

## Cricothyrotomy performed with the Melker™ set or the QuickTrach™ kit: procedure times, learning curves and operators' preference

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**SUMMARY:** Cricothyrotomy performed with the Melker™ set or the QuickTrach™ kit: procedure times, learning curves and operators' preference.

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**Background.** Cricothyroidotomy is a surgical airway technique in which an airway device is inserted into the trachea through an incision made at the cricothyroid membrane. It is used for the management of the "difficult airways" and may be a lifesaving procedure in "can't intubate, can't oxygenate" situations. However, many healthcare professionals working in emergency settings have little or no experience with this procedure. Achievement of theoretical and practical knowledge of different cricothyrotomy techniques is therefore a fundamental prerequisite for those healthcare professionals.

**Materials and methods.** In this study, 40 volunteers representative of different categories of healthcare professionals were enrolled for the theoretical and practical 1-day training course on cricothyrotomy. Two commercially available devices for cricothyrotomy were used during the course, the Melker™ set, which involves the Seldinger technique, and

the QuickTrach™ kit, which does not rely on the use of a guide-wire. Each participant performed a series of 5 attempts on a manikin with each kit. Procedure time was recorded, and satisfaction with the course, preference for each cricothyrotomy kit and self-rating of cricothyrotomy skills were assessed by a self-administered questionnaire.

**Results.** Mean procedure time significantly decreased from the first to the last attempt ( $48.7 \pm 21.9$  and  $27.8 \pm 13.7$  seconds, respectively;  $p < 0.0001$ ). The Melker™ set was the most preferred, being rated as "excellent" by 62% of participants. This preference was even more pronounced among anaesthesiologists, that are more familiar with the Seldinger technique. Participants' satisfaction was high: the course was rated as "excellent" by 66.7% of attendees, the theoretical and practical knowledge achieved was rated as "very useful" by 94% of all attendees and by 100% of the anaesthesiologists.

**Conclusions.** A systematic approach to teach healthcare professionals in the application of various devices for the management of the so-called "difficult airways" may maximize intubation success and minimize complication. The present study provides evidence for the efficacy of training courses in Emergency Departments aimed at improving theoretical and practical cricothyrotomy skills in emergency situations.

**KEY WORDS:** Cricothyrotomy - Difficult airways - Seldinger technique - Melker™ test - QuickTrach™ kit.

## Background

Cricothyrotomy consists in the creation of a percutaneous opening of the upper airway at the easiest and most rapidly accessible level, i.e. the cricothyroid membrane, through which a respiratory cannula is introduced to be connected to the ventilatory system (1). This surgical procedure was initially performed in the 20's as al-

ternative to "high tracheostomy" that became rarely used because of a subglottic stenosis after tracheostomy described in 158 cases (1, 2). In the anesthesia literature, cricothyrotomy is indicated for the management of the so-called "difficult airways", or "can't intubate, can't oxygenate" conditions, i.e. all those clinical situation, defined by the American Society of Anesthesiologists in which there is a lack of control of the airways due to either failure of oral/nasal endotracheal intubation or supraglottic obstruction of the upper airway (3-5). Such situations can be represented, especially in emergency, by anatomical abnormalities of the airways, oral and maxillofacial traumas, suspected cervical spinal injury, obesity, emesis, oral hemorrhage, which obstruct the visualization of the vocal cords (3-6). In such a scenario, cricothyrotomy is the only procedure that allows re-establishing oxygenation quickly enough to prevent the consequences of

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cerebral hypoxia (7). Cricothyrotomy is not a definitive method of airway control, therefore tracheostomy or endotracheal intubation should be performed as soon as the patient has been stabilized.

The current cricothyrotomy follows the original technique where instead of dividing the cricoid cartilage, entering through the thyroid cartilage and the first tracheal ring, one gets access to the airway through an incision in the cricothyroid membrane, expanding the surgical site and inserting a device into the airways (8). Several commercial prepackaged kits are available that allow performing an emergency cricothyrotomy, with or without the Seldinger technique (9). Sometimes, the lack of operators' skills in the management of various device for a cricothyrotomy can take place, impairing the intubation success and inducing complications (10-12). Therefore, competence in this procedure, whose importance has widely been acknowledged by the majority of recent guidelines on difficult airway management, is essential for all healthcare professionals who work in emergency settings (13). As a consequence, implementation of specific training courses on cricothyrotomy has become a fundamental need for all hospitals and medical facilities that provide emergency care. Studies in the literature suggest that, when cricothyrotomy is performed on mannequins, at least five attempts are necessary to successfully perform the procedure (14). Our study aimed to delve into the issues related to cricothyrotomy training through the evaluation of three different aspects: (i) the teaching efficacy of a course intended for health professionals involved in the management of the critically ill patient in an emergency setting, designed to improve cricothyrotomy skills; (ii) preference rates for two different commercially available cricothyrotomy kits, i.e., the Melker™ Emergency Cricothyrotomy Catheter set (Cook Medical Inc., Bloomington, IN, USA) which involves using the Seldinger technique (15), and the QuickTrach™ Emergency Cricothyrotomy kit (CRR Medical Inc., St. Petersburg, FL, USA); and (iii) the learning skills for each technique.

## Materials and methods

### Study participants

We enrolled 40 health professionals among physicians (Anaesthesiologists, n=10, Anaesthesiology Residents, n=10), paramedics (Professional Nurses, n=10) and Medical Students attending the last year of Medical School (n=10), all working in the Emergency Department (ED) of the "Polinclinico Umberto I" University Hospital, Roma Italy.

### Study setting and design

The study was carried out at the Emergency Department of the "Polinclinico Umberto I" University Hos-

pital in Rome, Italy. We organized a 1-day course on cricothyrotomy techniques that was divided into two sessions: a first theoretical session during which a description of the procedure was provided and a second session during which each participant practiced on a mannequin. During the first part of the course different cricothyrotomy techniques and kits were illustrated with the help of audio-visual training materials. Two cricothyrotomy kits were used during the second, practical part of the course: the Melker™ set and the QuickTrach™ kit (QT kit). The Melker cricothyrotomy device requires the use of a Seldinger technique, according to which the cricothyroid membrane is pricked by a needle mounted on the syringe (15). Through the needle, a guide wire is introduced into the tracheal lumen, it widens the skin by a scalpel and you slide over the guide wire the cannula mounted on the introducer dilator. Finally, the dilator is removed with the guide wire and the cannula is connected to the ventilation system. Using this technique, cannulae of different sizes can be introduced into the trachea from a minimum of 3.5 mm ID (internal diameter) and 3.8 mm in length, to a maximum of 6 mm ID and 7.5 mm in length. The QuickTrach™ kit, unlike the previous one, does not require the endotracheal positioning of a guide wire; it uses a needle by which a large hole is made on the cricothyroid membrane, the air is aspirated, and the needle is removed, then a short and flexible tube remains that will be connected with the ventilation system (16).

Each participant performed a series of five cricothyrotomies with each technique, under the supervision of an experienced tutor, as recommended (14, 17). Procedure time for each attempt was measured with a stopwatch and recorded. At the end of the practical session, participants were invited to complete an anonymous questionnaire to express their satisfaction with the usefulness and didactic content of the course, and to rate their preference for each cricothyrotomy technique (Supplementary Table S1). Other information assessed by the questionnaire included participants' self-evaluation of their knowledge and cricothyrotomy skills before and after the course, previous attendance of similar courses and the time they had been working in the Emergency Department. Representatives of cricothyrotomy kits manufacturers were not involved in the organization of the workshop.

### Statistical analysis

The Student *t* test and the analysis of variance (ANOVA) were used for testing differences between means. A *P* value of less than 0.05 was considered statistically significant. Data are presented as means ± SD. Statistical analyses were performed using STATA software, version 11 (STATA Corporation, College Station, TX, USA).

**Supplementary Table S1**

**QUESTIONNAIRE**

**1. TITLE:**

- A) PROFESSIONAL NURSE
- B) ANAESTHESIOLOGIST/SURGEON
- C) ANAESTHESIOLOGIST RESIDENT
- D) OTHER

**2 EXPERIENCE IN ED:**

- A) > 5 YEARS
- B) < 5 YEARS

**3 DEGREE OF PREFERENCE BETWEEN THE KITS:**

- |                |           |      |      |      |
|----------------|-----------|------|------|------|
| B) MELKER:     | EXCELLENT | GOOD | FAIR | POOR |
| C) QUICKTRACH: | EXCELLENT | GOOD | FAIR | POOR |

**4 HAVE YOU PREVIOUSLY TAKEN A COURSE ON CRICOTHYROTOMY?**

- A) YES
- B) NO

**5 HOW DID YOU JUDGE YOUR EXPERIENCE BEFORE THE COURSE?**

- A) EXCELLENT
- B) GOOD
- C) FAIR
- D) POOR

**6 AFTER THE COURSE HOW DO YOU RATE YOUR KNOWLEDGE?**

- A) EXCELLENT
- B) GOOD
- C) FAIR
- D) POOR

**7 HOW DO YOU RATE THE PROVIDED INFORMATION?**

- A) VERY USEFUL
- B) USEFUL
- C) NOT SO USEFUL
- D) USELESS

**8 IF YOU HAD TO EVALUATE THE WHOLE COURSE YOUR OVERALL RATING IS?**

- A) EXCELLENT
- B) GOOD
- C) FAIR
- D) POOR

**NOTES:**

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## Results

Thirty-six questionnaires (90%) were completed out of a total of 40. The analysis of answers revealed that 67% of those who filled the questionnaire had been working at the Emergency Department for more than 5 years. Only 30.56% of participants reported having previously taken a course or workshop on cricothyrotomy. Subgroup analysis of the “Anaesthesiologists” group (n=10) revealed that 70% of participants had been working in the Emergency Department for more than 5 years, which is consistent with what observed in the whole population considered. Forty percent of the anaesthesiologists reported having previously taken a course

or workshop on cricothyrotomy. Participants judged their knowledge of cricothyrotomy techniques prior to the course as “poor” in 58.3% of cases, “fair” in 33.3% of cases, and “good” in only 8.3% of cases (Fig. 1). Of note, none of the participants judged their knowledge of the cricothyrotomy as excellent. Evaluation of the five attempts of cricothyrotomy during the technical course revealed that the mean procedure time for cricothyrotomy on mannequins resulted 48.72 seconds at first attempt (A1), 37.46 seconds at the second attempt (A2), 33.10 seconds at the third attempt (A3), 30.07 seconds at the fourth attempt (A4) and 27.87 seconds at the fifth attempt (A5) (Tab. 1). These results indicated that the time of carry out cricothyrotomy decreased from the first to the fifth attempt. Data analysis showed a statistically significant difference between the first attempt A1 and the fifth attempt A5, estimating a confidence interval of 95% ( $48.7 \pm 21.9$  and  $28.9 \pm 13.7$  seconds, respectively;  $p < 0.0001$ ), whereas the difference between the fourth and the fifth attempt was not statistically significant ( $p = 0.32$ ). As for the comparison between the two cricothyrotomy kits used, a higher proportion (62%) of participants preferred the Melker™ set rated as “excellent”, compared to the QuickTrach™ kit rated as “excellent” in only 38% of cases. Preference for the Melker™ set (70%) compared to the QuickTrach™ kit (30%) was even more evident among anaesthesiologists; moreover, in this subgroup, the Melker™ set was rated as “excellent” in 60% of cases while the QuickTrach™ kit was rated “good” in 60% of cases. Regarding participants’ satisfaction, the overall rating of the whole course was “excellent” for 66.7% and “good” for 33.3% of the attendees. Of note nobody reported a “fair” or “poor” judgment for this question (Fig. 3). Moreover, the provided theoretical and practical information were rated “very useful” for 94% of the attendees and “useful” for only 6%. Finally, 60% of participants judged their knowledge of cricothyrotomy techniques after the course as “excellent”, while the 40% rated their knowledge as “good”.

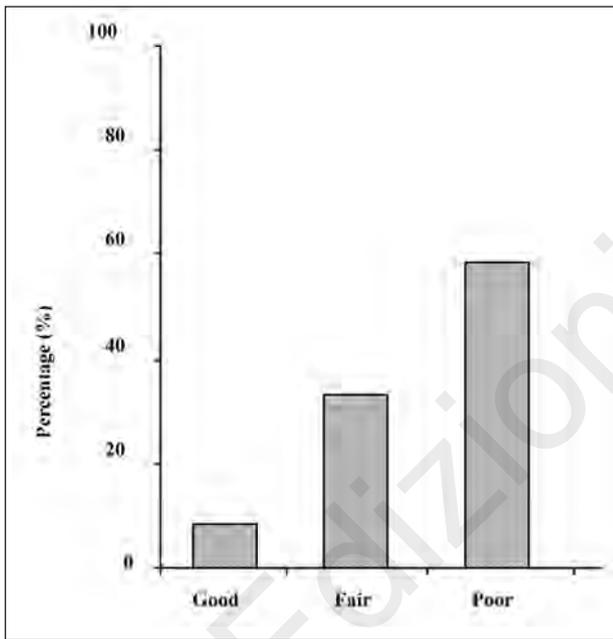


Fig. 1 - Graphic representation of the knowledge of cricothyrotomy techniques by the enrolled personnel. The knowledge of cricothyrotomy before taking the course was self-rated as Poor, Fair and Good and expressed as percentage.

TABLE 1 - MEAN PROCEDURE TIME (SECONDS) FOR CRICOTHYROTOMY DURING 5 ATTEMPTS.

Statistical test		Mean	No.	Attempts
	A	48.725	80	A1
	B	37.463	80	A2
C	B	33.100	80	A3
C		30.075	80	A4
C		27.875	80	A5

A1-A5: number of attempts.

Statistical test: means with the same letter have not statistically significant differences.

The statistical tests show that attempt A1 is statistically different from other results (A), and that attempts A4 and A5 have not statistically significant differences between them and for this reason they are indicated by letter C.

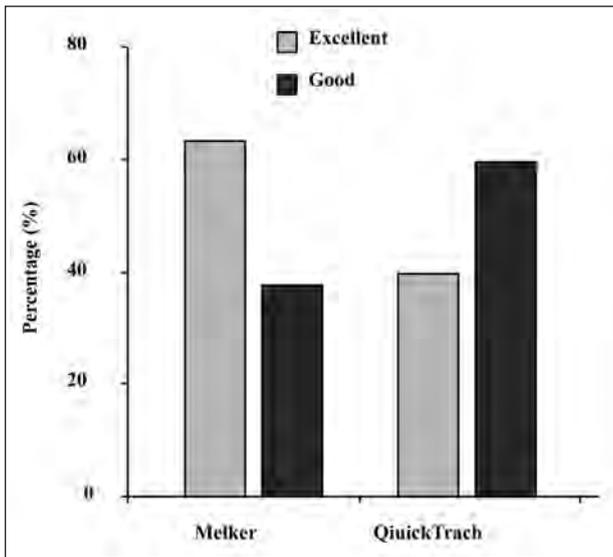


Fig. 2 - Graphic representation of the participants' degree of preference between the Melker and QuickTrach kits during the course. The preference was mainly assessed as excellent or good and expressed as percentage.

## Discussion

Achievement of theoretical and practical knowledge of different cricothyrotomy techniques is a fundamental prerequisite for healthcare professionals who work in emergency settings. In this light, implementation of specific courses is pivotal for training these professionals. All cricothyrotomy techniques, which rely on the use of commercially available kits, can be divided into two categories based on whether or not the Seldinger technique is used (9). The cricothyrotomy course held at our Institution consisted of a 1-day theoretical session followed by a practical session during which each participant performed a series of five procedures on a mannequin by using two approaches, i.e. the Melker™ set which involves the Seldinger technique, and the QuickTrach™ kit, which does not rely on the use of a guide-wire. Data obtained from participants were quite homogenous across different professional categories. The course received high acceptance from participants that mainly rated the theoretical and practical knowledge achieved during the course as “very useful” for their professional activity. Cricothyrotomy performed using Melker™ device received the highest rating, compared to the technique that uses the QuickTrach™. Among the subpopulation of anesthesiologists, more familiar with the Seldinger technique, this preference was even more pronounced. Importantly, the efficacy of such training programs was conclusively deduced by the evidence of a significant reduction of the execution time for the procedure between the first and the fifth attempt in both performed methods. A

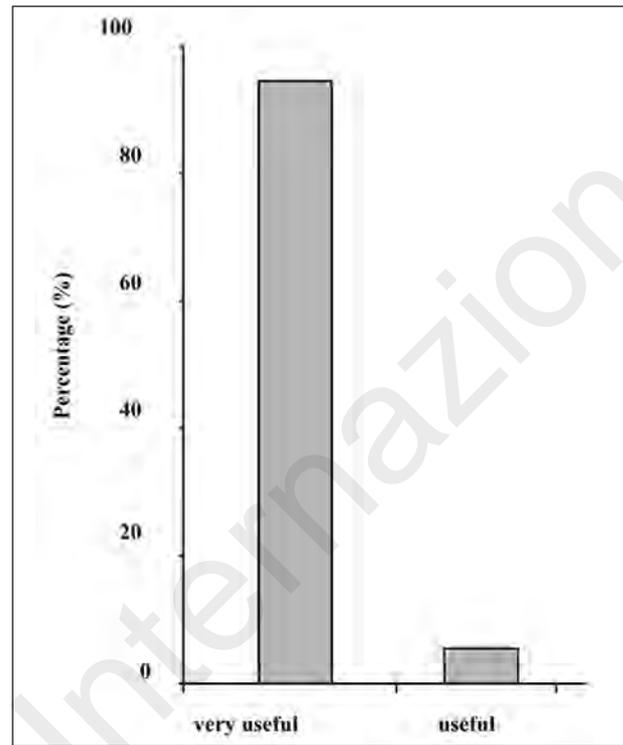


Fig. 3 - Graphic representation of the participants' satisfaction concerning the organization and content of the workshop. The satisfaction was assessed as “useful” and “very useful” and expressed as percentage.

limitation of our study might be the use of mannequins for practical cricothyrotomy training, which does not replicate the complications and stress occurring in real-life situations. However, the number of attempts allowed for each participant with both techniques was considered as an adequate training for learning and successful performing cricothyrotomy in less than 40 seconds, as recommended. Another limitation of the present study might be the restricted number of enrolled participants, however, in light of the high participants' satisfaction and increased self-rating of cricothyrotomy skills after the training, we believe that the course will be easily repeated, for instance on a semestral schedule, in the Emergency Department.

## Conclusions

The present study provides evidence for the efficacy of training courses in Emergency Department aimed at improving theoretical and practical cricothyrotomy skills, highlighting the importance of implementing cricothyrotomy courses to increase operators' familiarity with this rarely performed but potentially life-saving procedure, to increase the intubation success and reduce complications.

### Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

CEB, VP and VDO designed and wrote the paper. DS, LDV, AM, RM and AP performed the literature search and supported the writing of the paper. CEB, PU and

VDO carried out the theoretical course and acted as tutors for the practical session. All authors read and approved the final manuscript.

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