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Original Contribution

Retention of cricothyrotomy skills by paramedics using a wire guided technique

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ABSTRACT

Introduction: Cricothyrotomy may be necessary for airway management when a patient's airway cannot be maintained through standard techniques such as oral airway placement, blind insertion airway device, or endotracheal intubation. Wire-guided cricothyrotomy is one of many techniques used to perform a cricothyrotomy. Although there is some controversy over which cricothyrotomy technique is superior, there is no published data regarding long term retention rates. The purpose of this study is to determine whether ground based paramedics can be taught and are able to retain the skills necessary to successfully perform a wire-guided cricothyrotomy.

Methods: This retrospective study was performed in a suburban county with a population of 160,000 with 23,000 EMS calls per year. Participants were ground-based paramedics who were taught wire-guided cricothyrotomy as part of a standardized paramedic educational update program. After viewing an instructional video, the paramedics were shown each the steps of the procedure on a simulation model, using a low fidelity task trainer previously developed to train emergency medicine residents. Using a 16 step procedural checklist, participants were allowed open-ended practice using the task trainer. Critical steps in the checklist were marked in bold lettering indicating automatic failure. Each paramedic was then individually supervised performing a minimum of 5 successful simulations. Retention was assessed using the same 16 step checklist 6 to 12 weeks following the initial training.

Results: A total of 55 paramedics completed both the initial training and reassessment during the time period studied. During the initial training phase 100% (55 of 55) of the paramedics were successful in performing all 16 steps of the wire-guided cricothyrotomy. During the retention phase, 87.3% (48 of 55) of paramedics retained the skills necessary to successfully perform the wire-guided cricothyrotomy. On the 16 step checklist, most steps were performed successfully by all the paramedics or missed by only 1 of the 55 paramedics. The step involving removal of the needle prior to advancing the airway device over the guide wire was missed by 34.5% (19 of 55) of the participants. This was not an automatic failure since most participants immediately self-corrected and completed the procedure successfully.

Conclusion: Paramedics can be taught and can retain the skills necessary to successfully perform a wire-guided cricothyrotomy on a simulator. Future research is necessary to determine if paramedics can successfully transfer these skills to real patients.

1. Introduction

Cricothyrotomy may be necessary for airway management when a patient's airway cannot be maintained through standard techniques such as oral airway placement, bind insertion airway device, or endotracheal intubation [1]. Cricothyrotomy is most often reserved as the last method employed to obtain an airway due to its highly invasive nature and relatively high complication rate when performed emergently. Cricothyrotomy is a procedure included in most failed airway protocols for most health care professionals including paramedics in the prehospital environment [2].

Wire-guided cricothyrotomy is only one of many techniques used to perform to a cricothyrotomy [1, 3-5]. Other techniques used to perform cricothyrotomy include open surgical, catheter over needle, and specialized cricothyrotomy scissors [1, 2, 3, 5-7]. There is controversy over which technique is superior in regards to success rates, lower complication rates, and operator comfort. Some studies suggest that for inexperienced health care professionals, open techniques are superior to a wire-guided technique [1, 5]. Other research suggests that wire-guided cricothyrotomy has a higher success rate when compared to other techniques such as catheter over needle or open technique [3, 4, 7]. Data also suggests that physicians feel more comfortable and prefer the wire-guided method over other methods due to their familiarity with the Seldinger technique used for central venous catheter placement [3, 4].

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Several published studies suggest that wire-guided cricothyrotomy has a lower complication rates when compared to other techniques [1, 4]. This technique was specifically developed for use by paramedics who do not routinely perform cricothyrotomies and tracheostomies [4].

Currently there is no data examining the long term retention rates of cricothyrotomy performed by paramedics. The purpose of this study is to determine whether ground based paramedics can be taught and if they can retain the skills necessary to successfully perform wire-guided cricothyrotomy.

2. Methods

This study was performed in a suburban county with a population of 160,000 and approximately 23,000 EMS calls per year. Participants were ground-based paramedics in a county-wide EMS system. The participants were taught wire-guided cricothyrotomy as part of a required standardized paramedic educational update program. As part of the educational program paramedics were taught wire-guided cricothyrotomy on a simulation model, using a low fidelity task trainer, previously developed to train emergency medicine residents, see Fig. 1. This low cost task trainer is currently being employed by several emergency medicine residency programs in the southeastern US to teach wire-guided cricothyrotomy and is a variation of a previously studied task trainer [8, 9].

A 2 h course was presented including an instructional video on wire-guided cricothyrotomy. Participants were then allowed to practice the technique on the task trainer using a 16 step check-list, see Fig. 2. Steps that appear in bold print were previously identified by our EMS Continuing Education Committee as critical steps and were deemed automatic failure points during instruction and testing. In addition, paramedics were required to successfully complete 14 of the 16 steps in order for an attempt to be considered successful.

Each participant was individually supervised performing a wire-guided cricothyrotomy on the task trainer until the procedure was performed successfully without instructor guidance. A minimum of five successful performances were required. Following completion of the training session, short term retention was immediately evaluated using the same 16 step checklist to assure that the paramedic had correctly learned the technique. Paramedics who were unsuccessful required re-education on the simulator until they were successful.

Long term retention was assessed using the same 16 step checklist 6 to 12 weeks after the initial training session as part of a recurrent skill assessment. This study was approved by the local Investigational Review Board, and participants were required to sign consent forms to release their individual data.

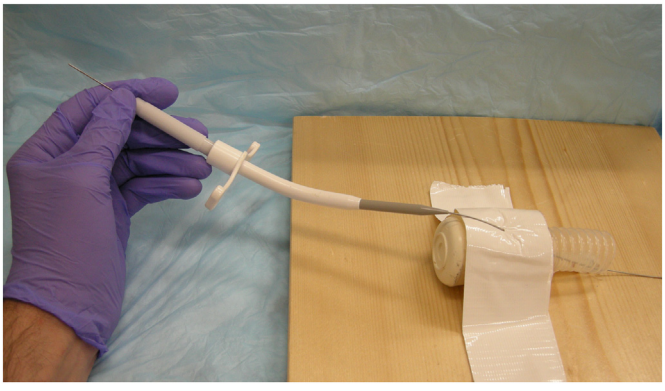

Fig. 1. Task trainer model.

3. Results

Fifty-five paramedics completed the initial training, short term assessment, and long term reassessment during the study period. Fifty (91%) of the participants were male. The mean age of the participants was 39.4 years of age with a range of 23–65. The mean experience was 8.7 years with a range of 0–15 years.

During the initial training and short term retention phase, all 55 (100%) of the paramedics were successful in performing all 16 steps of the wire-guided cricothyrotomy. However, during the initial training phase, two paramedics did require reeducation with each participant performing one additional simulation on the task trainer.

During the long term retention phase, 48 (87.3%) retained the skills necessary to successfully perform the wire- guided cricothyrotomy. Of the 16 step checklist, the majority of steps were performed successfully by all the paramedics or missed by only 1 of the 55 paramedics, see Fig. 3. One of the 55 paramedics who failed did miss 11 of the 16 steps.

The step involving removal of the needle prior to advancing the airway device over the guide wire, step #8, was missed by 19 of the 55 (34.5%) of the participants. This step was not deemed an automatic failure since most participants immediately self-corrected this error and completed the procedure successfully.

4. Discussion

Wire-guided cricothyrotomy is one of many techniques used to perform to a cricothyrotomy. Although there is controversy over which technique is superior in regards to success rates, lower complication rates, and operator comfort; there is no published data regarding long term retention rates for the different techniques. Although a checklist was used during the initial training, neither the checklist nor the task trainer were available to the paramedics after the initial training session was completed. Furthermore the checklist was also not in the regional/county protocols for the paramedic to review prior to the retesting. The long term retention rate of 87.3% noted in this wire-guided cricothyrotomy study, is higher than the reported 68% success rate seen with an open technique in battlefield situations, but this represents a simulated environment in comparison to a failed airway situation in combat [10].

A 100% success rate was recently obtained in a study by Quick et al., which used an open technique together with an elastic bougie and endotracheal tube, using a high fidelity simulation model. Yet this study did not examine long term retention and the participants included flight nurses [11]. Another study by Hill et al. noted the medical students and residents using a bougie-assisted cricothyrotomy technique had success rates of only 90% [12]. Furthermore, none of these studies looked at long term retention and none of these studies studied only ground paramedics.

With the advent of BIAD and other advanced techniques, a failed airway in the prehospital environment is a very rare event. Consequently, this makes it impossible to perform a large prospective study on cricothyrotomy. As such, it is even more important that any future simulation studies comparing different cricothyrotomy techniques examine not just initial success rates but also long term retention rates.

Currently, there are no published studies examining long term retention rates using the different cricothyrotomy techniques. This is the first study to examine the individual steps in the process of cricothyrotomy. This is also the first study that identified which steps were most problematic and difficult to retain. In examining any procedural technique, it is important to separate the process into steps in order to analyze each step individually. By having a stepwise analysis, initial and recurring education can be focused on specific problematic steps in an attempt to increase overall short and long term success rates [13].

1. **Identifies indication and contraindication of the Melker surgical cricothyrotomy catheter set**
2. Employs universal precautions and attempts to ventilate patient with a BVM
3. Assembles equipment (includes checking cuff)
4. **Palpates and cleanses the insertion site appropriately**
5. **Makes a vertical incision midline**
6. **Advances the 18 g TFE catheter introducer needle (attached to a 6 cc syringe) through the incision into airway at 45 degree angle to frontal plane in the midline in a caudad direction**
7. **Verify entrance into airway by aspirating the syringe- free air return should be present**
8. Remove syringe and needle, leaving TFE catheter in place
9. Advance soft, flexible end of wire guide through TFE catheter and into airway several centimeters
10. **Remove TFE catheter, leaving wire guide in place**
11. Advance handled dilator, tapered end first, into connector end of airway catheter until handle stops against connector
12. **Advance airway access assembly over wire guide until proximal stiff end of wire guide is completely through and visible at handle end of dilator**
13. Remove wire guide and dilator simultaneously
14. Inflate cuff (5-6 cc air)
15. Secure airway device and ventilate
16. **Reassess**

(14 of 16 required to pass)

Bolded items represent "automatic failures" and the need for retesting.

Examiner: _____ Exam Date: _____

Fig. 2. SKILL CHECK SHEET – Cricothyrotomy.

5. Limitations

This study has several limitations including small sample size and a geographically small region within one state. The most important limitation was that this was a simulated training model using a low fidelity task trainer. In addition, there is currently no published data regarding use of wire-guided cricothyrotomy during a failed airway on live patients in the prehospital environment. Yet a recent study by Jayaraman et al. suggests that use of a low fidelity task trainer significantly increases the success rate of cricothyrotomy when performed by inexperienced resident physicians using an open technique in a swine model [14].

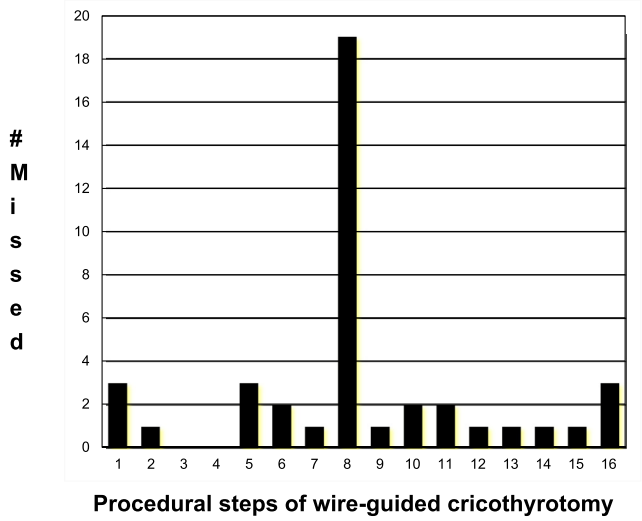

Fig. 3. - Total number of failures for each of the 16 steps in the check sheet, total $N = 55$.

Another limitation is that this data cannot be extrapolated to other cricothyrotomy techniques. This study also did not determine which cricothyrotomy technique in a paramedic population is easiest to learn and which is best retained. Since cricothyrotomy by paramedics is rarely performed, future studies comparing different cricothyrotomy techniques need to include long term retention.

Another limitation of this study is the relatively short time frame of only 6–12 weeks used for retesting. Some will say that this is not true long term retention, yet several studies suggest that significant degradation with other procedural skills begin after only a few short weeks [15-18]. Nevertheless, there are no other studies looking at “long” term retention and attrition of cricothyrotomy skills in paramedics.

Lastly, any future studies need to include a stepwise checklist to help identify problems areas. By identify problems areas future instructors and students can appropriately adjust initial training and retraining.

6. Conclusion

Paramedics can be taught to perform and retain the skills necessary to successfully perform a wire-guided cricothyrotomy on a simulator. Future research is necessary to determine if paramedics can successfully transfer these skills to real patients.

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