking in the assessment of the cognitive processes that lead to the decision to perform TCCC interventions (including SC). In addition, minimal literature exists that examines whether years of experience, training, and protocol inclusion are factors in military vs. civilian prehospital SC decisions.[8,9] In this study, we present a descriptive analysis of the decision-making process of the prehospital emergency providers to perform prehospital interventions, with a focus on SC.

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METHODS

We conducted a scenario-based survey using two brief sequential helmet-cam-video clips of an explosive injury event resulting in significant facial trauma and traumatic amputation. We included in our study civilian and military prehospital health care providers, as well as in-hospital emergency medical providers. The participants viewed the video clips and completed the survey online (Quick Response code for the full clip is provided in Supplemental Fig. 1). The participants were asked about their level of training, certification in TCCC and Tactical Emergency Casualty Care, the intervention of choice after each clip and the reason for that choice, whether they had watched the clips previously, and whether certain interventions were within the scope of their protocols. Using the collected answers from these questions, we conducted a descriptive summary of the results.

We assessed whether TCCC training was associated with the choice of the SC as the preferred intervention after watching either clip. We categorized the reasons for choosing the SC into three groups: (1) facial trauma: the respondents decision was mainly based on the presence of facial trauma; (2) logical reasoning: the respondents decision was based on description of the patient's status and ruling out inappropriate interventions; and (3) maintaining airway: the respondents did not provide a specific reason for their decision aside from maintaining an airway. We used logistic regression models to estimate the association between TCCC and the following: (1) whether the providers were military or civilian and (2) choosing the SC controlling for relevant variables (P-value < 0.05). The SAS version 9.4 (SAS Institute Inc., Cary, North Carolina) was used to conduct our analyses. The study protocol constituted human subjects' research and met 32 Code of Federal Regulations (CFR)§219.101(b) requirements for exemption from the regulatory requirements of 32 CFR§219. The research protocols were approved by the Department of Defense Human Research Protections Office.

RESULTS

There were 254 respondents who completed the online survey between October 2015 and December 2017. Of all respondents, 176 (69%) were civilians and 78 (31%) were military. Emergency Medical Technician combat medics constituted the largest group among respondents ($n = 56$; 22% overall; 72% among military respondents). The complete breakdown of the levels of training of the participants is shown in Figure 1. There were 123 (48%) emergency providers who completed certification in TCCC (Supplemental Fig. 2); 67 (54%) of them were military providers. Compared with their civilian counterparts, military providers were more likely to have completed TCCC certification (86% of military personnel; odds ratio [OR]: 13.1; confidence interval [CI]: 6.4–26.6; P-value: < 0.001). However, only 46 (31.8%) of civilian providers completed the TCCC certification. Respondents chosen interventions are displayed in Table I. In regard to protocol scope, 220 (93.6%) had some form of advanced airway intervention within their scope; 214 (91.1%) could perform needle decompressions; and 185 (78.7%) had tranexamic acid administration capability. Around 78 (33.2%) of all participants said that they had watched the clips before completing the survey. Most respondents who chose SC after watching the first video clip said that their decision was due to the presence of facial trauma ($n = 32$; 42.11%), which became the second reason after watching the second video clip ($n = 19$; 33.93%) as shown in Table II.

SC was the most frequently chosen intervention after the first clip ($n = 76$; 29.92%), followed by jaw thrust ($n = 62$; 24.41%), and a deliberate tourniquet ($n = 26$; 10%). The SC was also the most chosen intervention after the second clip ($n = 56$; 22%), followed by a large-bore peripheral intravenous line ($n = 47$; 19%), and extremity intraosseous line ($n = 36$; 14%). The choice of SC after the first clip did not differ by the level of provider (P-value: 0.89) or by TCCC certification (P-value: 0.25). However, providers with TCCC certification were more likely to choose SC at least once after viewing either video clip, as shown in Figure 2 (OR: 1.9; CI: 1.2–3.2; P-value: 0.009). Controlling for provider level, whether the providers had previously watched the clips, and whether advanced airway interventions were within their scope of protocols, the providers with TCCC certification remained more likely to choose SC (OR: 2.3; CI: 1.1–4.8; P-value: 0.033).

DISCUSSION

As of the time of the study, TCCC training focuses on didactic teaching with emphasis on specific skills and tasks. The TCCC was created by the U.S. Department of Defense Committee on TCCC (CoTCCC) to provide evidence-based lifesaving trauma care on the battlefield. The CoTCCC provides an algorithm of preferred interventions in the combat settings, and many military providers have completed—or partially completed—their certification in TCCC.[10,11] The TCCC guidelines are mostly simulation based, and training on simulated casualties generally drive the provider toward certain interventions in a rather predictable and sequential manner. Depending on the fidelity of the simulation model as well as the details of the scenario, the instructor expected interventions can be quite apparent to the trainee. For example, a medic training on a manikin with a neck membrane for an SC will be automatically cued into that intervention. Video simulation of real cases or high-fidelity scenarios that collect data on mental modeling via decision-making surveys is not currently within the TCCC curriculum. This military model of training is similar to the civilian Tactical Emergency Casualty Care curriculum; a civilian adaptation of the TCCC guidelines is meant to cater to the domestic emergency medical services law enforcement settings.

Successful prehospital emergency airway interventions can reduce a significant component of all preventable death causes

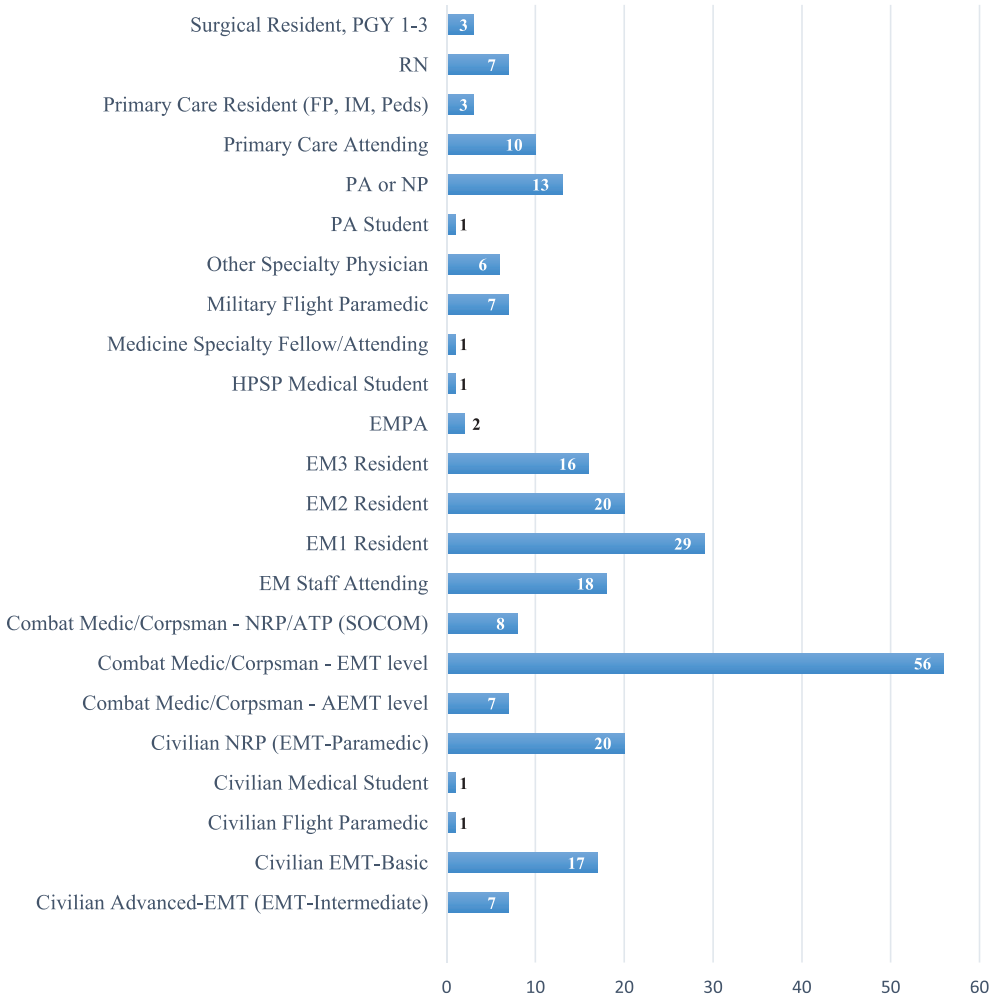

FIGURE 1. Level of Training of the Participants in the Survey

TABLE I. The Choice of Interventions by the Participants after Watching Each Clip

Chosen Intervention	After 1st Clip	After 2nd Clip
Jaw thrust	62 (24.41%)	14 (5.51%)
Nasopharyngeal airway	28 (11.02%)	8 (3.15%)
Recovery position/position of comfort	24 (9.45%)	9 (3.54%)
Supraglottic airway	17 (6.69%)	8 (3.15%)
Surgical cricothyrotomy or cricothyrotomy key	76 (29.92%)	56 (22.10%)
1 Large-bore peripheral IV	8 (3.15%)	47 (18.50%)
1 Extremity IO line	3 (1.18%)	36 (14.17%)
Deliberate tourniquet	26 (10.24%)	13 (5.12%)
Junctional tourniquet	7 (2.76%)	1 (0.39%)
Bilateral chest needle decompression	3 (1.18%)	25 (9.84%)
1 unit whole blood or PRBCs[a]	—	7 (2.76%)
IV/IO ketamine[a]	—	3 (1.18%)
IV/IO fentanyl[a]	—	0 (0%)
IV/IO TXA[a]	—	11 (4.33%)
No answer	—	16 (6.30%)

[a]Provided as an option after the 2nd clip only.

TABLE II. The Reasons for Choosing Cricothyroidotomy by the Participants

Reason for Choosing Cricothyroidotomy	After 1st Clip ($n = 76$)	After 2nd Clip ($n = 56$)
Facial trauma	32 (42.11%)	19 (33.93%)
Logical reasoning	27 (35.53%)	17 (30.36%)
Maintaining airway	17 (22.36%)	20 (35.71%)

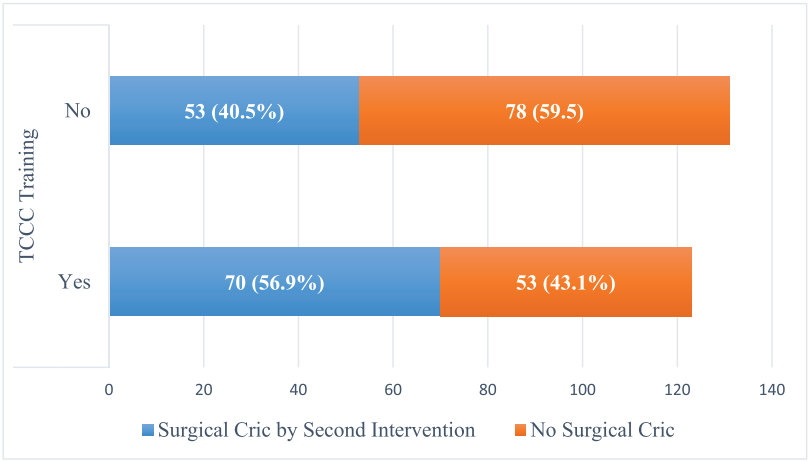

FIGURE 2. Counts and Proportions of Participants Choosing SC by the Second Intervention in Relation to TCCC Training.

on the battlefield.[1,9,12–14] Performing an SC only at the end of the other failed airway maneuvers is akin to traditional notions about tourniquet use as a last resort only after field and pressure dressings failed. However, intubation via direct laryngoscopy is difficult in the far forward military setting, and the use of SC at success rates between 89% and 100% is at least used twice as often in the military than it is in civilian traumas for definitive airway securement.[1,6,9] Field medical providers tend to be enlisted personnel who are protocol driven, and the reliance on SC in the military environment highlights the need for standard approaches that facilitate the cognitive leap to surgically obtain an airway.[15,16] In our study, we assessed factors that affected decision-making for the emergency providers in choosing SC as the preferred intervention in a real case of airway compromise with massive oropharyngeal trauma. More than two-thirds of the 254 respondents to the survey were civilians and compromised an array of medical professionals (eg, physicians, physician assistants, paramedics, residents, students, etc.).

Survey respondents who completed TCCC training were twice as likely to choose SC after watching either video clip. After controlling for provider's training levels, airway scope of protocols, and whether respondents have seen the videos before, TCCC training was still strongly associated with choosing SC. Interestingly, there was no difference in choosing SC when comparing civilian and military providers, independent of TCCC training. This suggests that the training military providers undergo through TCCC breaks down the cognitive barriers to selecting SC, but being a military provider alone does not necessarily confer this mindset. The video clip showed an explosive incident with facial trauma; however, only a little >40% of the respondents after watching the first video clip and 30% after the second one stated that it was their reason for choosing SC. This could be due to how the video clips have been viewed, as we had no control over how the respondents viewed them or what devices were used. Moreover, the helmet cam perspective can be limited and deprive the ability to detect and assess the presence and the extent of trauma.

CONCLUSIONS

TCCC training has successfully instilled in its trainees the preference to attempt SC more often than those who have not completed TCCC training. After the conclusion of this study, TCCC was further emphasized as mandatory training for all U.S. military service members. Ongoing refinement of the method of the cognitive component of TCCC must be explored further. Though this study does not assess whether TCCC training confers technical skill in the procedure, it does address the traditional viewpoint that the most difficult part of performing an SC is deciding to do it. Prospective comparative research is needed to explore other factors that contribute to prehospital emergency airway management's decision-making process.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *MILMED* online.

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