SUCCESSFUL SURGICAL AIRWAY PERFORMANCE IN THE COMBAT PREHOSPITAL SETTING: A QUALITATIVE STUDY OF EXPERIENCED MILITARY PREHOSPITAL PROVIDERS

By

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To my classmates, who may never see this, thank you. You guys made each synchronized session more stimulating and more fun. We shared some tough times together but because of your continued participation and good mood, we came through.

DEDICATION

I would like to dedicate this research to the front-line combat veterans who were placed in the worse scenarios on the worst day and still managed to render medical aid to those who were injured. It is with your bravery that we are able to save lives and reunite families.

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ABSTRACT

Introduction

Military first responders are in a unique category of the healthcare delivery system. They range in skill sets from combat medic and corpsman to nurses, physician assistants, and occasionally, doctors. Airway obstruction is the second leading cause of preventable battlefield death, and the decision for intervention to obtain an airway depends on the casualty's presentation, the provider's comfort level, and the available equipment, among many other variables. In the civilian prehospital setting cricothyroidotomy (cric) success rates are over 90% but, in the US, military combat environment success rates range from 0-82%. This discrepancy in success rates may be due to training, environment, equipment, patient factors and/or a combination of these. Many presumed causes have been assumed to be the root of the variability, but no research has been conducted evaluating the first-person point of view. This research study is focused on interviewing military first responders with real-life combat placement of a surgical airway to identify the underlying influences that contribute to their perception of success or failure.

Materials and Methods

We conducted a qualitative study with in-depth semi-structured interviews to understand participants' real-life cricothyroidotomy experiences. The interview questions were developed based on the Critical Incident Questionnaire. In total, there were eleven participants - four retired military and seven active-duty service members.

Results

Nine themes were generated from the eleven interviews that were conducted. These themes can be categorized into two groups: factors that are internal to the provider, which we have called intrinsic influences, and factors that are external to the provider, which we call extrinsic influences. Intrinsic influences include personal well-being, confidence, experience, and decision-making. Extrinsic influences include training, equipment, assistance, environment, and patient factors.

Conclusions

This study revealed that practitioners in combat settings felt the need to train more frequently in a stepwise fashion while following a well-understood airway management algorithm. More focus must be on utilizing live tissue with biological feedback, but only after anatomy and geospatial orientation are well understood on models, mannequins, and cadavers. The equipment utilized in training must be the equipment available in the field. Lastly, the focus of the training should be on scenarios that stress the physical and mental capabilities of the providers. A true test of both self-efficacy and deliberate practice is forced through the intrinsic and extrinsic findings from the qualitative data. All of these steps must be overseen by expert practitioners. Another key is providing more time to focus on medical skills development, which is critical to overall confidence and overcoming hesitation in the decision-making process. This is even more specific to those that are least medically trained and the most likely to encounter the casualty first, EMT-Basic level providers. If possible, increasing the number of medical providers at the point of injury would achieve multiple goals under the self-efficacy learning theory. Assistance would instill confidence in the practitioner, help with the ability to prioritize patients quickly, decrease anxiety, and decrease hesitation to perform in the combat environment.

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INTRODUCTION

Purpose

The purpose of this study was to identify the factors that contribute to the success of a prehospital cricothyroidotomy by US Military members while in the combat environment. According to research, the success rates for the US Military with cricothyroidotomies range from 0-82% (Barnard 2014; Hessert 2013; Mabry 2010; Mabry 2011). The civilian prehospital rates range from 90-99% (Bennett 2011; Lockey 2014; Schober 2019) and the British Military rates are >90% (Kyle 2016). Research around cricothyroidotomy performance in the US Military has resulted in many presumed causes for difficulty in successful airway placement (Bennett 2011). Some of these include training, equipment, environment, and patient factors. Additionally, EMT-level providers are considered the least trained in the medical provider continuum of education, however, they are entrusted to perform cricothyroidotomies without oversight. Unfortunately, there is a lack of research addressing what prehospital providers who have performed cricothyroidotomies perceive as the factors that contribute to a successful procedure.

A qualitative study using semi-structured interviews based on the critical incident methodology was designed to study prehospital providers' perceptions of success or failure in performing cricothyroidotomies in combat zones. The critical incident methodology grew from Air Force investigations into different but specific flight problems to point toward possible reasons and solutions (Flanagan 1954). We used thematic analysis to review the interview transcripts and develop themes and subthemes (Braun & Clarke 2006). Once all the data were reviewed and coded, we identified nine major themes in two broad categories. Self-efficacy and deliberate practice theory explained our findings. Potential exists for extrapolation of the data to inform teaching practices for US Military medical providers.

Study Context

In the past 20 years, the Global War on Terrorism has created many casualties, and airway compromise is one well-known preventable cause of mortality for those casualties. In the combat setting, there is a continuum of medical care delivery for injured personnel. For the United States (US), these levels of care are defined as Roles. Role 1 is the first point at which a casualty reaches a dedicated medical provider. Role 1 is usually staffed with EMTs and a PA or MD without ancillary services. From the point of care through Role 1 the environment is considered austere. The cricothyroidotomy is the main choice for prehospital treatment of airway compromise due to its supposed ease of placement and because it is considered a secure airway. However, studies by Mabry (Mabry 2010; Mabry 2011) demonstrated that the success rates ranged widely but were still significantly lower than civilian and British counterparts. Civilian research from Lockey et al. 2014 demonstrated that out of 28,939 patients 7,256 needed advanced airway and they were able to be successful in using many airway adjuncts with a 99% success rate. British military research from Kyle et al. 2016 reviewed surgical airways in 2006-2014 and found that 86 patients required surgical airways of which only eight were unsuccessful reaching a success rate of 92%. All rescue airways were successful resulting in 100% success. Bennett (2001) suggested a full review of how the cricothyroidotomy procedure is taught and performed. Bennett (2001) stated that there were many presumed causes for failure including training, equipment, environment, and patient factors. To add to the complexity, there are over 12 different techniques to perform a cricothyroidotomy and more than three off-the-shelf packaged equipment sets, and many more personally handmade kits (Hessert 2013).

For patient factors, the average Glascow coma scale (GCS) score ranges from 3-15, and for those who require intubation the score is generally eight or less. A score of eight equates to a severe head injury. For those casualties who received a cricothyroidotomy their average GCS was a three, which is completely unresponsive to any stimulus (Mabry 2011). They also have different anatomy, personal protective equipment, and injury patterns that could affect the cricothyroidotomy. The environmental influences presumed to cause difficulty were the low light or blackout conditions, temperature extremes, rugged or uneven terrain, and limited access to additional or missing supplies. Training is also an important factor. Bennett et al. conducted a ground-up review in 2010 stemming from the data of extremely high failure rates. They identified five different areas. First was the limited anatomical review provided to participants. Second, was the lack of hands-on human anatomy. Third, were non-standardized techniques. Fourth, were poor training models. Last, was the lack of standardized refresher training. A review of 18 separate articles revealed discussions of training, novel devices, and models as they relate to surgical airways. Most of the reviewed studies suggest training with models or simulation is superior to training with live tissue and some thought they could replace live tissue altogether. This contradicted the suggestions of Bennett et al. who thought hands-on anatomy training was vitally important. Pandian et al., on the other hand, stated that there were no differences between individuals who performed cricothyroidotomies on either a swine model or a robotic manakin. However, in their data set, there was one failure and two dangerous errors reported with placing the tube in an inappropriate place constituting an almost 19% error rate in swine models.

The major gap in the literature was understanding why failure rates in cricothyroidotomies are so high for one group of prehospital providers compared to others. There

were no research studies evaluating the performance from the practitioner's perspective. All research was observational and retrospective analyzing the outcome after the patient made it to a tertiary center or autopsy. There were no studies at Role 1 or forward checking for placement. This leads to a gap in potential causes for failure in transit that may have been overlooked. Research is needed to evaluate placement success at the point of injury, during transit, and at the next highest level of care. Additional qualitative research about the training received for these types of procedures would be beneficial to pinpoint not just differences in data but differences in confidence after training.

This topic is critical to study because of the potential for lifesaving measures to be improved in the austere environment. It is important to understand how individuals learn critical skills when there is significant potential for poor outcomes. Specifically, trying to change decades of training requires significant research and development as well as feedback from the field on the performance of the task. The research suggests that there is significant room for improvement with success rates for cricothyroidotomies and the results of this qualitative study could help shape how training is conducted throughout the continuum of medical delivery. Feedback specifically from those who have performed this task has the most insight into the potential reasons for failure.

This research study focused on prehospital providers and their experiences in performing cricothyroidotomy. Observing retrospective results and making suggestions based on assumptions can lead to a delay in improvements. The best way to find out how to improve on a task is to hear directly from those who performed the task using strategies such as the critical incident research.

Theoretical background

Two theories informed the interpretation of the data. They were self-efficacy and deliberate practice.

Self-efficacy theory is a four-step theory focused similarly to deliberate practice theory. The keys are vicarious experience, physiological feedback, verbal persuasion, and performance outcomes. Vicarious experience is about learning from watching others. This is a classical part of training adaptation that the military follows, “watch one, do one, teach one.” Where seeing someone perform an action on a live patient is significantly helpful for personal experience. Physiological feedback when the job is performed correctly improves the learner’s confidence and emotional state. Verbal persuasion is similar to expert feedback. The difference being negative feedback can be as beneficial as positive reinforcement. Performance outcomes, both positive and negative, influence the next round of training as long as the learner incorporates changes to improve the negative outcomes. This is very similar to our providers' reports about how they train and what they think they need to improve.

Deliberate practice theory is the main theory we chose to evaluate our data. Deliberate practice theory focuses on individualized training activities that are designed by a coach or teacher to improve one task. There are five principles: pushing beyond the comfort zone, working toward specific goals, focusing intently, high-quality feedback, and developing a mental model. These combined principles help create the mental models to build from. Expert feedback on quality repetitions leads to quality improvement. This is compared to multiple repetitions done incorrectly. The more times the task is performed incorrectly and not corrected the more likely the learner will perform the same mistakes. In short, quality over quantity. Our study involved a difficult and rare procedure. For most of the participants, current mandatory training

is annually performed on a simulated mannequin with nondetailed anatomy. There were also many participants who conduct live tissue training bi-annually or more. We saw that lack of confidence and overconfidence were both detrimental to outcomes. There were also very few individuals who received expert feedback from the higher echelons of care. Most assumed they performed the cricothyroidotomy well. However, previous studies suggest that although they feel they may have been successful, there were many cricothyroidotomies that failed. This suggests there is a gap between perceived success and actual success. The deliberate practice theory would suggest that they need more detailed feedback during training and after the real-life procedure is performed. There is a need for deliberate refinement of how training scenarios are designed to match the combat environments more closely. There should be both point-of-contact scenarios as well as aid station environments that should include equipment options, lighting, noise, mannequins, anatomical variations, and live tissue. Past studies revealed that students who train on mannequins have improved confidence and lower time-to-completion scores. They also improve similarly on live tissue models (Pandian 2020). It is important to see that anatomical or improved mannequin-based training can increase baseline skills performance as seen in the meta-analysis by Sun (Sun 2017). However, Pandian (2020) shows that there are still errors in translation to live tissue and it is important to create a stepwise progression of training and refinement.

Research Question(s)/Purpose/Aim

The aim of this study was to identify the influences that contribute to the perceived success or failure of a prehospital surgical airway performed by US military personnel in a combat environment.

Study Findings

The findings from the interviews conducted in this study revealed nine themes that were categorized into two groups: intrinsic influences - those that are internal to the provider, and extrinsic influences - factors that are external to the provider. Intrinsic influences include personal well-being, confidence, experience, and decision-making, and extrinsic influences include training, equipment, assistance, environment, and patient factors. The intrinsic and extrinsic influences while separate from each other are internally interdependent and affect each other. Training is an aspect of both intrinsic and extrinsic influences and all three of these factors affect the outcome of a cricothyroidotomy.

With regard to training, practitioners in combat settings felt the need to train more frequently in a stepwise fashion while following a well-understood airway management algorithm. They wanted more focus on utilizing live tissue with biological feedback, but only after anatomy and geospatial orientation are well understood on models, mannequins, and cadavers. The equipment utilized in training must be the equipment available in the field. Lastly, the focus of the training should be on scenarios that stress the physical and mental capabilities of the providers. A true test of both intrinsic and extrinsic influences is to use detailed scenario-based training and all these steps must be overseen by expert practitioners. Another key is providing more time to focus on medical skills development, which is critical to overall confidence and overcoming hesitation in the decision-making process. This is even more critical for those that are least medically trained and the most likely to encounter the casualty first i.e., EMT-Basic level providers. If possible, increasing the number of medical providers at the point of injury would achieve multiple goals under the self-efficacy learning theory. Assistance would

instill confidence in the practitioner, help with the ability to prioritize patients quickly, decrease anxiety, and decrease hesitation to perform in the combat environment.

The background studies that help support these results are both positive and negative. Kyle's paper talks about all the different ways to perform a cricothyroidotomy and suggests that not having a consistent approach is why the US has higher failure rates. This was brought to light by some of the providers. They want to practice in a stepwise fashion and have a flowchart or algorithm to follow. Bennett's bottom-up review had 5 major findings: limited gross anatomy review, lack of hands-on human anatomy, non-standardized procedure, inferior standards for anatomically correct mannequins, and lack of standardized refresher training. These findings were consistent with what the providers were saying. The only real differences were choosing a single piece of equipment to train with and use, making the training scenario as real as possible, and if possible, increasing the number of medical providers at the point of injury. Our study adds to the body of knowledge from a first-person point of view. The findings of this study were similar to previous research examining causes of failure, but there were also differences such as the lighting, environment, and presence of blood not having as much of an effect as previously suggested.

The limitations of this study are inherent to the procedure studied. There were few documented cases of cricothyroidotomies within the 20 years span of the War on Terror. Recruitment of participants was through emails and then snowball technique. There is no way to capture all of those who were involved and therefore it is impossible to say that these individuals account for all possible reasons for success and failure. The time between the procedure and the interview was sometimes greater than a decade and responses can be affected by recall bias. Although a guide was used for each interview, there was only one interviewer. This could

potentially lead to biased answers. To limit the possibility the interview guide was followed, and an open-ended answer format was used.

Future research could include a longer recruitment period and interviews could be conducted by multiple people. Other first responders could enrich data across all fields to broaden the reach of future changes. Lastly, future research could expand into other similarly infrequent procedures using a similar format.

Military Relevance

Military relevance is the primary focus of this study owing to the large discrepancy between civilian reports and military reports of success rates of obtaining a surgical airway. According to the NDAA 2017, the focus of the next generation of the military is prolonged field care, and it is important that successful airways are placed as quickly as possible to hopefully increase survival outcomes. This needs to be able to happen as far forward as possible to incorporate the near-peer threat when we could lack the ability to evacuate injured combatants by air.

Unfortunately, there does not appear to be research on the reasons for success and failure through the eyes of those performing the cricothyroidotomy. Understanding how they feel about what contributes to the success or failure of their performance may now influence future training requirements, models used, equipment selection, airway algorithms, training frequency, and possibly increase the number of available medical providers at the point of injury.

Conclusion

The aim of this study was to identify the influences that contribute to the perceived success or failure of a prehospital surgical airway by the US military in the combat environment.

The interviews outlined nine themes. These themes can be categorized into two groups: influences that are internal to the provider, which we have called intrinsic influences, and those that are external to the provider, which we call extrinsic influences. Intrinsic influences include personal well-being, confidence, experience, and decision-making. Extrinsic influences include training, equipment, assistance, environment, and patient factors.

We were able to get detailed information about the perceptions of the practitioners. They provided a large pool of potential areas of improvement when it comes to improving the success rates of a cricothyroidotomy. The participants self-outlined both self-efficacy theory and deliberate practice theory in their responses, even so far as directly stating that they needed experts to critique their training performances and that they needed physiological feedback in their training scenarios. The key takeaway is that those with experience in the field are requesting changes and suggesting how they would like to be trained and challenged. The other key is that these results may influence how all low frequency, but difficult medical tasks are performed.

Further research in the same qualitative fashion after field performances of difficult medical tasks may continue to provide valuable feedback to our training units. This could become a routine way to evaluate data from the field such as through debriefing which interventions worked, and which didn't. Currently, there are very few first responders who receive any kind of feedback or performance reviews.

Chapter 2 Submission

SUCCESSFUL SURGICAL AIRWAY PERFORMANCE IN THE COMBAT PREHOSPITAL SETTING: A QUALITATIVE STUDY OF EXPERIENCED MILITARY PREHOSPITAL PROVIDERS

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Structured Summary

Introduction

Military first responders are in a unique category of the healthcare delivery system. They range in skill sets from combat medic and corpsman to nurses, physician assistants, and occasionally, doctors. Airway obstruction is the second leading cause of preventable battlefield death, and the decision for intervention to obtain an airway depends on the casualty's presentation, the provider's comfort level, and the available equipment, among many other variables. In the civilian prehospital setting cricothyroidotomy (cric) success rates are over 90% but, in the US, military combat environment success rates range from 0-82%. This discrepancy in success rates may be due to training, environment, equipment, patient factors and/or a combination of these. Many presumed causes have been assumed to be the root of the variability, but no research has been conducted evaluating the first-person point of view. This research study is focused on interviewing military first responders with real-life combat placement of a surgical airway to identify the underlying influences that contribute to their perception of success or failure.

Materials and Methods

We conducted a qualitative study with in-depth semi-structured interviews to understand participants' real-life cric experiences. The interview questions were developed based on the Critical Incident Questionnaire. In total, there were eleven participants - four retired military and seven active-duty service members.

Results

Nine themes were generated from the eleven interviews that were conducted. These themes can be categorized into two groups: factors that are internal to the provider, which we

have called intrinsic influences, and factors that are external to the provider, which we call extrinsic influences. Intrinsic influences include personal well-being, confidence, experience, and decision-making. Extrinsic influences include training, equipment, assistance, environment, and patient factors.

Conclusions

This study revealed that practitioners in combat settings felt the need to train more frequently in a stepwise fashion while following a well-understood airway management algorithm. More focus must be on utilizing live tissue with biological feedback, but only after anatomy and geospatial orientation are well understood on models, mannequins, and cadavers. The equipment utilized in training must be the equipment available in the field. Lastly, the focus of the training should be on scenarios that stress the physical and mental capabilities of the providers. A true test of both self-efficacy and deliberate practice is forced through the intrinsic and extrinsic findings from the qualitative data. All of these steps must be overseen by expert practitioners. Another key is providing more time to focus on medical skills development, which is critical to overall confidence and overcoming hesitation in the decision-making process. This is even more specific to those that are least medically trained and the most likely to encounter the casualty first, EMT-Basic level providers. If possible, increasing the number of medical providers at the point of injury would achieve multiple goals under the self-efficacy learning theory. Assistance would instill confidence in the practitioner, help with the ability to prioritize patients quickly, decrease anxiety, and decrease hesitation to perform in the combat environment.

Introduction

In the past 20 years, the Global War on Terrorism has created many casualties, and airway compromise is one well-known preventable cause of mortality for those casualties.[1,2] Airway obstruction can result from facial trauma, airway swelling, loss of respiratory drive, and unconsciousness, among others. A compromised airway causes the body to circulate less oxygen, and an adjunct airway is needed to reestablish oxygen delivery. Standard airway adjuncts help open the airway but are not considered secure as they can easily become dislodged or obstructed. Additionally, many require operator assistance to continue moving air. According to the Joint Trauma System (DoD), surgical airways are the only ones that are considered secure. The surgical airway intervention, cricothyroidotomy (cric), is considered a secure airway and the only secure airway that is taught from the Emergency Medical Technician (EMT) level all the way through the surgeon level for both military and civilian populations.[3] The cric is also the final common pathway for almost all airway algorithms to obtain an airway should all other adjuncts fail.[4]

Trauma-related crics are generally performed in the prehospital setting (Role 1). The prehospital setting includes the geographical area that is both before and during patient evacuation from the point of injury up to the moment when the patient makes it to a dedicated surgical team, either an independent forward surgical team or at a Role 2/3. That is not a hospital per se, but the surgical teams offer a higher level of care, surgical intervention, blood products, and additional expertise. In the US Military, those who perform pre-hospital medicine are usually EMTs (combat medics and Corpsmen), paramedics (paramedic trained, usually flight medics), physician assistants, and more rarely, emergency trained nurses and doctors. The

success rates for the US Military with crics range from 0-82%,[3,5-7] while the civilian prehospital rates range from 90-99% [8-10] and the British Military rates are >90%.[11]

Research about cric performance in the US Military has highlighted various causes for difficulty in successful placement.[5,8] Some of these include training, equipment, patient factors, and the environment. There are also known procedure complications between techniques.[12] Training is unit-dependent; some units are on annual training events, and others are spaced out further. EMT level providers are considered the least trained in the medical provider continuum of education, but they are usually the only providers at the point of injury. The current requirement for the EMT level combat medic is annual simulation training on crics. No current requirement for cric training on live tissue exists. To add to the complexity, there are over 12 different techniques used to perform a cric.

Environmental influences such as low light or blackout conditions, temperature extremes, rugged or uneven terrain, and limited access to additional supplies further complicate the procedure.[8] In terms of equipment, there are more than three off-the-shelf prepackaged equipment sets and many more personally handmade kits.[5] For patient factors, the average Glasgow coma scale (GCS) score ranges from 15-3, and for those who require intubation, GCS is generally eight (severe head injury) or less. The average GCS for casualties who received a cric was a three (completely unresponsive to any stimulus).[7] Other patient factors also play a role, such as anatomical differences, casualty-worn combat equipment, and differences in injury patterns.

In the research on battlefield crics, there is a lack of research addressing what prehospital providers who have performed crics think influences the success or failure of the procedure.

Therefore, this study aims to identify the influences that contribute to the perceived success or failure of a prehospital surgical airway by the US Military in the combat environment.

Methods

We conducted in-depth qualitative semi-structured interviews to understand participants' real-life cric experiences. The interview questions were developed based on the Critical Incident technique and Questionnaire.[13-16] This study was approved by our Institutional Review Board (DBS.2021.291).

Participant demographics

We initially put out an email request through the branch chiefs to elicit possible participants, which enabled the self-selection of participants. We obtained five participants through these emails. We followed this with snowball sampling, and an additional six participants were solicited. In total, there were eleven participants - four retired military and seven active-duty service members. (See Table Y for inclusion criteria). We had three officers and eight enlisted members. All enlisted members were junior enlisted at the time of their procedure. Five of the eight enlisted members were entry-level EMT-Basic trained, while three were special operations. See Table X.

Data Collection

One 60–90-minute semi-structured interview was conducted per participant via Zoom or over the phone. Verbal consent was obtained from each participant before the interview was conducted. The interview posed a series of open-ended questions about the individual's lived experiences and the meaning that individuals attached to their cric experiences (See Appendix X for interview questions). Data were transcribed as participants completed the interview process. The data and interviews were de-identified to ensure the anonymity of participants.

Data analysis

Braun and Clark's thematic analysis process guided the data analysis.[17] Two interview transcripts were randomly selected, and all four authors coded them independently. We then met to review our codes and identify themes. The initial themes were tested against two more transcripts and further refined by the team. The team then searched for connections across themes and generated overarching categories. (See Table Z for themes) When thematic saturation was reached, two more interviews were conducted to test the themes and ensure that nothing was overlooked.

INSERT Table Z Themes

Results

Nine themes were generated from the eleven interviews that were conducted. These themes can be categorized into two groups: influences that are internal to the provider, which we have called intrinsic influences, and those that are external to the provider, which we call extrinsic influences. Intrinsic influences include personal well-being, confidence, experience, and decision-making. Extrinsic influences include training, equipment, assistance, environment, and patient factors.

Intrinsic Influences

The participants in this study indicated that their perceptions of the success of the cric they performed depended on four intrinsic influences: personal well-being, confidence, experience, and decision-making.

Personal well-being includes the individual's physical and mental state. The individual's mental state was a huge influencer in the ability to perceive success and perform on the battlefield. Adrenaline and anxiety were critical influences in the participant's experience of the

combat environment. Participant six noted, “My adrenaline flow is about a 1,000 times normal at that point because of the mission itself. And then, when I got my patient realized my anxiety hit incredible” and participant five said, “I just remember, like the smell of everything, and I just remember, like man, my heart was just like beaten so fast.” Physical fitness was as important as mental fitness. Many participants were running or dragging patients to secure areas to treat them, which they suggested decreased their ability to perform due to fatigue. Those participants suggested rigorous physical training should be conducted to overcome that physical withdrawal before the procedure.

Confidence and overconfidence were themes that influenced perceptions of success as well. Participant five stated, “Did one procedure, it went really well, I thought I was like, the man. Then, a month later, I had, like an American casualty who actually had ended up dying. I like totally (expletive) the cric up on that guy. Because I was like, overconfident.” Because of this overconfidence, he didn’t follow his standard stepwise technique, which inevitably led to failure. Those with prior experience assisting or one-on-one supervision felt that played a tremendous role in success and confidence not only for performing the procedure but also for setting up their specific equipment and developing their technique. Participant one noted, “My confidence level far exceeded my competence level” and participant three said, “It's not that simple when you cric someone’s neck. I had done everything else properly. From my recollection as in, the incision was properly placed, landmark was found, everything was there. Just didn't give myself, the right opening and I rushed it in like a drunk frat boy.” These are great examples of overconfidence and how it led to perceived or actual failure. The result of the procedure also plays into the mental health and prolonged traumatic stress the provider feels afterward. Participant six described how it made him feel, “The outcome I didn't know. So, you

know that kind of sticks with you a little bit, and it's pretty…. it's pretty vivid in my mind actually." Very few providers received feedback from the next higher echelon of care; most did not know the overall outcome of the patient. These stressors can create barriers to confidence in the follow-on procedure, as suggested by the above participant.

Experience level with the equipment and procedure was instrumental in the ability to perform the procedure. Those with no experience with actual human casualties, either firsthand or with assisting another provider, hesitated to perform the procedure and felt less confident at the moment. Participant six stated, "I might have been a little overconfident going into it and then, when it happened, I was oh, at a moment, the moment of realization that, am I really this confident with it?" Those with prior experience or assisting felt far more confident the second time. However, some success with a prior cric led one participant to be overconfident and fail a second attempt, as we saw above with participant five. Furthermore, even when additional providers were available, without an expert nearby, failure was still possible. As participant two noted when he mentioned there were three or four providers. "So, it was not necessarily the blind leading the blind but there wasn't, really anyone who had a total level of expertise." Those with hands-on experience with their equipment and with real patients felt that experience helped them feel like they were successful in the field. Participant one was heavily influenced by the experience he got from his physician assistant prior to his cric. "I had the kit that like I put together with the help of my battalion physician assistant, who was really, really experienced, and had already walked me through like a live tissue cric." This experience helped him perceive that his procedure was successful and attributed the success to that experience with an expert. Participant six thought his prior experience on an actual patient was more important than any prior training, "My best set up for success, helping someone else do a cric in combat."

Making the call to perform the cric is one of the toughest decisions. Making sure to know the steps and follow them in order also plays a significant role in the perception of success. Participant eight noted, “It's the decision to make the, to actually perform the procedure. Does this patient need it? We, or am I just being too aggressive here. That's the real dilemma I think when you're looking at your patient.” The decision to perform the cric should be clear-cut and based on the Joint Trauma System guidelines. However, many struggled with understanding the decision tree and when to perform the cric. Two participants suggested we must improve the decision-making process and take each step deliberately instead of jumping from a supraglottic airway adjunct directly to a surgical airway. Participant one’s recommendation was, “I think that maybe the first step is to think through what interventions are available, and which one will be appropriate rather than rushing into procedure.”

Extrinsic Influences

Five extrinsic influences affect the participant’s perceptions of success with their cric: equipment, assistance, patient-related factors, environment, and training.

The equipment that the participants used to perform their crics was a key extrinsic influencer for the perception of success of the cric. Over half of the participants had a custom-made cric kit. They modified their kit either through practice with simulations or through the guidance of an experienced provider. The equipment they used played a critical role in their perception of success. Although everyone talked about their equipment, familiarity and repetition of cric procedures on their specific equipment led to the highest perceptions of success. One provider who was trying a new device for the first time and on a live patient was thoroughly confused about exactly how it worked which inevitably led to failure. However, another individual, using the same piece of equipment for the first time but had one on one oversight

during the procedure, was successful. Some of the equipment just didn't inspire confidence. Participant seven elaborated, "If you've got a lot of subcutaneous tissue, have very much mobility in your neck, then putting in a 3-inch or 2.5-inch cric to the chance of it dislodging, I'm not comfortable with hanging a patient's life on that." Participant four mentioned, "we generally ditch most of the stuff we didn't see is relevant, so you know, the alcohol swab in combat. We weren't too worried about the 4 by 4 gauze. The securing device that originally used to come with them was pretty bad." The lack of confidence in the off-the-shelf equipment resulted in many participants working with custom-made kits.

The next most important extrinsic influencer was assistance. Almost all point of care and evacuation participants were alone as the single medical provider for their casualties. The three fixed area participants had additional help from other medical providers. Those who were in areas with additional medical personnel felt more confident in their ability to perform. Those who were alone wanted help, and those who weren't alone still asked for supervision or a "sanity check" before performing the procedure, as participant eight described. Participant six also wanted assistance, "Nothing is better to have two medics, you know. Is it overkill? It could be at times, but in some situation like that, two people in the back, I think you get much better at success".

The environment of combat is significant and does play a role in the success of cric placement for multiple reasons. One participant performed care under fire, two performed during flight evacuation, three performed the task in a fixed aid station or area, and six participants performed the task during the tactical field care phase. Time constraints of the procedure and evacuation timelines also played a role. Time it takes to do the procedure and when the MEDEVAC will arrive influenced when or how soon the decision for a surgical airway was

made. Of those who performed care under fire or tactical field care most stated the combat environment influenced their performance. From participant four, “But you know, two out of my three crics were in a field, or you know, and at a target while the gunfight was still going on, while I had just been participating in the gunfight and then having to do it with a little bit of red light from my head lamp.” This quote brings out multiple layers of how the environment plays on anxiety, fear of imminent danger, and visualization of the anatomy. Participant eight noted the effect of the timeline and additional patient load with this quote, “Had I had more time, I probably would have. I would have addressed his need for cric. …I was the only medic on scene with dealing with the 3 patients.” This influence from the environment affected his decision tree, demonstrating many influences are interdependent on outcomes.

Patient factors also played a significant role in the ability to perform a cric. The responses from participants demonstrated the key importance of knowing the anatomy by touch. Being able to correctly identify the starting location increases the likelihood of success as perceived by the provider. “Really being able to identify landmarks on multiple personnel” and “touch everybody’s neck.” (Participants 2 and 4) There is a need for practicing identifying landmarks through soft tissue. It is of key importance to make sure practice is done on individuals with more soft tissue as anatomy is less pronounced. According to multiple participants obscured vision due to the patient’s blood was not a factor in success. Directly quoted from participant four, “So on every cric I’ve done there [was] or has been blood but it's never been a problem where I've had an issue visualizing”. This is contradictory to some of the previous assumptions about reasons for failure. However, no participant in this study, identified blood as a significant influence in the success or failure of a cric.

Both intrinsic and extrinsic influences are affected by the training received before the procedure was performed. We derived multiple training-related responses from the interviews, including the type of training received, specifically, simulation-based training with mannequin, cadaver, or live tissue, training frequency, and the type of training that plays a role in translating training to real-life performance. The training received varied between individuals but those with high volume, hands-on instruction conveyed the most confidence and firm belief their training directly contributed to their success. Participant eight, with his high volume, realistic training, suggested, "train often and train hard for the guys about to deploy. Take advantage of every opportunity that presents itself and I don't think there's ever a substitute for live tissue, patient models and cadavers" and participant three, "really do treat every situation as if it really is one of your guys there. Realistic training is everything". Participants were keen on live tissue training and the ability for true biological feedback. Progressive training from anatomy classes to mannequins to cadavers to live tissue was the most common suggested progression. Most participants mentioned they wanted live tissue training as a culminating event. The suggested training timeline was focused around 3 months prior to deployment and at least a biannual refresher for those not deploying. However, those who were the most confident in their ability to perform had the most effective training - live tissue every 3-6 months, as noted in this response from participant five, "I had a lot of live tissue training, and that really made me comfortable with the procedure. So, I knew, like all the steps really well. I could do them in the dark." Another notable insight from participant six was, "medical training wasn't as important as everything else, and I think we lose focus on that until we're needed, and that's the downfall." The participants were commonly used for other tasks unrelated to improvement in medical skills. It was also mentioned that instructors/trainers need to be fluent in the procedure and have the

experience to back it up. There was concern about not receiving expert-level feedback. Rushing through the procedure and lack of previous training led to poor outcomes. However, those who had live tissue training every six months stated that they felt confident but not overconfident and they did have success with the procedure.

Discussion

This study identified intrinsic influences and extrinsic influences as having an impact on the performance of a cric. The intrinsic influences are personal well-being, confidence, experience, and decision-making. The extrinsic influences are equipment, environment, patient factors, and assistance. Both intrinsic and extrinsic influences are affected by training and affect the final outcome in the ability to perform a cric. See FIGURE 1.

Insert Figure 1

The intrinsic influences are interdependent and affect each other. Without one of the other influences of decision-making skills, confidence, and experience, it is very hard to develop a sense of personal well-being to overcome nervousness, anxiety, or fear. It is also hard to gain experience or confidence without positive physiological feedback from the training or through positive vicarious examples as mentioned by the participants, and simulation research.[18-21] The learner must not be distracted and must be in the right state of mind to conduct valuable training. Feedback from the training is also important for developing self-efficacy, especially feedback from an expert.[22] Verbal cues and verbal persuasion in the correct performance are key elements to self-efficacy.[22] Performance outcomes from training give not only positive or negative results,

but they also supply valuable confidence once the task is performed correctly. Performing high-quality repetitions increases experience, and performing the task correctly improves confidence.[23,24] These two directly affect personal well-being by alleviating nervousness, anxiety, and fear through continued positive physiological feedback after each positive training outcome.

The extrinsic influences for success or failure in the performance of a cric are as vitally important as the intrinsic influences. These are also interdependent on each other. Assistance was available for only three of the participants, and having assistance can affect many aspects of extrinsic influences and self-efficacy. Allowing the practitioner, through deliberate practice, to have a "sanity-check" or to get positive reinforcement about this critical task is instrumental during training and during the critical incident. The assistant can also improve patient-specific factors by removing excess gear, positioning the airway, holding the surgical field steady, holding a light, or many other aspects of the incident. That still may not help if the equipment is faulty or it has never been used before, as we saw with one of the participants. The same can happen with the environment. When one participant performed a cric while still being subjected to enemy fire, they were forced to attempt the cric from an unfamiliar starting position. The extrinsic influences may be beyond personal control. However, training for those scenarios could potentially supply all the aspects needed for improving self-efficacy.

We all have heard from a young age that we need to practice, as practice makes perfect. However, everything about how we practice makes a critical difference in performance outcomes.[25-30] In this study, both intrinsic and extrinsic factors were influenced by training. Through deliberate practice, participants could practice and improve their cric skills. The quality of practice with expert feedback and allowing the learner to process and integrate what was

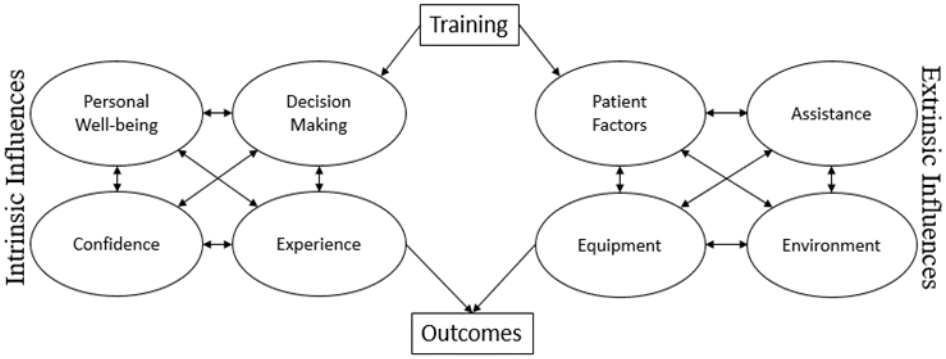
learned is vital.[4,31,32] Continued deliberate practice leads to improved self-efficacy. Continued self-efficacy leads to a positive feedback loop and improved confidence. Then the cycle continues again. The time for self-reflection and internalization of what was learned is equally important to the intrinsic influences and the ability to perform the task under pressure.

Intrinsic and extrinsic influences both affect outcomes. Training is the only major theme that affects all the elements of intrinsic and extrinsic influences, and it directly correlates to outcomes. Setting up deliberate practice scenarios while keeping the self-efficacy theory in mind would improve the areas that participants said hindered their success. Bennett et al. provided a bottom-up review that clearly showed the need for training.[8] Seven out of the eleven participants performed crics after the recommendations were made, but still the participants requested more training reinforcing studies that show that mannequin-based simulation training provides valuable feedback and improves accuracy, timing, and success.[1,4,8,10,15,33-36] According to the participants of this study, initial training is important to understand the steps of performance and the decision-making process. However, after initial training, for critical tasks, participants wanted live tissue feedback after the mannequin-based simulation training is completed.[5,34] The repetitive finding for training is that there is underlying self-realization right at the point of injury that is either overcome by previous training and self-efficacy or there is a failure to perform. All the intrinsic influences force the individual to focus on self-efficacy and internal strife. The extrinsic influences are more dependent on deliberate practice with continuous challenging practice and expert feedback in order to overcome challenges.

Conclusion

This study highlights how practitioners in combat settings felt the need to train more frequently in a stepwise fashion while following a well-understood airway management

algorithm. More focus needs to be on utilizing live tissue with biological feedback, but only after anatomy and geospatial orientation are well understood on models, mannequins, and cadavers. The equipment utilized in training must be the equipment available in the field. Lastly, the focus of the training should be on scenarios that stress the physical and mental capabilities of the providers. A true test of both self-efficacy and deliberate practice is forced through the intrinsic and extrinsic findings from the qualitative data. All of these steps must be overseen by expert practitioners. Another key is providing more time to focus on medical skills development, that is critical to overall confidence and overcoming hesitation in the decision-making process. This is even more specific to those that are least medically trained and the most likely to encounter the casualty first, EMT-Basic level providers. If possible, increasing the number of medical providers at the point of injury would achieve multiple goals under the self-efficacy learning theory. Assistance would instill confidence in the practitioner, help with the ability to prioritize patients quickly, decrease anxiety, and decrease hesitation to perform in the combat environment.



Participant	Branch	Year	Theater	Phase of care	MOS	Rank	Equipment	Additional Training
1	Army	2005	Iraq	Tactical Field Care	Medic	E4	Off the shelf	BCT3
2	Army	2005	Iraq	Established	PA	O3	Off the shelf	MC4
3	Army	2012	Afghanistan	Tactical Field Care	Medic	E5	Off the shelf	BCT3
4	Army	2016	Afghanistan	Tactical Field Care	Special Ops Medic	E5	Custom	SOM LTT
5	Army	2005	Iraq	Tactical Field Care	Medic	E5	Custom	LTT
6	Army	2017	Afghanistan	Enroute Evacuation	Flight Medic	E6	Custom	BCT3 and Cadaver
7	Army	2012	Afghanistan	Tactical Field Care	Special Ops Medic	E5	Custom	SOM LTT
8	Navy	2005	Iraq	Established	Special Ops Medic	E6	Off the shelf	NTTC
9	Army	2005	Afghanistan	Established	Medic	E4	Custom	BCT3
10	Army	2010	Afghanistan	Care under fire	PA	O3	Off the shelf	TCMC and LTT
11	Army	2018	Afghanistan	Enroute Evacuation	Trauma Nurse	O3	Custom	TCMC/TCCC/ECCN

Table X Participant Demographics

Inclusion Criteria	**Exclusion criteria**
• US Military or prior military • Have performed a cric in the combat environment- as defined by an area where combat operations are taking place; land, sea or air where kinetic operations are occurring • They were considered prehospital in their duties	• Those who were part of a surgical team • Role 2 or higher echelon of care • Performed cric outside of a combat environment

Table Y Participant Inclusion/Exclusion Criteria

Broad Categories	Themes	Sample quotations
Intrinsic Influences	Personal well being	The first one was memorable, because I was just like real nervous
	Decision and steps to perform	He eventually did get a cric. However, I was hesitant to do it at the time, because it was one of my guys
	Experience level	My best set up for success, helping someone else do a cric in combat
	Confidence	My confidence level far exceeded my competence level.
Extrinsic Influences	Assistance	The ER Doc was supervising because I told him “Hey, this is the first time I’ve actually done this on a real patient”
	Equipment	Our particular problem, for sure, was lack of familiarity with that piece of equipment
	Training	Ultimately live tissue training with as many repetitions as possible on the live tissue
	Patient specific factors	Really being able to identify landmarks on multiple personnel
	Environment	I didn't have time to debate you know? it's just that make decision and do it versus, you know, think about it

Table Z Themes

Appendix X

Critical Incident Interview Guide

Interview Background Information

Name of Interviewer: Date:

Person being interviewed

Job when you had to perform the cric:

Rank when you had to perform the cric:

Instructions:

Use this outline to help guide the Critical Incident interview. Try to focus on the events, behaviors, and actions. Avoid assigning blame or introducing biased opinions. Focus on the facts. Lead with the intro prompt and see further possible probing questions below.

Intro prompt:

Tell about a memorable time when you had to perform a Cricothyroidotomy, in a combat setting, trying to focus on what do think helped or hindered your success

Probing prompts

Who, What, When, Where: If not hit in the initial presentation; possible probing questions, use all, some or none

What happened?

When and where did it happen?

What was happening when you did this, care under fire, combat casualty care phase, evacuation or aid station, etc?

What happened that was beneficial or positive in outcome; was the cric successful?

What happened that was detrimental or had a bad outcome, did you try another airway first?

What led to the decision to perform a cric?

What happened before this, can you recall the GCS number?

What circumstances existed that caused the change between no airway, supraglottic, intubation and surgical airway?

What equipment did you use to perform?

What would you have done differently if you could do it over again; i.e initial training, annual training, equipment, supplies, level of provider, patient factors, etc?

What will you do differently in the future to be more successful?

Actions of Individuals

What did you do that helped or was effective?

What did you do that did not help or was ineffective?

What was the outcome of these actions?

Why did this help or not help the incident to occur?

What did you observe being done by others?

If you could change anything about the process of training or retraining, what would you change? (i.e., frequency of refresher training, depth or type initial training, access to training, etc)

Consequences of Actions

What was the outcome of these actions?

Why do you think the actions were effective or ineffective?

Why do you think the actions had a positive or negative outcome?

Closing Questions:

What training did you have prior to the event?

What equipment did you use?

Did you have assistance from another professional?

Were there any patient factors that made it harder or easier to perform?

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