3. Tobias JD. Current evidence for the use of sugammadex in children. *Paediatr Anaesth* 2017; **27**: 118–25
4. McGuire B, Dalton AJ. Sugammadex, airway obstruction, and drifting across the ethical divide: a personal account. *Anaesthesia* 2016; **71**: 487–92
5. Nishino T. Physiological and pathophysiological implications of upper airway reflexes in humans. *Jpn J Physiol* 2000; **50**: 3–14
6. Tanaka A, Isono S, Ishikawa T, Sato J, Nishino T. Laryngeal resistance before and after minor surgery: endotracheal tube versus Laryngeal Mask Airway. *Anesthesiology* 2003; **99**: 252–8
7. Iwasaki H, Igarashi M, Namiki A, Omote K. Differential neuromuscular effects of vecuronium on the adductor and abductor laryngeal muscles and tibialis anterior muscle in dogs. *Br J Anaesth* 1994; **72**: 321–3
8. Tagaito Y, Isono S, Nishino T. Upper airway reflexes during a combination of propofol and fentanyl anesthesia. *Anesthesiology* 1998; **88**: 1459–66
9. Hajiha M, DuBord MA, Liu H, Horner RL. Opioid receptor mechanisms at the hypoglossal motor pool and effects on tongue muscle activity in vivo. *J Physiol* 2009; **587**: 2677–92
10. Friedrich S, Raub D, Teja BJ, et al. Effects of low-dose intraoperative fentanyl on postoperative respiratory complication rate: a pre-specified, retrospective analysis. *Br J Anaesth* 2019; **122**: e180–8

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Training anaesthetists in cricothyrotomy techniques using video demonstrations and a hands-on practice session: a shift towards preferred surgical approaches

Laurent Fradet, Christian Iorio-Morin, Maxime Tissot-Therrien, Pierre-Hugues Fortier and Marie-José Colas*

Sherbrooke, QC, Canada

*Corresponidng author. E-mail: Marie-Jose.Colas@USherbrooke.ca

Keywords: CICO; cricothyrotomy; emergency front of neck access; percutaneous airway; surgical airway; training program

Editor—The cannot intubate, cannot oxygenate (CICO) situation should lead to a lifesaving cricothyrotomy. Cricothyrotomy techniques are broadly categorised as closed 'percutaneous' or open 'surgical', the latter including both the 'classic surgical' technique and the 'scalpel–bougie–tube' technique popularised by the Difficult Airway Society (DAS).[1] Many studies suggest that surgical approaches yield better results.[2–6] However, the fourth National Audit Project (NAP4) and a Canadian survey, before publication of the DAS guidelines, both highlighted that the first-choice technique in a CICO situation is the percutaneous option for a large proportion of anaesthetists.[6,7] We hypothesised that this paradoxical choice might result from a lack of confidence in performing surgical techniques and that a formal cricothyrotomy training program could reverse this trend. We designed a training program and evaluated its effect on the level of confidence in being able to perform a cricothyrotomy and whether this training would modify the anaesthetist's first-choice technique in a CICO situation. This study does not fulfil the definition of Clinical Research according to the International Committee of Medical Journal Editors, and hence has not been registered in a public trial registry. However, it was approved by our institution's Ethics Committee (Comité d'éthique de la recherche du CIUSSS de l'Estrie – CHUS, FWA #00005894 and IRB00003849) under reference number 2017-1517.

Subjects were recruited among participants in a workshop at both the October 2016 and March 2017 Quebec Association of Anaesthetists' Meetings. Participants provided written consent and data collection was anonymous. Initially, an online survey was completed by the participants, composed of questions assessing confidence and preference for each cricothyrotomy technique (baseline survey, n=44). Then, participants visualised unbiased educational videos produced by the authors demonstrating three cricothyrotomy techniques ('scalpel–bougie–tube', 'classic surgical', and 'percutaneous') on cadavers (available at http://cricotraining.com). Participants then repeated the same survey (post-video survey, n=38). The last step of the program involved live demonstration and practice of the three cricothyrotomy techniques during a 50 min workshop, with a learner to skilled instructor ratio of 3:1. We used manikins and a porcine model based on previous publications.[8,9] Porcine larynxes were purchased from a local abattoir (£2.40 each), stabilised with foam, and

Table 1 Evolution of the proportion of participants 'confident' in performing each cricothyrotomy technique. Likert scale: 'very unconfident', 'unconfident', 'neutral', 'confident', and 'very confident'. Data presented in the table represent the cumulative percentage of respondents 'confident' or 'very confident' towards each technique.

Technique	Baseline survey (%) $n=44$	Post-video survey (%) $n=38$	Post-workshop survey (%) $n=35$	P
Classic surgical	10	63	77	<0.0005
'Scalpel–bougie–tube'	8	66	91	<0.0005
Percutaneous, >4 mm	14	66	74	<0.0005
Percutaneous, <2 mm (with jet ventilation)	10	–	–	–
P	0.004	0.478	0.091	

wrapped with a plastic pellicle to simulate the skin. Participants had to execute each technique successfully, defined as the proper insertion of the cannula with an adequate, efficient, and safe sequence of movements. All were clearly made aware that the lack of neck haematoma, massive aspiration, obesity, and the absence of a stressful environment would have the potential to make the execution of the techniques easier than in a real CICO situation. We counselled participants that proper management of a CICO crisis would also require mastery of non-technical behaviours. After that, participants completed a third survey, identical to the previous but also evaluating the pedagogic impact of each step of the training and the perceived bias (post-workshop survey, $n=35$).

Statistical analyses were performed with SPSS Statistics Software, version 24.0.0.0 (IBM, Armonk, NY, USA). Evolution of the confidence level for each technique and the preferred procedure in a CICO situation at three timepoints (baseline, post-video, and post-workshop surveys) were assessed with Friedman's test, which was also used to assess the difference in confidence level between each of the techniques at the same three specific timepoints, using the Wilcoxon signed-rank test for *post hoc* analysis. The proportion of participants selecting one of the percutaneous techniques as their first choice at the various time points was assessed using a χ^2 test for association.

Table 1 shows that for each technique, the level of confidence significantly improved after the videos and the workshop ($P<0.0005$). The most impressive gain was observed with the 'scalpel–bougie–tube' technique, from 8% self-confidence at baseline to 91% after the workshop. In a CICO situation, the proportion of participants choosing a percutaneous technique as their first choice decreased from 46% to 28% after the videos ($P=0.001$) and from 28% to 4% after the workshop ($P=0.021$), with a significant move towards the 'scalpel–bougie–tube' technique ($P<0.0005$). The videos and workshop were considered neutral by 87% and 66% of repliers, respectively. Amongst those who perceived a bias, this was evenly distributed between all techniques.

Practicing the technique on the porcine model was the most relevant component of the program, with 91% of the participants describing it as having a substantial impact.

Our data suggest that the proportion of participants choosing a percutaneous technique as the first choice decreased significantly after the videos, but even more so after the workshop. This change could be in part attributable to tutor bias. However, the fact that the workshop was considered neutral by most participants suggests that the experience of hands-on practice enables participants to realise the simplicity and ease of the open techniques compared with the percutaneous approach.

A physician with poor confidence in his own cricothyrotomy skills may tend to delay the realisation of the procedure, a problem highlighted by NAP4.[6] As such, we believe that the confidence level of a clinician is a very important outcome, as highlighted in a recent study comparing surgeons and anaesthetists in performing a surgical airway precedure.[10] The increase in comfort levels, particularly towards the scalpel–bougie–tube approach, highlights the quality of our training program, even though it is relatively simple. We hope that clinicians will be motivated to build similar training programs in their respective hospitals. In Canada, more than 175 anaesthetists have been trained so far with our accessible program, which is more affordable than most simulated laboratory training. Since the introduction of this program in our institution, three CICO situations have been successfully dealt with using the surgical techniques, suggesting that adequate training may contribute to saving lives.[11] Whilst our workshop focused on practicing the technical skills required for each cricothyrotomy approach, the addition of real-life scenarios might benefit the development of non-technical behaviours.[12,13]

Even though the literature suggests that surgical cricothyrotomy approaches yield better results than percutaneous techniques, many anaesthetists still favour the latter. We showed that a simple, low-cost, easily reproducible training program consisting of educational videos and a hands-on practice session can reverse this deeply ingrained practice, improve physician confidence towards their cricothyrotomy skills, and change preference towards surgical cricothyrotomy techniques, making them more likely to follow the DAS recommendations.

Authors' contributions

Conception and design of the study: all authors
Drafting the article: LF
Final approval of the version submitted, agreement to be accountable for all aspects of the work: all authors
Analysis and interpretation of data: CIM
Revising the article critically: CIM, MTT, PHF, MJC
Participant recruitment, acquisition of data: MTT

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Declaration of interest

Production of the educational videos was performed free of charge by Hyperexis, a company owned by one of the authors (CIM). The other authors declare that they have no conflicts of interest.

References

1. Frerk C, Mitchell VS, McNarry AF, et al. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. *Br J Anaesth* 2015; **115**: 827–48
2. Hubble MW, Wilfong DA, Brown LH, Hertelendy A, Benner RW. A meta-analysis of prehospital airway control techniques part II: alternative airway devices and cricothyrotomy success rates. *Prehosp Emerg Care* 2010; **14**: 515–30
3. Heymans F, Feigl G, Graber S, Courvoisier DS, Weber KM, Dulguerov P. Emergency cricothyrotomy performed by surgical airway–naive medical personnel. A randomized crossover study in cadavers comparing three commonly used techniques. *Anesthesiology* 2016; **80**: 204–9
4. Schober P, Hagemann MC, Schwarte LA, Loer SA, Noetges P. Emergency cricothyrotomy – a comparative study of different techniques in human cadavers. *Resuscitation* 2009; **80**: 204–9
5. Chrisman L, King W, Wimble K, Cartwright S, Mohammed KB, Patel B. Surgicric 2: a comparative bench study with two established emergency cricothyroidotomy techniques in a porcine model. *Br J Anaesth* 2016; **117**: 236–42
6. Cook TM, Woodall N, Frerk C, Fourth National Audit Project. Major complications of airway management in the UK: results of the fourth national Audit Project of the royal college of anaesthetists and the difficult airway society. Part 1: anaesthesia. *Br J Anaesth* 2011; **106**: 617–31
7. Wong DT, Mehta A, Tam AD, Yau B, Wong J. A survey of Canadian anesthesiologists' preferences in difficult intubation and "cannot intubate, cannot ventilate'' situations. *Can J Anesth* 2014; **61**: 717–26
8. Fiorellia A, Carellia E, Angiolettia D, et al. A home-made animal model in comparison with a standard manikin for teaching percutaneous dilatational tracheostomy. *Interact Cardiovasc Thorac Surg* 2015; **20**: 248–53
9. Wang EE, Vozenilek JA, Flaherty J, Kharasch M, Aitchison P, Berg A. An innovative and inexpensive model for teaching cricothyrotomy. *Simul Healthc* 2007; **2**: 25–9
10. Groom P, Schofield L, Hettiarachchi N, et al. Performance of emergency surgical front of neck airway access by head and neck surgeons, general surgeons, or anaesthetists: an in situ simulation study. *Br J Anaesth* 2019; **123**: 696–703
11. Bandura A. Self-efficacy mechanism in human agency. *Am Psychol* 1982; **37**: 122–47
12. Booth AWG, Vidhani K. Human factors can't intubate can't oxygenate (CICO) bundle is more important than needle versus scalpel debate. *Br J Anaesth* 2017; **118**: 466–8
13. Moneypenny MJ. When are 'human factors' not 'human factors' in can't intubate can't oxygenate scenarios? When they are 'human' factors. *Br J Anaesth* 2017; **118**: 469

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Improving laryngoscopy technique and success with the C-MAC® D blade: development and dissemination of the 'Bath C-MAC D blade guide'

Emily C. Reynolds*, Nicola Crowther, Lucy Corbett, Timothy Cominos, Vivienne Thomas, Timothy M. Cook and Fiona E. Kelly

Bath, UK

*Corresponding author. E-mail: e.reynolds2@nhs.net

Keywords: airway; education; laryngoscopy; tea trolley teaching; training; tracheal intubation; videolaryngoscopy

Editor—We are aware that some hold the opinion that videolaryngoscopy improves the view at laryngoscopy, but that tracheal intubation is difficult despite this.[1] This situation is more commonly described with hyperangulated videolaryngoscope blades such as the C-MAC® D blade (Karl Storz GmbH, Tuttlingen, Germany). Such hyperangulated blades have the advantage that they can 'see around the corner,' but because of this, direct visualisation of the vocal cords is prevented.[1]

In our hospital we have been using videolaryngoscopy for all intubations ('universal videolaryngoscopy') in operating theatres, delivery suite, and the ICU for the past 18 months.[2] We emphasise that when an intubator is able to see the vocal cords when using a hyperangulated videolaryngoscope blade but is unable to intubate, this is likely because of poor technique or training in the vast majority of cases.

The C-MAC® D blade can be inserted into the patient's mouth either in the midline or conventionally along the right side of the tongue, watching the tip of the blade as it is inserted into the mouth and, when it disappears from view, continuing to watch the tip on the videolaryngoscope screen. We propose that the key element is to optimise the view of the larynx, it works well to mentally divide the ovidelaryngoscopy screen