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A mixed-methods pilot study to evaluate a collaborative anaesthetic and surgical training package for emergency surgical cricothyroidotomy

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In a 'can't intubate, can't oxygenate' (CICO) scenario success of emergency front of neck access (FONA), is dependent upon a clinician's skill, competence and confidence to initiate the procedure. Surgical cricothyroidotomy (SCT) is an important airway skill as it can be employed as both the primary method of emergency FONA or as a rescue approach, should a needle technique fail. We designed a collaborative surgical and anaesthetic training package to address perceived anaesthetic reluctance to perform SCT and undertook a pilot study of the package using a mixed methods approach. The package consisted of three elements: theory teaching, surgical experience and repeated high-fidelity simulation.

Ten anaesthetic trainees were trained using the package. Training was comprised of face-to-face tuition on the 2015 Difficult Airway Society (DAS) guidelines, Vortex cognitive aid, manikin-based SCT instruction and surgical experience gained from an elective surgical tracheostomy. A standardised, high-fidelity in-situ CICO simulation was used to assess performance at baseline, two weeks and six months post-training. Participants scored their self-efficacy, underwent qualitative semi-structured interviews and had their performance quantitatively assessed to evaluate this training.

Six months' post training, participant's performance had improved: they reported significantly increased self-efficacy and demonstrated significantly reduced deliberation time to initiate SCT in the simulated CICO emergency. Thematic framework analysis of interview transcripts revealed that reluctance to perform SCT was related to fear and anxiety performing the procedure.

These results support wider adoption of collaborative educational training packages, including hands-on surgical teaching, to improve trainees' efficacy and confidence with SCT and FONA in an emergency CICO scenario.

Introduction:

The can't intubate can't oxygenate (CICO) scenario is an anaesthetic emergency that requires emergency front of neck access to avoid patient death. For front of neck access (FONA), International guidelines recommend surgical cricothyroidotomy (SCT) as either the primary procedure[1] or as a rescue procedure if initial needle or guide wire cricothyroidotomy fails[2-5,]. In the UK, the 2011 National Audit Project Four (NAP4) revealed high failure rates for narrow-bore and wide-bore needle FONA techniques, frequently requiring rescue using the surgical technique.[6] Consequently the Difficult Intunation Society (DAS) revised their UK guidelines for unanticipated difficult airway management advocating SCT as the preferred method of emergency FONA.[1] This guideline was subsequently adopted by UK head and neck surgeons, on the basis that a simplified, consensus approach would reduce operator indecision in an emergency.[7]

Although SCT is considered the fastest way to secure the airway, an anaesthetist may be reluctant to perform SCT. [7-11] Regular, well-designed airway management training is crucial to acquire, and retain the technical skills and confidence to initiate emergency SCT.[1,6,11-13] Developing anaesthetic confidence to execute a time-critical, life-saving, surgical procedure when clinicians may have had no hands on surgical experience since medical school is challenging.[11] Greenland *et al*. have previously suggested that Australian anaesthetists address this deficit by scrubbing to assist with routine, simple surgical procedures, ideally elective tracheostomies.[11]

To improve both the technical ability and confidence of trainee anaesthetists to undertake SCT as part of a CICO emergency, the departments of Anaesthesia and Maxillofacial Surgery at Aintree University Hospital collaborated to develop a training package combining hands-on surgical teaching with instruction on the DAS 2015 guidelines[1] and Vortex cognitive aid[14] . The surgical training element provides experience of assisting in an elective tracheostomy (e.g. patient positioning, neck's surface anatomy, use of a scalpel, feel of neck tissues, bleeding and depth of trachea relative to skin) to develop

basic surgical skills to augment ‘standard’ anaesthetic CICO training. Our aim was to evaluate this educational package to determine utility as a precursor to guide potential wider adoption.

Methods

We followed the principles of the UK Medical research Council (MRC) framework for the development and evaluation of a complex intervention, with an initial pilot phase before an intervention trial.[15] An essential aspect of the pilot phase is to identify which elements of an intervention are useful. Therefore, we took a structured longitudinal approach to evaluate our training intervention using a mixed-methods approach. The study protocol and evaluation has been set out using the TIDieR guidance for invention description and replication[16]:

1. Self-efficacy scoring (confidence) of managing a CICO emergency.[17]
2. Qualitative assessment of the educational package and participant's confidence managing a CICO scenario explored using structured interviews and thematic framework analysis.[18]
3. Quantitative measurement of how quickly participants performed SCT in a simulated CICO scenario.
4. Quantitative measurement of how participants managed the CICO emergency with respect to DAS 2015[1] and Vortex[14] guidance.

Participants

We recruited a cohort of 10 anaesthetic specialist trainees (year five to seven) with national training numbers as they rotated to Aintree University Hospital (AUH). Health Education England North West (Mersey) trainees complete their higher and advanced airway competencies at AUH, the regional tertiary referral centre for Head & Neck surgery. The only exclusion criterion was participant refusal. The study was reviewed and approved by NHS Health Research Authority (16/HRA/4434) and Health Education England Research Governance (North West Office). All participants consented to emergency CICO training, simulation and to undergo longitudinal semi-structured interviews for qualitative analysis, and filming to facilitate quantitative assessment of their management of a simulated CICO

scenario. The sample size of 10 participants was chosen based on advice for minimal numbers for usability testing[19] and credibility of qualitative data collection and analysis[20,21].

Intervention and assessments

The components of the intervention and assessments are described in Figure 1. After baseline semi-structured interviews and assessment of airway management skills, participants began the training package intervention (Phase 1). The anaesthetic component was delivered by a consultant anaesthetist with airways expertise (P.G.) in Phase 1 and revised in Phase 2. This comprised of one-to-one teaching on the DAS 2015 guidelines[1], the Vortex cognitive aid[14], the laryngeal handshake, airway ultrasound and SCT training using a low fidelity manikin.[1,14,22,23] Participants were provided with a multimedia bundle consisting of the DAS 2015 guidelines[1] and Vortex[14], a guide to airway ultrasound, instructional videos demonstrating the performance of SCT and website references of clinicians' accounts of performing SCT.[24-28] The surgical component was delivered in Phase 2 by a consultant maxillofacial surgeon (S.R.). The participant became a directly supervised assistant for an elective tracheostomy, appropriately positioning the patient and marking out the surface anatomy of the neck. Crisis resource management behaviours were not taught as part of the package. To evaluate the utility of the training package further assessments and semi-structured interviews took place in Phases 3 and 4 of the study (Figure 1).

Simulated CICO scenario design

To evaluate the training package we developed a standardised high-fidelity scenario. This re-created a CICO emergency that arose after induction of anaesthesia in an otherwise healthy patient with a normal airway assessment. The scenario was performed in situ (anaesthetic room) and with clinical staff (operating department practitioner and health care assistant) as is standard practice in our hospital and reproduced identically for simulations A, B and C. The scenario facilitators (H.W., R.B., W.G., S.M.) used a standardised approved script to ensure identical conditions across each simulation. The

same scenario facilitator controlled and filmed the scenarios from outside the anaesthetic room. Full details of the equipment used, standardised simulation and debrief are provided in the supplemental data (Appendix 1,2). A TruCorp® TruMan Trauma X (TruCorp® Ltd, Belfast) manikin was used for its superior airway attributes, incorporating a novel bleeding neck prosthesis to mimic a patient with an impalpable cricothyroid membrane.[29] This mandated a midline vertical incision according to the revised DAS guidelines.[1] Monitoring was provided remotely with SimMon (Castle+Andersen ApS) displayed on an iPad. In the simulation, participants were permitted to attempt face-mask ventilation, LMA and endotracheal methods of oxygenation, but only FONA yielded positive capnography and resolution of oxygen saturation (both simulated by the faculty member).

Qualitative Data:

The qualitative aspect of the study was longitudinal by design with each participant interviewed four times [S.S.]:

Interview 1: *Baseline perceptions*

Interview 2: *Change in baseline perceptions after managing a simulated CICO scenario*

Interview 3: C*hange in perceptions after managing a simulated CICO scenario one week after completing the training package*

Interview 4: *Perceptions towards managing a simulated CICO scenario six months after completing the training package*

At interview, participants were asked questions relating to their reflections on the training package, and any perceived effect it had on their self-confidence and competence. Anonymised labels were assigned for participant, interview and quote (e.g. participant P2[1]). At the time of each interview participants also rated their self-efficacy score for managing the CICO emergency. Each of the forty interviews was transcribed verbatim. The essential steps of the thematic framework analysis

approach were followed to identify key themes.[12] Researchers [J.S. and J.B.] independently read all the transcripts to familiarise themselves with the data to identify a thematic framework. Sections of text were indexed to the identified themes in the framework until all of the textual data had been gathered. An illustrative quote from the interview transcript was selected to represent each theme and labelled with interview and representative participant number. Throughout the process of analysis, any differences in the identification of themes and indexing were discussed between J.S. and J.B. until consensus was reached. Involvement of two independent researchers (J.S. and J.B.) throughout the qualitative data analysis added rigour to the process.

[FIGURE 1]

Quantitative Data

Our quantitative analysis was undertaken for exploratory purposes. Our sample size was selected for qualitative analysis only. Therefore, whilst we present exploratory statistical tests, there is a high risk of type II error. Video recordings were made of the three high-fidelity CICO simulations to assess performance of SCT. Our primary outcome was time to complete SCT. The secondary outcome was whether the surgical cricothyroidotomy method employed was in accordance with the DAS 2015 guidelines.[1] We also assessed how the simulated emergency was managed prior to performance of the SCT with reference to the DAS 2015 guidelines[1] and Vortex cognitive aid[10]. In each simulation we timed three phases of SCT.

1. **Deliberation time**: *Time from declaration of a CICO scenario to initiation of the SCT*
2. **Surgical time**: *Time from initiation of* SCT *to completion*
3. **Total time**: Time *from declaration of a CICO scenario to completion of the* SCT

'CICO' was defined as the declaration of an inability to oxygenate the patient, via intubation, supraglottic airway device or bag-mask techniques. Completion of SCT was defined as manikin intubation

via a neck incision. Participants were permitted to attempt face-mask ventilation, LMA and endotracheal methods of oxygenation, but only FONA yielded positive capnography and resolution of oxygen saturation. Successful insertion was signified by return of capnography (simulated) and confirmation of chest expansion that was reinforced by the simulation facilitator, operating department practitioner. Time to completion was measured on video recording. In addition, correct placement was confirmed post scenario when the model was dissembled. Statistical analysis was performed with JASP (Version 0.8.6, JASP Team 2018, University of Amsterdam). Kruskal Wallis and Wilcoxon Signed Rank Sum Tests were used to assess significance, for the small sample size, non-parametric tests were used.

Results

1. **Self-efficacy scores**

We found reported self-efficacy for managing a CICO emergency significantly improved at six months upon study completion (medians after simulation A: 50%, simulation B: 80% and simulation C: 87.5%, $p<0.001$, Kruskall Wallis).

2. **Thematic framework analysis results**

Thematic framework analysis of semi-structured interviews with study participants is summarised in Figure 2. Theme saturation was achieved by 6 participants (24 interviews) and full saturation was found by 9 participants, confirming adequate sample size. The quote provided for each theme represents a typical participant's response

Themes identified before completion training (interviews 1 - 3)

Sub theme 1: Feeling of failure

A key finding was a feeling of failure experienced by anaesthetists compounded by anxiety that their performance had contributed to the CICO scenario:

> "[I]*t's the sort of thing that you hope you would never have to see, but then, also hope that you would be able to manage […] I'd be wondering, am I at this stage, because I'm not doing a very good job at the initial steps?"* (Interview 1)

Sub Theme 2: Reluctance to admit the need to perform surgical cricothyroidotomy

We noted indecision to promptly perform the SCT due to self-doubt concerning management of the emergency:

> "*I think my initial thought would be: 'what else, or what have I missed? Is there anything I can do to avoid this?' I think that sometimes the problem with the surgical [FONA] is the reluctance to finally pick up the scalpel".* (Interview 1).

The CICO scenario was associated with feelings of panic and participants struggling to reconcile the evolving crisis:

> "*I think my initial feeling would be panic. […] And I think my initial thoughts would be like; 'I can't believe this is happening to me, this isn't ever really supposed to happen.' We're trained for it, but, […] it's very, very rare".* (Interview 1).

There was reluctance to perform the SCT since trainees considered the CICO scenario a failure of their anaesthetic management:

> "*I don't think we are programmed to accept failure, especially in something we do every day for how many years. [I]n a way you are letting yourself down if you can't intubate that patient. [I]n your mind, you are thinking; 'somehow I need be able to get a tube down".* (Interview 2).

> *"I think it's just everybody is desperate to avoid 'front of neck', and anyone who says they're not, is lying".* (Interview 3).

Sub theme 3: Inevitable acceptance of the need to perform surgical cricothyroidotomy

Despite low confidence, from the lack of experience performing this surgical procedure, SCT was accepted as an inevitable last resort:

> "*I have full confidence in myself; but confidence of my technique, having never done the procedure other than a manikin, would be significantly less."* (Interview 1)

> "*I think the most difficult part, for me, would be making the decision that I need to go down that algorithm and put a knife to someone's neck. I think once I'd made that decision, yes, it might be technically difficult, but I have done tracheostomies in ITU".* (Interview 1).

Sub theme 4: Concerns about performing cricothyroidotomy

There was high anxiety about correctly performing SCT, the emotions encountered in dealing with an iatrogenic, potentially fatal situation had to be conquered:

> "*I would struggle to, I think, overcome the 'emotions' side of it […], trying to fight down the utter panic […] and the real probability that this patient might die - and it really is my responsibility."* (Interview 1).

Inserting the scalpel correctly was a major concern as well as anxiety about the whole SCT procedure:

> "[K]*nowing where to put the knife, especially if you can't feel the anatomy - that's probably the most difficult thing, but, actually, there's probably a lot of other difficult things: like remembering to call a senior, getting the patient in the right position, staying calm, getting the right equipment, [and] doing it quickly, efficiently."* (Interview 1).

Themes identified after training was completed

Sub theme 1: Feeling confident in performing surgical cricothyroidotomy and less reluctant to initiate it

Trainees were satisfied with the development of their technical SCT skills:

> '*I've got to a stage where I'm really […] happy, with the technical bits. And I think it's important to not let that go. Technical skills sort of go after time*." (Interview 4).

> *"I'd feel less anxious about actually having to do [FONA] in real life, and less, 'Oh God, is this actually happening to me?'".* (Interview 4).

However, there was less hesitancy when deciding to perform the SCT:

> "*I would definitely hesitate less. […] I think the period of time I'd spend hesitating would be less because […] my technical skills in doing it have improved - because we've done so many repeated attempts."* (Interview 4).

Sub theme 2: Concerns about skill degradation

Recognising the CICO emergency is rare, the repeated assessment simulations highlighted the importance of maintaining skills over time and offered participants the opportunity to develop their skills.

> *"[Y]ou might not ever see [FONA] in your career at all, or you might only see it once. And so, I think, probably, regular training [is important]."* (Interview 4)

Themes regarding usefulness of the training package

Sub theme 1: Opportunity to learn surgical skills

The surgical training was highly regarded by trainees. The benefit of '*getting a feel*' of what it is like to incise a patient's neck: the anatomical structures, fat, tissue planes and encountering bleeding, whilst performing the elective surgical tracheostomy was noted.

> "*Doing the tracheostomy, or at least the initial incision and dissection, helped a lot: having a feel of the scalpel and the skin and […] the tissues. […] I think helped me with […] the technical bit of the procedure" […]. "So the actual tracheostomy made a huge difference. [A]ctually, playing the role of the surgeon […]. Then […] having a feel of the scalpel, having a feel of pressures and how you should actually feel when you're dissecting tissue, […], and then also [the] feel [of] the trachea and the cartilages. [I]t might give me a mental reminder […] if I end up having to do an emergency airway."* (Interview 3).

Sub theme 2: A complete training package

Besides the surgical element, the package employed one-to-one SCT manikin training, airway ultrasound and revision of the DAS guidelines[1] and Vortex[10]. Airway ultrasound was highlighted as a potentially useful prospective adjunct if a difficult airway was suspected (if available) but was not used during our high-fidelity simulations. Participants also received links to online instructional SCT videos and first-hand accounts from clinicians involved in real CICO scenarios. The whole package was considered useful:

> "*Going in to theatre and actually scrubbing in, and feeling the cricothyroid membrane, and assisting […] surgeons in doing the procedure. I think that was really helpful, just to feel [the] anatomy. [D]oing lots of those would be beneficial. [The] private tutorial in the anaesthetic room, learning all the ways to polish the technique and the proper way to do it, and then*

actually getting to do it again [in the simulation, to] bed in that knowledge [was useful].” (Interview 4).

Sub theme 3: Opportunity for in-situ CICO simulation

Trainees commented that the three high-fidelity used simulations to assess their performance were valuable, especially combined with the one-to-one training:

“*I think it was probably good to go through a ‘sim’ session in the first place, before any training, to identify which bits I struggle with. [G]oing through the ‘sim' and using the model both in the ‘sim’ scenarios and in the one-to-one teaching with [P.G.] was probably the most helpful for me.”* (Interview 4).

“I think we’ve had a lot of repetitive practice […]. It almost just flows now, like a robot.” (Interview 4).

[FIGURE 2]

3. Quantitative Data Results

All ten anaesthetic trainees completed the training package, interviews 1-4 and simulations A-C. Video data on one candidate (P7) for simulation B was lost due to technical failure.

Total time for SCT significantly decreased, from simulation A (median: 225.0s, IQR: 163.8-244.0s), to simulation C (median: 151.5s, IQR: 129.3-190.0s, p=0.002), but not at B (median: 213.0s, IQR 170.5 - 246.5s, p=1.0) Figure 3. This reduction from simulation A to C was due to a significant reduction in the deliberation time: simulation A (median: 101.5, IQR: 92.25-177.5), to simulation C (median: 76.0, IQR

63.25-92.0, p=0.027). As shown in Figure 3, the interquartile ranges decreased from Simulation A through C, indicative of improved consistency of trainee performance at SCT (Total time IQR A: 80.2s, B: 76.0s, C: 60.7s; Deliberation time IQR A: 85.25s, B: 58.25s, C 28.75s; surgical time A: 56.8s, B: 59.0s, C: 44.05s).

[FIGURE 3]

The length of vertical incisions did not change across the study period (Simulation A: 71.0 mm, IQR: 60.75 - 81.5mm; Simulation B: 65.0mm, IQR: 47.5 - 75mm; Simulation C: 67.5mm, IQR: 63.75 - 77.0mm). All were less than the recommended 8 - 10cm as suggested by DAS[2]. There was a signal towards concordance with the recommended vertical surgical approach over time (Simulation A: 60%, Simulation B 90% and Simulation C 100%, n=10) but this was not significantly different (p=0.134, McNemar's Test). Video analysis of the conduct of managing the CICO emergency revealed that adherence to the stepwise progression set out in the DAS guidelines[1] from A-D, did not alter from baseline to six months, (A = 60%, B = 70%, C = 60%). Instead Plan B (attempt ventilation via a supraglottic airway device) and Plan C (attempt face mask ventilation) were often switched around, possibly reflecting adoption of the Vortex approach.[10]

Discussion

We have developed and evaluated a pilot collaborative surgical training package for anaesthetic trainees to prepare for surgical cricothyroidotomy (SCT). We found that the delivery of anaesthetic theory and surgical tracheotomy experience was highly valued by trainees. Repeated high-fidelity simulations consolidated this knowledge and experience. These results support wider adoption of collaborative educational packages to improve trainees' efficacy and confidence with SCT and FONA in an emergency CICO scenario. We recommend that in addition to standard theoretical teaching, CICO training programmes should consider including an element of 'hands-on' surgical teaching as well as the opportunity for anaesthetists to rehearse their skills in a high-fidelity simulation of the emergency.

Deliberation time, a surrogate for non-technical skill performance, was the rate limiting step that our training package improved. The reduced total time to successfully perform SCT was *due to a significant reduction in the deliberation time* not surgical time. This reduction was evident at six months, but not two weeks suggesting the improvement is attributable to cognitive reprocessing; the participants learning from reflection and consolidation of their procedural knowledge and understanding.[30] Participants clearly described this aspect, informing us that they had considered where their performance could be improved.

Thematic framework analysis confirmed that before participation in the training package, performing SCT is associated with significant anxiety and reluctance to initiate SCT. After training there was a statistically significant improvement in the participants' deliberation time and reported self-efficacy. These findings were corroborated by the thematic analysis, with many participants reporting a reduction in anxiety and deliberation associated with performing SCT.

The quantitative analysis supported the development of improved performance, though this pilot was not designed to analyse results inferentially.

Reluctance to perform SCT is a multifaceted and nuanced phenomenon. We developed the following integrated model to describe the mindset of an anaesthetist contemplating performing SCT. See Figure 4.

1. *Ownership of SCT - A hard to acquire surgical skill set*
2. *Need for SCT perceived as a failure by the anaesthetist*
3. *Acceptance of the perceived anaesthetic failure is a prerequisite to performing SCT*
4. *'Willingness' equates to acceptance of failure and ownership of SCT*

[FIGURE 4]

The interviews highlighted the importance practicing and rehearsing SCT. Visualisation and rehearsal are effective learning tools known to improve performance in athletes and surgeons.[31,32] By anticipating and visualising a CICO scenario and mentally rehearsing failure, participants were able to transcend the perceived non-ownership of a surgical skill to salvage the airway. The importance of mentally preparing, or 'priming for FONA' is increasingly well recognised.[14,33] In our study, the effect of rehearsal and visualisation was reflected in the increased consistency (reduced interquartile ranges) and speed with which SCT was performed over the six-month study period. We noted evidence of continued mental rehearsal months after the training in interview four, with participants mentally preparing for FONA when it was a possible outcome.

At six months, participants reported significantly increased self-efficacy dealing with a CICO emergency. Participants valued the ‘’private tutorial’ that emphasised the ‘tips and tricks’ imparted by the one-to-one teaching format, as tacit knowledge was deemed important compared to that gained from the literature.[34] In teaching, emphasis was placed on the Vortex[10] for ‘real-time’ use to manage a CICO emergency. The Vortex is a specially designed cognitive aid promoting a fluid approach to airway management: alleviating the cognitive overload encountered in CICO emergency.[35] Serial video analysis of the simulations revealed that Plans B and C were often instituted out of order and did not improve with training. We believe this represents the participant’s adoption of the Vortex over strict adherence to a DAS 2015 Plan A,B,C approach. It supports the logic behind the pragmatic approach of the DAS 2017 ITU guidelines[33] and their adoption of a Vortex method to the implementation of Plans B and C. This sentiment was echoed by trainees in the interviews. We advocate that the DAS 2015 guidelines[1] are used ‘in the classroom’ to teach the theory of CICO management and that the Vortex[10] is taught ‘in the anaesthetic room’ to support ‘real time’ decision making.

Based on NAP4, approximately 100 CICO events occur in the UK each year.[6] The NAP5 audit estimated that there were 2.7 million general anaesthetics given per year in the UK.[36] If we estimate that the typical anaesthetist administers 750 routine general anaesthetics per year this equates to a risk of 1/36 per year. If an anaesthetic career lasts 30 years, then anaesthetists on average will experience about only one CICO event in their career. However, the risk of airway complications in settings outside of the operating theatre such as the emergency department or intensive care is likely to be much higher as NAP4 demonstrated.[2, 37] It is ambitious to expect an anaesthetist, with no prior surgical training, to promptly, confidently and competently perform a life-saving SCT, in a time-critical CICO emergency. This notion is expounded by Greenland *et al*. who highlight that whilst anaesthetists may lose situational awareness, a surgeon may be in no better a position to perform SCT.[11] Interview transcripts demonstrated the axiomatic principal of reluctance in SCT performance. Surgical experience was a highly valued aspect of the training package and experience gained helping perform an elective

surgical tracheostomy augmented traditional anaesthetic SCT training. Besides fostering the development of motor and sensory schemata for expertise at SCT[38], surgical experience was an important to improve self-confidence. Candidates especially reported benefit from the feel of live human tissue. In time-critical emergencies, pattern recognition is key as there is little time for deliberation.[11]

Although employed as an assessment tool, the high-fidelity simulations proved to be valuable as these provided four opportunities for revision of the DAS 2015 guidelines[1], Vortex[14] and experience of SCT. Specifically, the simulations provided participants with the opportunity to rehearse failing conventional anaesthetic airway management techniques before instituting and practicing their SCT technical skills. Over time, the management of CICO became a more familiar and palatable experience for participants to institute SCT. McCrossin *et al*. previously explored training techniques for percutaneous airway access in a simulated CICO scenario.[39] Our study focused specifically on surgical FONA in standardised high-fidelity in situ scenarios working with multi-disciplinary operating department staff. Our holistic methodology qualitatively and quantitatively examines what happens between declaration of CICO and the steps required to put 'knife to skin'. We believe that our study offer insights beyond exploratory trainee confidence measures by highlighting the decision points that educators should target to improve clinician performance.

Limitations

Pilot studies are inherently limited by their sample size but are designed as an essential component to inform further experimental studies.[15] Routine, serial in-situ simulations are an accepted way of assessing similar teaching packages[40] but in our study these inadvertently served as a training tool: embedding learnt skills into a realistic narrative to provide heuristic improvements. Familiarity may have contributed to the observed confidence increase, and reduced deliberation time. However, participants remarked on the usefulness of the simulation in enhancing their learning experience during qualitative interviews. We view repeated high-fidelity simulation important in the provision of

future educational training packages for SCT. This training programme did not address the management of a failed SCT. This is an important issue to address in future work but was beyond the scope of our study. We did not compare the effect of surgical training versus no surgical training on trainee performance in this study. The benefit of the training programme was assessed at a maximum of six months. It may, of course, take 30 years of clinical practice to experience a CICO event, and we cannot comment on the longevity of benefit. The retention of cricothyroidotomy skills are known to be lost after 6-9 months[41] so we suggest anaesthetists refresh their CICO skills annually (ideally every six months[42]). The delivery of this training package may be limited by resources in the host institution; however, we have found it feasible to run. In our hospital, all consultants and trainees undertake the training package on an annual basis.

Summary and Recommendations

Using the MRC definition, our collaborative programme represents a complex intervention in CICO training.[11] Accordingly, we undertook a pilot, mixed-methods study, to assess its usefulness in a cohort of anaesthetic trainees. We have demonstrated improved performance; competence and self-confidence in surgical skills leading to increased willingness to initiate SCT. The thematic analysis identified a reluctance to take on the role of a surgeon. We consider that this can be improved by repeated deliberate practice, including exposure to 'hands on' surgical training. Not all hospitals offer exposure to elective surgical tracheostomy on a weekly basis; but other operations, not necessarily performed on the neck, may offer similar opportunities to gain transferable skills and diminish the unfamiliarity of SCT.[11] This work suggests that our CICO training package is feasible and warrants further evaluation with national anaesthetic training programmes. Our results describe potential mechanisms through which improvements in managing a CICO may be achieved and explores the complex psychological processes that occur when an anaesthetist encounters a CICO scenario. SCT is indicated as a final method of airway salvage in many international airway algorithms[1-5], even if percutaneous methods have been employed as a first method in CICO. We therefore recommend incorporating an element

of ‘hands-on’ surgical teaching in CICO training programmes. In our opinion this may represent the future of FONA training internationally, not just in the UK.

Declaration of Interests

R.B.: Has received equipment from TruCorp Ltd.

W.G.: None Declared

S.S.: None Declared

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Authors’ Contributions and Authorship:

R.B.: Simulation design and running; Data Collection; Data Analysis: Statistical analysis; Writing Manuscript, Revising the Manuscript

W.G.: Simulation design and running; Data Collection; Data Analysis; Writing Manuscript, Revising the Manuscript

S.S.: Design of Data Collection Method; Data Collection; Data Analysis;

H.W: Simulation design and running; Data Collection; Data analysis; Writing Manuscript, Revising the manuscript

S.M.: Design of Data Collection Method; Revising the Manuscript

J.B.: Design of Data Collection Method; Data Analysis; Revising the Manuscript

J.S.: Design of Data Collection Method; Data Analysis; Revising the Manuscript

B.M.: Study Design and concept; Design of Data Collection Method; Statistical Analysis, Revising the Manuscript

P.G.: Study Design and Concept; Design of Data Collection Method; Participant Recruitment; Writing Manuscript: Revising the Manuscript

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