

EDITORIAL

Emergency front-of-neck access: scalpel or cannula—and the parable of Buridan's ass[†]

K. B. Greenland^{1,2,*}, W. P. L. Bradley^{3,4}, G. A. Chapman^{5,6}, G. Goulding⁷ and M. G. Irwin¹

¹Department of Anaesthesiology, University of Hong Kong, Hong Kong, SAR, ²School of Medicine, The University of Queensland, Brisbane, Australia, ³Department of Anaesthesia and Perioperative Medicine, The Alfred, Melbourne, Victoria, Australia, ⁴Faculty of Medicine, Nursing and Health Sciences, Monash University, Melbourne, Australia, ⁵Department of Anaesthesia and Pain Medicine, Royal Perth Hospital, Western Australia, Australia, ⁶Faculty of Health and Medical Sciences, The University of Western Australia, Australia and ⁷Department of Anaesthesia and Perioperative Medicine, Royal Brisbane and Women's Hospital, Queensland, Australia

*Corresponding author. E-mail: french9a@yahoo.co.uk

[†]Buridan's ass is an illustration of a paradox in philosophy in the conception of free will. It refers to a hypothetical situation wherein an ass that is equally hungry and thirsty is placed midway between a stack of hay and a pail of water. As the paradox assumes the ass will always go to whichever is closer, it will die of both hunger and thirst because it cannot make a rational decision to choose one over the other. See *The Oxford Dictionary of Phrase and Fable*, Oxford University Press, 2006.

Maintaining oxygenation is the principal purpose of airway management. Oxygen delivery in airway crises is aimed at preventing cardiac arrest and limiting hypoxic consequences before quickly moving on to secure the airway or wake the patient up if appropriate. Currently, there is **debate**^{1 2} concerning the **most appropriate** method to facilitate oxygenation during a **'can't intubate, can't oxygenate' (CICO)** scenario while a definitive airway is secured. Emergency front-of-neck access (FONA) courses include a critical analysis of cannula cricothyroidotomy as part of their curricula. This has been driven by widespread acceptance and teaching of Heard's algorithm.³ However, concerns^{1 2 4-6} have been raised over the high failure rate of cannula cricothyroidotomy in CICO management when compared with surgical access, and its future omission has been advocated. The **Canadian** Airway Focus Group⁷ **excludes cannula cricothyroidotomy** from their recommendations unless the clinician is very experienced with jet ventilation. They state that options should be **limited to** either the **percutaneous needle-guided wide-bore cannula** or an **open surgical technique**.

The case for a standardized approach to emergency FONA with scalpel cricothyroidotomy was recently made in an editorial,² emphasizing that most FONAs were performed at the point of cardiac arrest or death, and, in over 60% of instances, a

surgical airway was obtained but was too late to avoid a poor outcome. So why is it perceived that cannula cricothyroidotomy has a poor success rate and is there any evidence that anaesthetists are better at using a scalpel?

Several authors^{1 8-11} have raised **concerns that clinical identification of the cricothyroid membrane is difficult**. However, this is **applicable to both** placing a **cannula** and performing a **surgical** airway. The use of **ultrasound** has been suggested to improve the chance of identifying the location and depth of the trachea,¹² particularly where there is possible anatomical distortion.

Unfortunately, the availability, proximity and portability of equipment, as well as developing and **maintaining suitable proficiency, limit its use in CICO** scenarios. The Canadian Airway Focus Group has suggested a 'double setup airway intervention', which refers to ensuring the immediate availability of equipment and personnel capable of performing a surgical airway.⁷ They admit that, while **ultrasound** might be helpful, there is currently **no evidence to support its emergency use**.

An **alternative** to ultrasound for identifying the trachea and cricothyroid membrane is to make a **3–6 cm vertical skin incision** so that it can be either visualized or palpated directly. Using this approach within a suitable time frame raises a potential psychological hurdle in CICO cases—will the anaesthetist be

Editorial decision March 20, 2017; Accepted: March 22, 2017

© The Author 2017. Published by Oxford University Press on behalf of the British Journal of Anaesthesia. All rights reserved. For Permissions, please email: journals.permissions@oup.com

willing to pick up a scalpel and make a large wound rather than utilizing the apparently less traumatic cannula?¹³

Fortunately, **correct identification of the cricothyroid membrane** (i.e. whether emergency FONA is performed through the cricothyroid membrane or anterior wall of the trachea) is **not likely** to be **important** for **re-oxygenation**. A retrospective review of emergency **cricothyrotomies** and **tracheotomies** in an American trauma centre found **no complications in either group**.¹⁴

It is also important to consider the next step once the infero-glottic airway has been accessed with a cannula. Transtracheal **jet ventilation** has, justifiably, been implicated in **secondary barotrauma**, which highlights the pitfalls of attempting to achieve minute volume ventilation via a small diameter instrument without appropriate equipment and sufficient training.⁴ While animal models might not be applicable to humans, simulated crisis in live anaesthetized animals is, arguably,¹⁵ the closest method of reproducing the stressful conditions of a CICO crisis that we have. The Royal Perth Hospital (RPH) group in Australia have observed over 10 000 CICO rescue attempts in anaesthetized sheep by practitioners, and have refined their approach over time. The rationale for using a cannula as a conduit for re-oxygenation includes a high success rate with training, its potential for conversion by Seldinger technique to a cuffed airway, anaesthetists' familiarity and confidence using cannulas, less tissue destruction and bleeding compared with a scalpel, and an attempt does not significantly impair subsequent attempts with either cannula or scalpel. The RPH group has repeatedly found the **cannula technique to be the fastest** and **most efficient means of providing emergency rescue re-oxygenation** in their sheep model.¹⁶ Wong and colleagues,¹⁷ using a rabbit model, have shown supportive evidence for rapid re-oxygenation using both a hand-triggered jet injector and an Enk Oxygen Flow Regulator. Unfortunately, there is little good scientific evidence in airway management as a whole, and certainly very little for FONA specific to anaesthesia.

Some of the **risks** of narrow-bore cannula jet oxygenation **have been overcome with the Rapid-O2™ cricothyroidotomy insufflation device™** (previously known as 'Leroy'; Meditech Systems Ltd, Dorset, UK),¹⁸ which by focusing on oxygenation (**not CO₂ clearance**) and limiting jetting attempts might reduce risk. This device is affordable for both training as well as placement at all anaesthesia locations, is a true on-off device, provides feedback and also affords an expiratory pathway. However, there is insufficient evidence in humans to recommend its widespread adoption.

Watterson and colleagues¹⁹ identified a large variety of clinical scenarios that can lead to a CICO situation. Training should incorporate discussion of airway management nuances outside the operating theatre, including remote anaesthesia areas such as interventional radiology suites, gastroenterology, bronchoscopy and stand-alone surgical and dental practices.²⁰ Other specialities such as Emergency Medicine, Intensive Care and Retrieval Medicine are not directly included in the scope of this training but are able to contribute to speciality-specific clinical scenarios such as trauma anaesthesia. Clearly, there are many CICO scenarios in which trained surgeons are not readily available and the anaesthetist is the only qualified practitioner to perform emergency FONA.

Clinicians who oppose the cannula cricothyroidotomy technique often cite the fourth National Audit Project (**NAP4**)²¹ and trauma scenarios²² where **using a scalpel** and **bougie** has a high success rate. Care needs to be taken when drawing parallels between trauma and an unexpected failed airway during routine anaesthesia practice. The high success rate of supraglottic

airway management in anaesthesia means that FONA is rare. In contrast, supraglottic airway management in trauma has a higher failure rate for a number of reasons, including manual in-line neck stabilization, facial trauma and low level of airway expertise compared with anaesthesia. In such cases, FONA is more common, rarely incurs criticism and may even be received with a degree of reverence for being heroic. Indeed for emergency responders in a recent military audit, pre-hospital cricothyrotomy was successful in only 67% of cases (of which 66% died) despite managing fit, healthy and lean individuals.²³ In a large pre-hospital series, in which there was a 100% success rate in 90 patients with a primary or rescue scalpel technique, the mortality rate was 80%.²⁴ Given the seriousness of their injuries, the question has been raised as to **how much of an impact, if any, hypoxia contributed to the outcome**.²⁵

There are **major differences in the mind-set and expectations** between **anaesthetists** performing their routine work and emergency personnel attending trauma. The anaesthetist might feel responsible for the CICO scenario as a situation they have created in comparison with the emergency responder who is confronted with a pre-existing obstructed airway. Anaesthetists and their supportive staff have more experience with successful supraglottic airway management, which can lead to hesitation when an emergency FONA is required.

The NAP4 has been widely used to justify scalpel-based techniques.²¹ It examined an environment in which the **cannula** technique was **rarely taught**, and their findings are likely to reflect the situation in many countries around the world. The **numbers**, however, are **limited** and the comparison of surgeons' success rate using a scalpel with the anaesthetists' use of a cannula is problematic. Two conclusions that might be drawn are: (i) **anaesthetists untrained in CICO** techniques have a **high failure rate** with **cannula** and **scalpel** techniques (61% and 67%, respectively),²⁶ and (ii) **surgeons** have a **high success rate** but might be **slow** to perform a **surgical airway** in many cases. Support or dismissal of any clinical procedure should be based on scientific evidence that correlates with the environment where it is being used. A survey of surgeons in Western Australia showed that they were rarely involved in emergency surgical airway procedures, often had little experience in crisis management and, as a result, can have difficulty in decision making when called upon to perform a definitive surgical airway.²⁷ With increasing subspecialization in surgery, the situation is likely to be similar in many parts of the world. Anaesthetists, therefore, should be proficient in both supraglottic and FONA techniques. **It is not appropriate to rely on a surgeon to perform a surgical airway**, especially as the surgeon might not be immediately available or experienced in emergency airway management.

Hamaekers and Henderson²⁸ have stated that **there is no consensus** on the **best technique** or device for emergency percutaneous airway at this time and, quite rightly, recommend that all anaesthetists should be skilled in more than one technique because avoiding delay is at least as important as the choice of method in determining outcome. Another reason to know more than one technique is that for **specific situations such as impalpable neck anatomy**, observation from the RPH wet lab show the **use of the scalpel deep in the neck is technically far more challenging** to achieve than the **scalpel-finger-cannula technique**²⁹ to achieve rapid oxygenation.

It is apparent that non-technical skills in airway crisis management are an essential aspect of teaching.²⁰ Simply teaching participants the mechanics of an emergency FONA is severely limited unless the decision-making process is closely examined. FONA is often either not performed or performed at a late stage.

Over the years there has been a change in medical culture where both specialists and trainees focus on the dangers of 'commission' while ignoring the problems of 'omission'. That is to say, it is better to do nothing than to act and be criticized should a bad result occur. *Primum non nocere* ('first, do no harm') is equated to avoiding any action while ignoring that doing nothing can itself cause harm. The fear of causing lower airway and/or neck trauma by mismanaging any type of cricothyroidotomy inhibits the practitioner to act.

Similar to basic life support, the lack of large scientifically sound studies leads to expert consensus providing direction in management. Although efforts have been made to change, a certain 'blame' aspect still exists in medical culture when examining crisis management retrospectively.³⁰ Polarized viewpoints on the correct technique for FONA lead to a fear of criticism by 'airway experts', which, in turn, is the very reason that practitioners fail to act in a timely manner.

Before the cannula technique is dismissed, the impact of teaching and non-technical training needs to be investigated further. Currently, the technique might continue to have a role in a difficult airway curriculum where the technique has been adequately taught. Whilst the discussion on FONA techniques will continue, there remain many important issues of difficult airway management, including a lack of readily accessible difficult airway kits,³¹ poor airway assessment and planning,³² and deviation from accepted algorithms.³³ Many cases often display a number of system errors and rarely is the choice of scalpel-bougie or cannula cricothyroidotomy a significant issue. While the FONA debate is important, many other fundamental principles of difficult airway management are being forgotten or ignored.

Authors' contributions

Substantial contributions to the first draft of the paper, final approval of the version to be published, agreed to be accountable for all aspects of the article in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: K.B.G., W.P.L.B., G.A.C.

Substantial contributions to the first draft of the paper, review and suggested changes relevant to international standards, final approval of the version to be published, agreed to be accountable for all aspects of the article in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: G.G., M.G.I.

Declaration of interest

K.B.G., W.P.L.B. and G.A.C. are executive board members of the Airway Special Interest group (ANZCA/ASA/NZSA). G.G. is a recent past president of ANZCA. M.G.I. is a member of the Editorial board of *Anaesthesia*, *Expert Opinion in Pharmacotherapy*, and is an Associate Editor of *Perioperative Medicine*.

Funding

None to declare.

References

1. Baker PA, O'sullivan EP, Kristensen MS, Lockey D. The great airway debate: is the scalpel mightier than the cannula? *Br J Anaesth* 2016; **117**: i17–9

2. Pracy JP, Brennan L, Cook TM, et al. Surgical intervention during a can't intubate can't oxygenate (CICO) Event: emergency front-of-neck airway (FONA)? *Br J Anaesth* 2016; **117**: 426–8
3. Heard AMB, Green RJ, Eakins P. The formulation and introduction of the "can't intubate, can't ventilate" algorithm into clinical practice. *Anaesthesia* 2009; **64**: 601–8
4. Duggan LV, Ballantyne Scott B, Law JA, Morris IR, Murphy MF, Griesdale DE. Transtracheal jet ventilation in the 'can't intubate can't oxygenate' emergency: a systematic review. *Br J Anaesth* 2016; **117**: i28–38
5. Kristensen MS, Teoh WH, Baker PA. Percutaneous emergency airway access; prevention, preparation, technique and training. *Br J Anaesth* 2015; **114**: 357–61
6. Scrase I, Woollard M. Needle vs surgical cricothyroidotomy: a short cut to effective ventilation. *Anaesthesia* 2006; **61**: 962–74
7. Law JA, Broemling N, Cooper RM, et al. The difficult airway with recommendations for management—part 1—difficult tracheal intubation encountered in an unconscious/induced patient. *Can J Anaesth* 2013; **60**: 1089–118
8. Elliott DS, Baker PA, Scott MR, Birch CW, Thompson JM. Accuracy of surface landmark identification for cannula cricothyroidotomy. *Anaesthesia* 2010; **65**: 889–94
9. Lamb A, Zhang J, Hung O, et al. Accuracy of identifying the cricothyroid membrane by anesthesia trainees and staff in a Canadian institution. *Can J Anaesth* 2015; **62**: 495–503
10. Aslani A, Ng SC, Hurley M, McCarthy KF, McNicholas M, McCaul CL. Accuracy of identification of the cricothyroid membrane in female subjects using palpation: an observational study. *Anesth Analg* 2012; **114**: 987–92
11. Hiller KN, Karni RJ, Cai C, Holcomb JB, Hagberg CA. Comparing success rates of anesthesia providers versus trauma surgeons in their use of palpation to identify the cricothyroid membrane in female subjects: a prospective observational study. *Can J Anaesth* 2016; **63**: 807–17
12. Kristensen MS, Teoh WH, Graumann O, Laursen CB. Ultrasonography for clinical decision-making and intervention in airway management: from the mouth to the lungs and pleurae. *Insights Imaging* 2014; **5**: 253–79
13. Law JA. Deficiencies in locating the cricothyroid membrane by palpation: we can't and the surgeons can't, so what now for the emergency surgical airway? *Can J Anaesth* 2016; **63**: 791–6
14. Dillon JK, Christensen B, Fairbanks T, Jurkovich G, Moe KS. The emergent surgical airway: cricothyrotomy vs. tracheotomy. *Int J Oral Maxillofac Surg* 2013; **42**: 204–8
15. Sahdev P. Comparison of manikin models vs live sheep in 'can't intubate can't ventilate' training. *Anaesthesia* 2010; **65**: 759
16. Heard A. Instructor Check-lists for Percutaneous Emergency Oxygenation Strategies in the "Can't Intubate, Can't Oxygenate" Scenario. 2014 Available from <https://www.smashwords.com/books/view/494739> (accessed 19 March 2017)
17. Wong CF, Yuen VM, Wong GT, To J, Irwin MG. Time to adequate oxygenation following ventilation using the Enk oxygen flow modulator versus a jet ventilator via needle cricothyrotomy in rabbits. *Paediatr Anaesth* 2014; **24**: 208–13
18. Frerk C, Mitchell VS, McNarry AF, et al. Reply. *Br J Anaesth* 2016; **117**: 535–6
19. ANZCA working party edited L. Watterson. "Transition for CICO". Available from <http://www.anzca.edu.au/resources/professional-documents>. 2015 (accessed 1 February 2017)
20. Greenland KB, Acott C, Segal R, Goulding G, Riley RH, Merry AF. Emergency surgical airway in life-threatening acute

- airway emergencies—why are we so reluctant to do it? *Anaesth Intensive Care* 2011; **39**: 578–84
21. Cook TM, Woodall N, Frerk C, Fourth National Audit P. 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
 22. Crewdson K, Lockey DJ. Needle, knife, or device—which choice in an airway crisis? *Scand J Trauma Resusc Emerg Med* 2013; **21**: 49
 23. Mabry RL, Frankfurt A. An analysis of battlefield cricothyrotomy in Iraq and Afghanistan. *J Spec Oper Med* 2012; **12**: 17–23
 24. Lockey D, Crewdson K, Weaver A, Davies G. Observational study of the success rates of intubation and failed intubation airway rescue techniques in 7256 attempted intubations of trauma patients by pre-hospital physicians. *Br J Anaesth* 2014; **113**: 220–5
 25. Dinsmore J. A correct representation of the evidence? 2016. Available from https://academic.oup.com/bja/article/117/suppl_1/i17/1744477/The-great-airway-debate-is-the-scalpel-mightier?searchresult=1#usercomments (accessed 1 February 2017)
 26. Bradley P. Continued provision of cannula cricothyroidotomy equipment. *Anaesthesia* 2016; **71**: 854–5
 27. Riley RH, Strang T, Rao S. Survey of airway skills of surgeons in Western Australia. *Anaesth Intensive Care* 2009; **37**: 630–3
 28. Hamaekers AE, Henderson JJ. Equipment and strategies for emergency tracheal access in the adult patient. *Anaesthesia* 2011; **66 Suppl 2**: 65–80
 29. Heard A, Dinsmore J, Douglas S, Lacquiere D. Plan D: cannula first, or scalpel only? *Br J Anaesth* 2016; **117**: 533–5
 30. Clinical Human Factors Group. Healthcare Safety Investigation Branch—Expert Advisory Group Report <http://chfg.org/policy-research/hsib-advisory-group-report/2017> (accessed 2 February 2017)
 31. Baker PA, Hounsell GL, Futter ME, Anderson BJ. Airway management equipment in a metropolitan region: an audit. *Anaesth Intensive Care* 2007; **35**: 563–9
 32. Cook TM, Woodall N, Frerk CA. national survey of the impact of NAP4 on airway management practice in United Kingdom hospitals: closing the safety gap in anaesthesia, intensive care and the emergency department. *Br J Anaesth* 2016; **117**: 182–90
 33. Rosenstock CV, Nørskov AK, Wetterslev J, Lundstrøm LH; The Danish Anaesthesia Database. Emergency surgical airway management in Denmark: a cohort study of 452 461 patients registered in the Danish Anaesthesia Database. *Br J Anaesth* 2016; **117**: i75–82