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Editorial

EDITORIAL

Difficult Airway Society 2015 guidelines for the management of unanticipated difficult intubation in adults: not just another algorithm

C. A. Hagberg[1,*], Joseph C. Gabel[1] and R. T. Connis[2]

[1]Department of Anesthesiology, 6431 Fannin Street, MSB 5.020, Houston, TX, USA, and
[2]ASA Headquarters, 1061 American Lane, Schaumburg, Il, USA

*Corresponding author. E-mail: carin.a.hagberg@uth.tmc.edu

Since the first iteration of the ASA Difficult Airway Practice Guidelines for the management of the difficult airway was published in 1993 (updated in 2013),[1] a number of national societies have generated practice guidelines for difficult airway management, including the Difficult Airway Society (DAS).[2]

Unlike the ASA guidelines, which address both the anticipated and the unanticipated difficult airway, the DAS guidelines focus on the unanticipated difficult airway, an unpredictable problem. The new 2015 DAS guidelines differ from the original 2004 DAS guidelines in that they are more concise and more pragmatic, with considerable emphasis placed on preparedness and accountability of the practitioner by optimizing conditions and minimizing patient morbidity in a difficult airway situation. Training of physicians with alternative airway devices and techniques, including emergency invasive airway access, is not only considered essential but expected.

Practice guidelines rely on scientific literature to supply evidence in support of clinical recommendations. Evaluation of literature includes identifying whether the topic addressed is relevant and determining whether the methodology used has resulted in the minimization of potential bias in findings. Numerous sources of bias may occur during the development of a guideline, including article selection bias, reviewer bias, reporting bias, bias associated with study design, and subjective weighting or grading of studies.[3] Steps to mitigate bias should be a vital part of an evidence-based process.[4–6]

Difficult airway literature generally focuses on airway management devices and techniques. Airway management techniques often use a protocol or algorithm that includes a combination of choices that depend on the patient's condition at some point during a procedure.[1 2] The use of algorithms can be studied, but from these studies one cannot determine the impact of the individual components of the algorithm; these must be assessed individually with an appropriate research design, preferably a randomized controlled trial.

Devices to manage the difficult airway are varied, but most have the intent of quickly establishing a patent airway. An appropriate airway device should provide adequate ventilation and oxygenation while causing minimal airway morbidity and keeping the risk of aspiration to a minimum. Several factors should be taken into consideration when determining which type of airway device should be used in any given situation, including, but not limited to, patient anatomy, clinical situation, provider skill level, and equipment availability.

The introduction of new airway devices into clinical practice accounted for the most significant changes in the ASA Difficult Airway Practice Guidelines throughout the past two decades. From 1993 to 2003, it was the introduction of the laryngeal mask airway and from 2003 to 2013, it was the introduction of the video laryngoscope. Both of these devices have also been incorporated into the new DAS guidelines for good reason, because randomized controlled trials have been successfully conducted on patients with a history of difficult intubation, and intubation success with these patients has been appropriately assessed.

After an unsuccessful initial intubation attempt, restoration of ventilation is the priority, by either a non-invasive [i.e. supraglottic airway (SGA)] or an invasive intervention, or by awakening the patient. Repeated attempts at intubation should not delay non-invasive airway ventilation (i.e. SGA) or emergency invasive airway access. The new DAS guidelines favour the use of second-generation SGAs in this situation, because they have specifically designed features to reduce the risk of aspiration and provide a better airway seal. The Fourth National Audit Project study revealed that 56% of the airway complications involved the use of an SGA and that these devices were often used inappropriately.[7] Numerous aspiration events occurred when a first-generation SGA was used in patients with clearly identifiable risk factors for aspiration.[8] Although these events were no't as evident in the use of the second-generation devices, second-generation devices were used less commonly at the time (10% of SGA use). Nonetheless, recommendations were made to use second-generation SGA's rather than first-generation devices, because they are considered to provide better airway protection.

Conclusive evidence demonstrating better safety of one device compared with another regarding aspiration can only come from formal studies of several million patients, because harmful aspiration events occur infrequently. These studies may be impractical. Thus, safety data must be acquired by analysing the design features of airway devices, appropriate bench models, and surrogate measures of airway safety, such as seal pressures and laryngeal view.

Although all second-generation SGAs have features designed to lessen the likelihood of gastric insufflation, regurgitation, and aspiration, currently there is little or no scientific evidence to support their performance in improving such outcomes for difficult airway patients. Of the second-generation devices currently available, only the i-gel, the Proseal LMA, and the LMA Supreme have large-scale longitudinal studies in adults that support their use. There is little robust evidence to inform the practitioner of the safety and efficacy of each SGA or which device to use in a given situation.

Given that repeated instrumentation of the airway may lead to airway trauma and deterioration of the ability to ventilate, the number of laryngoscopy attempts with any particular device should be limited. In attempts to secure the airway, there is no single technique that is better than others in all situations. Practitioners involved in airway management should be familiar with several different devices and techniques, because if a difficult airway problem develops, it should be managed expeditiously and safely. Each device has unique properties that may be advantageous in certain situations, yet limiting in others.

For other difficult airway interventions, controlled studies with difficult airway subjects are not easy to conduct, primarily because of the emergent nature of difficult airway patency. In these situations, studies must rely on surrogate outcome measures or non-difficult airway patients to serve as subjects for controlled clinical trials. Successful intubation must be inferred rather than genuinely observed. Although these studies are indirect assessments, they can nonetheless be valuable for identification of a difficult airway before a procedure.

The increasing demands for evidence-based medicine encourage us to determine the effectiveness of new approaches and how they compare with traditional techniques. For video-assisted laryngoscopy (VAL), the standard of care is traditional direct laryngoscopy. Thus far, there is insufficient evidence to indicate that VAL should replace direct laryngoscopy in patients with normal or difficult airways.[9,10] Nonetheless, as more video laryngoscopes are introduced into clinical practice and as more practitioners become increasingly skilled with the technique of VAL, it could well become the standard for both routine and difficult intubations.

Similar to recommendations by other national societies, the new DAS guidelines incorporate the use of VAL for management of the difficult airway. Multiple reports have demonstrated improved glottic visualization and visual confirmation of tube placement, in addition to better team coordination during airway management with VAL. These devices should not only be immediately available, but the practitioner should become proficient in their use.[11,12]

The use of cricoid pressure (CP) in difficult intubation has not been extensively studied. Although the new DAS guidelines recommend the use of CP during rapid sequence induction, the application of CP during rapid sequence induction remains a matter of debate; some believe in its effectiveness in preventing pulmonary aspiration, whereas others believe it should be abandoned because of the paucity of scientific evidence of benefit and possible complications.[13,14] The literature does demonstrate that the use of CP is likely to make airway interventions, such as mask ventilation, SGA insertion, direct laryngoscopy, and intubation more difficult.[15,16]

As a result of the lack of sufficient scientific evidence that CP reduces regurgitation, in addition to evidence that it may interfere with airway management, the Scandinavian practice guidelines leave its use up to individual judgement rather than making its use mandatory.[17] The use of CP has been removed as a level I recommendation in both the 2010 American Heart Association Guidelines[18] and the Eastern Society for the Surgery of Trauma (EAST) practice management guideline for emergency tracheal intubation.[19] Despite these trends, the use of CP remains in the new DAS guidelines. Nonetheless, the guidelines recommend that if initial attempts at laryngoscopy are difficult with the application of CP, it should be released under vision with suction available; it should be re-applied if regurgitation occurs. It should remain off during insertion of an SGA.

Although controlled scientific research in the management of the unanticipated difficult airway is sparse, the new DAS guidelines provide valuable consensus from an expert panel that has drawn extensively on the experience of international experts. They are successful in their aim to provide a structured approach to a potentially life-threatening clinical situation and take into account current practice and recent developments. The authors note that these guidelines should not constitute a minimum standard of practice, nor be regarded as a substitute for good clinical judgement. They also acknowledge that the guideline recommendations may not be suitable in all circumstances; separate guidelines exist for paediatric and obstetric patients and for extubation.

Most importantly, the new DAS guidelines emphasize that in order to be most effective, our profession must address the impact of environmental, technical, psychological, and physiological factors on our performance. We must also consider human factor issues at individual, team, and organizational levels to optimize these guidelines. At both individual and societal levels, we have the responsibility to provide optimal patient care. Although there is not enough scientific literature to support every recommendation made concerning airway management in these guidelines, we must provide guidance based on the best available evidence we have, including expert consensus.

Difficult airway guidelines must be updated continuously to reflect the most current evidence and should be reviewed regularly for their content and continued relevance. There has been a tremendous growth in the literature on the management of the difficult airway in anaesthesia practice. The new DAS guidelines are not just another algorithm but rather an evolutionary advancement in how to address management of the unanticipated difficult airway in adults. The burden is now upon us to implement the guidelines in the most appropriate manner to maximize the safety of our patients.

Declaration of interest

None declared.

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Editorial

Editorial

Art of airway management: the concept of ‘Ma’ (Japanese: 間, when ‘less is more’)

K. B. Greenland

Department of Anaesthesiology, University of Hong Kong, Hong Kong SAR

17/40 Chasely Street, Auchenflower, Brisbane, QLD 4066, Australia. E-mail: french9a@yahoo.co.uk

Airway management has progressed in quantum leaps over recent decades, particularly with the introduction of the laryngeal mask and of videolaryngoscopy. In this issue of the *BJA*, the Difficult Airway Society Intubation Guidelines Working party provide an update[1] on the original 2004 consensus article.[2] This current document is an important resource for those at all levels of expertise in anaesthesia, emergency medicine, and intensive care. The authors are to be commended on their thoroughness and their informative approach.

The new guidelines are simple, easier to follow and have broached several important points:

- The impact of human factors in decision-making during airway crises and the ‘stop and think’ notion
- The place of videolaryngoscopy
- The use of ‘NO DESAT’[3] and ‘THRIVE’[4] techniques
- The concept that no patient should die from low arterial oxygen concentrations without a neuromuscular blocking agent being given
- The role of cricoid pressure during rapid sequence induction
- The evolution of the second-generation laryngeal mask

In my opinion, an understanding of the human factors in difficult airway management crisis is crucial to ensure patient safety.

Human factors

The 4th National Audit Project of the Royal College of Anaesthetists and Difficult Airway Society (NAP4) project[5 6] has documented several issues in the non-technical aspects of crisis management that have a direct impact on patient safety and outcome. Although many experienced practitioners have at least some degree of awareness of these problems, NAP4 provides clear evidence that non-technical factors are frequently a problem. The complex psychological impact on an anaesthetist when confronted by an unexpected difficult airway has been the subject of several recent studies.[7–11]

In 1993, the Australian Incident Monitoring Study (AIMS)[11] showed that ‘significant improvements may be achieved by putting more emphasis on eliminating rule-based errors; on developing and disseminating standard protocols and algorithms; on gaining insight into the mechanisms by which slips and lapses occur and on increasing the availability of sophisticated aids to learning.’

The NAP4 project provided more evidence for these conclusions and led to further work. Flin and colleagues[7 12] developed the anaesthetists’ non-technical skills (ANTS) taxonomy, a behaviour-rating tool, which classified human factors in airway management complications as situation awareness, decision-making, task management, and teamwork. Further research into the causes of airway management complications remains an anaesthetic priority.[9]

Understanding how and why these complications occur requires ongoing research. As a profession, we must continue to look to clinical psychologists for analysis of thought processes during stress.

The original Difficult Airway Society (DAS) guidelines in 2004 stated ‘a limitation of the American guidelines is the use of flow-charts which allow a wide choice of techniques at each stage. This makes them less useful for management of airway emergencies than simple and definitive flow-charts such as those in the European or American Heart Association Advanced Life Support guidelines.’

These latest DAS guidelines continue to pursue a simple algorithm to facilitate decision-making.

“Paradox of Choice”

In 2004, the American psychologist Barry Schwartz wrote a book called *‘The Paradox of Choice: Why More is Less’*,[13] in which he argues that reducing the number of choices available to a consumer will significantly lower anxiety in shoppers.

Complicated algorithms offering a plethora of airway devices create a ‘paradox of choice’ or ‘overchoice’, which prolongs the response time. Overchoice has two prerequisites. First, the practitioner does not have a clear preference for which airway management strategy is the most appropriate for the scenario. Second, the practitioner should not feel they have the required expertise in difficult airway management to make a correct choice.

If another practitioner is asked to enter and make a choice, the problem of overchoice may be reversed. When the practitioner calls for help in a difficult airway crisis, the second operator enters as a proxy decision-maker. The consequences of their choice will not impact directly on them as an individual. This frees them of the implications and allows them to work objectively within the crisis. The 'call for help' is an attempt to introduce objectivity and logic to the decision-making process. NAP4, however, shows that the new operator may also rapidly become a part of the overchoice problem and that effective patient management is further delayed or non-existent.

"Analysis paralysis"

Another pathological thought process that may occur during a crisis is 'analysis paralysis'.[14] The practitioner over-analyses the difficult airway options with the view to finding the ideal management strategy. As a consequence, rather than selecting an option and dealing with subsequent issues arising from it, no action is taken. The practitioner fails to respond in the time frame because of the fear of making a wrong choice, leading to errors of omission rather than of commission.

Each of these pathological thought processes can lead to significant delays in urgent patient management. There is a strong tendency to fixate on intermediate objectives (such as intubation), instead of maintaining an objective overview of the situation ('situation awareness') with progression through difficult airway algorithms to maintain oxygenation. Intense psychological stress tends to shut down that part of the brain responsible for innovative, creative thought.

A current Australian and New Zealand College of Anaesthetists (ANZCA) working party has formulated a series of documents focusing on airway assessment and the factors leading to a lack of transition from one difficult airway algorithm step to the next (Professional Documents PS61and Background paper PS61-BP).[15] It is hoped that through a better understanding of how and why these breakdowns occur, anaesthetists will manage crises in a more seamless manner.

The new DAS guidelines have taken the important step toward simplifying choices. They have also considered the techniques of Nasal Oxygenation During Efforts Of Securing A Tube (NODESAT)[3] and Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE)[4] to relieve the time pressure of decreasing oxygen saturations during the decision-making process.

Future research into decision-making by individuals on the crisis team should lead to a better understanding of how to improve the transitions between the steps. The simplification of steps in the algorithm and availability of user-friendly devices are both important steps to encourage movement from one part of the algorithm to the next. Understanding difficult airway management is a project that requires life-long training.

Life-long training

The traditional apprenticeship-only style of airway management teaching has now been recognized as outdated.[16] Future developments should focus on structured normal and difficult airway training with clear end points and assessment tools. Junior trainees should understand the principles and value of the true sniffing position in all airway management scenarios, including the morbidly obese. Basic airway skills, including bag–mask ventilation, laryngeal mask insertion, direct laryngoscopy, and infraglottic airway, should be learnt before trainees are allowed to be on call with remote supervision. Formal assessment of these skills should be part of future anaesthetic training curricula.[16]

Senior anaesthetic trainees should build on this foundation and supplement it with a systematic diagnostic approach to any difficult airway scenario. They should be able to analyse and identify various types of difficult airways, leading to appropriate management. This may include recognition of devices or techniques that will be successful and avoidance of those that are unlikely to be effective. The following skills should be taught: videolaryngoscopy; Aintree Intubation Catheter® (Cook Critical Care, Bloomington, IN, USA) technique, and awake fibreoptic intubation. Airway management fellowship programmes should explore other airway devices and techniques, such as alternative laryngoscope blades, optical stylets, and airway management teaching. The co-ordination of this training programme should be allocated to a senior consultant within the department.

Non-technical aspects of difficult airway management should be an integral part of crisis management. Leadership is an important aspect. Junior consultants need to train and practise in simulators with a view to improving the non-technical aspects of their professional role.[16]

The role of the senior consultant or 'airway expert' may be based on the Japanese aesthetic concept called 'Ma'. This idea embraces simplicity of form and is manifested in their architecture, garden design, music, flower arrangements, and poetry. Ma focuses on the 'negative space', which Western culture considers as the background and largely irrelevant. Ma, in contrast, recognizes it as an integral part of the whole and the promotion of simple designs. Contemporary Western business cultures, such as Google Inc., IKEA®, and Apple Inc., have successfully adopted this concept with the simplification of business goals and designs. Senior anaesthetic consultants should look to streamline teaching of airway management by providing clear goals and a simple framework within which staff can work confidently. Egos and one-upmanship should be eliminated from the senior ranks. The leader should quietly support the least skilled in the department, with a view to providing a clear path toward mastering this area of our profession.

In a recent editorial,[17] seven axioms for selecting difficult airway devices (see Table 1) were outlined. The first axiom is that oxygenation, not intubation, is the priority. This may be expanded to say that patient safety is the true priority by maintaining oxygenation and airway passage integrity. It is problematic that despite maintaining patient oxygenation, the operator causes airway trauma with repetitive ineffective airway manoeuvres. The priority, therefore, is not only oxygenation, but patient well-being.

The second axiom is that 'airway equipment should be purchased with the least experienced potential user in mind, and not the most experienced (i.e. ideally, devices should be intuitive and user-friendly, with a short training period).'

Senior consultants have three approaches to purchasing airway equipment: (i) 'anything goes' (no restrictions on the difficult airway devices to be used by staff); (ii) 'limited choice' (staff are allowed to choose from a restricted range of options); or (iii) 'no choice' (there is a fixed set of options, and everyone has to put up with it). Most institutions will benefit by providing a limited choice, while avoiding the potential chaos of 'anything goes' and the autocratic 'no choice'. Inevitably, there are anaesthetists who demand their favourite devices or techniques. However,

Table 1 The basis of a selection process for difficult airway devices

1. Oxygenation, not intubation, is the priority at all times.
2. Airway equipment should be purchased with the least experienced potential user in mind, and not the most experienced (i.e. ideally, devices should be intuitive and user-friendly, with a short training period).
3. Devices should have sufficient reliable research to support their clinical role.[18]
4. Ideally, rescue devices should have a close to 100% success rate to ensure the minimal number of steps when securing the airway. A device with a high success rate in routine use may have a lower success rate when used as a rescue manoeuvre—and vice versa—especially when the difficult airway is unexpected. The urgency and the possibility of morbidity or mortality are likely to hinder the success of any device.[19 20]
5. Devices should be trialled over an adequate period of time (several weeks or months in most instances) to ensure that the device is used for a variety of airway problems and by an adequate cross-section of staff.
6. Successful intubation should be followed by successful extubation. Similar to the diagnosis and management of a difficult intubation, extubation techniques should be carefully planned. Reintubation planning is an essential part of extubation management, with clearly defined end points for intervention.[21 22]
7. Provision of devices for oxygenation and technical and non-technical training for staff are mandatory for all areas where anaesthesia is conducted.

crisis management remains a 'team sport', and therefore, a limited range of devices avoids overchoice.

If we are to become masters of airway management, we need a structured approach to diagnosis, which then leads to clear management strategies.

Diagnosis–management paradigm

The cornerstone of medical care is the 'diagnosis–management paradigm'.[17] For example, when treating hypertension, we diagnose the cause of the patient's high blood pressure and then tailor the treatment. We would never contemplate treating essential hypertension by removing the patient's adrenal gland, treating renal artery stenosis with medication, or treating a phaeochromacytoma with a renal artery stent. Likewise, teaching the management of normal and difficult airways should begin with an understanding of the airway morphology and then tailoring a specific treatment for each type of abnormal airway. A logical and stepwise airway management-teaching programme can then be constructed for anaesthetic trainees, progressing to lifelong training for consultants. Simple algorithms and user-friendly devices are the key to providing these working conditions.

In conclusion, despite improvements in difficult airway management, NAP4 has highlighted many ongoing problems in an area in which we should be considered 'masters'. The new guidelines have made significant inroads into contemporary difficult airway management. It remains, however, 'work in progress', with a need for further updates in the coming years.

In time, we may look towards a single internationally recognized difficult airway algorithm and encourage a multidisciplinary approach with emergency medicine and intensive care practitioners to develop parallel and clinically relevant algorithms for their clinical situations. A governing body should be established to oversee and administer difficult airway management teaching in all clinical areas and in all parts of the world.

Ultimately, simple algorithms and user-friendly devices will provide the infrastructure for good airway management. It is our professional responsibility to put an end to the unnecessary loss of life by ensuring a clear goal of maintaining patient oxygenation.

> A perfection of means, and confusion of aims, seems to be our main problem.
>
> Albert Einstein.

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Special Article

SPECIAL ARTICLE

Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults†

C. Frerk[1,*], V. S. Mitchell[2], A. F. McNarry[3], C. Mendonca[4], R. Bhagrath[5], A. Patel[6], E. P. O'Sullivan[7], N. M. Woodall[8] and I. Ahmad[9], Difficult Airway Society intubation guidelines working group

[1]Department of Anaesthesia, Northampton General Hospital, Billing Road, Northampton NN1 5BD, UK, [2]Department of Anaesthesia and Perioperative Medicine, University College London Hospitals NHS Foundation Trust, 235 Euston Road, London NW1 2BU, UK, [3]Department of Anaesthesia, NHS Lothian, Crewe Road South, Edinburgh EH4 2XU, UK, [4]Department of Anaesthesia, University Hospitals Coventry & Warwickshire NHS Trust, Clifford Bridge Road, Coventry CV2 2DX, UK, [5]Department of Anaesthesia, Barts Health, West Smithfield, London EC1A 7BE, UK, [6]Department of Anaesthesia, The Royal National Throat Nose and Ear Hospital, 330 Grays Inn Road, London WC1X 8DA, UK, [7]Department of Anaesthesia, St James's Hospital, PO Box 580, James's Street, Dublin 8, Ireland, [8]Department of Anaesthesia, The Norfolk and Norwich University Hospitals NHS Foundation Trust, Colney Lane, Norwich NR4 7UY, UK, and [9]Department of Anaesthesia, Guy's and St Thomas' NHS Foundation Trust, Great Maze Pond, London SE1 9RT, UK

*Corresponding author. E-mail: chris.frerk@ngh.nhs.uk

Abstract

These guidelines provide a strategy to manage unanticipated difficulty with tracheal intubation. They are founded on published evidence. Where evidence is lacking, they have been directed by feedback from members of the Difficult Airway Society and based on expert opinion. These guidelines have been informed by advances in the understanding of crisis management; they emphasize the recognition and declaration of difficulty during airway management. A simplified, single algorithm now covers unanticipated difficulties in both routine intubation and rapid sequence induction. Planning for failed intubation should form part of the pre-induction briefing, particularly for urgent surgery. Emphasis is placed on assessment, preparation, positioning, preoxygenation, maintenance of oxygenation, and minimizing trauma from airway interventions. It is recommended that the number of airway interventions are limited, and blind techniques using a bougie or through supraglottic airway devices have been superseded by video- or fibre-optically guided intubation. If tracheal intubation fails, supraglottic airway devices are recommended to provide a route for oxygenation while reviewing how to proceed. Second-generation devices have advantages and are recommended. When both tracheal intubation and supraglottic airway device insertion have failed, waking the patient is the default option. If at this stage, face-mask oxygenation is impossible in the presence of muscle relaxation, cricothyroidotomy should follow immediately. Scalpel cricothyroidotomy is recommended as the preferred rescue technique and should be practised by all anaesthetists. The plans outlined are designed to be simple and easy to follow. They should be regularly rehearsed and made familiar to the whole theatre team.

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Key words: airway obstruction; complications; intubation; intubation, endotracheal; intubation, transtracheal; ventilation

Clinical practice has changed since the publication of the original Difficult Airway Society (DAS) guidelines for management of unanticipated difficult intubation in 2004.[1] The 4th National Audit Project of the Royal College of Anaesthetists and Difficult Airway Society (NAP4) provided detailed information about the factors contributing to poor outcomes associated with airway management and highlighted deficiencies relating to judgement, communication, planning, equipment, and training.[2] New pharmacological agents and videolaryngoscopes have been introduced, and further research has focused on extending the duration of apnoea without desaturation by improving preoxygenation and optimizing patient position.

These updated guidelines provide a sequential series of plans to be used when tracheal intubation fails and are designed to prioritize oxygenation while limiting the number of airway interventions in order to minimize trauma and complications (Fig 1). The principle that anaesthetists should have back-up plans in place before performing primary techniques still holds true.

Separate guidelines exist for difficult intubation in paediatric anaesthesia, obstetric anaesthesia, and for extubation.[3–5]

These guidelines are directed at the unanticipated difficult intubation. Every patient should have an airway assessment performed before surgery to evaluate all aspects of airway management, including front-of-neck access.

The aim of the guidelines is to provide a structured response to a potentially life-threatening clinical problem. They take into account current practice and recent developments.

Every adverse event is unique, the outcome of which will be influenced by patient co-morbidity, urgency of the procedure, skill set of the anaesthetist, and available resources.[2 6] It is acknowledged that anaesthetists do not work in isolation and that the role of the anaesthetic assistant is important in influencing the outcome of an airway crisis.[7] Decisions about the best alternatives in the event of difficulty should be made and discussed with the anaesthetic assistant before induction of anaesthesia.

These guidelines recognize the difficulties in decision-making during an unfolding emergency. They include steps to assist the anaesthetic team in making the correct decisions, limiting the number of airway intervention attempts, encouraging declaration of failure by placing a supraglottic airway device (SAD) even when face-mask ventilation is possible, and explicitly recommending a time to stop and think about how to proceed.

An attempt has been made to identify essential skills and techniques with the highest success rate. Anaesthetists and

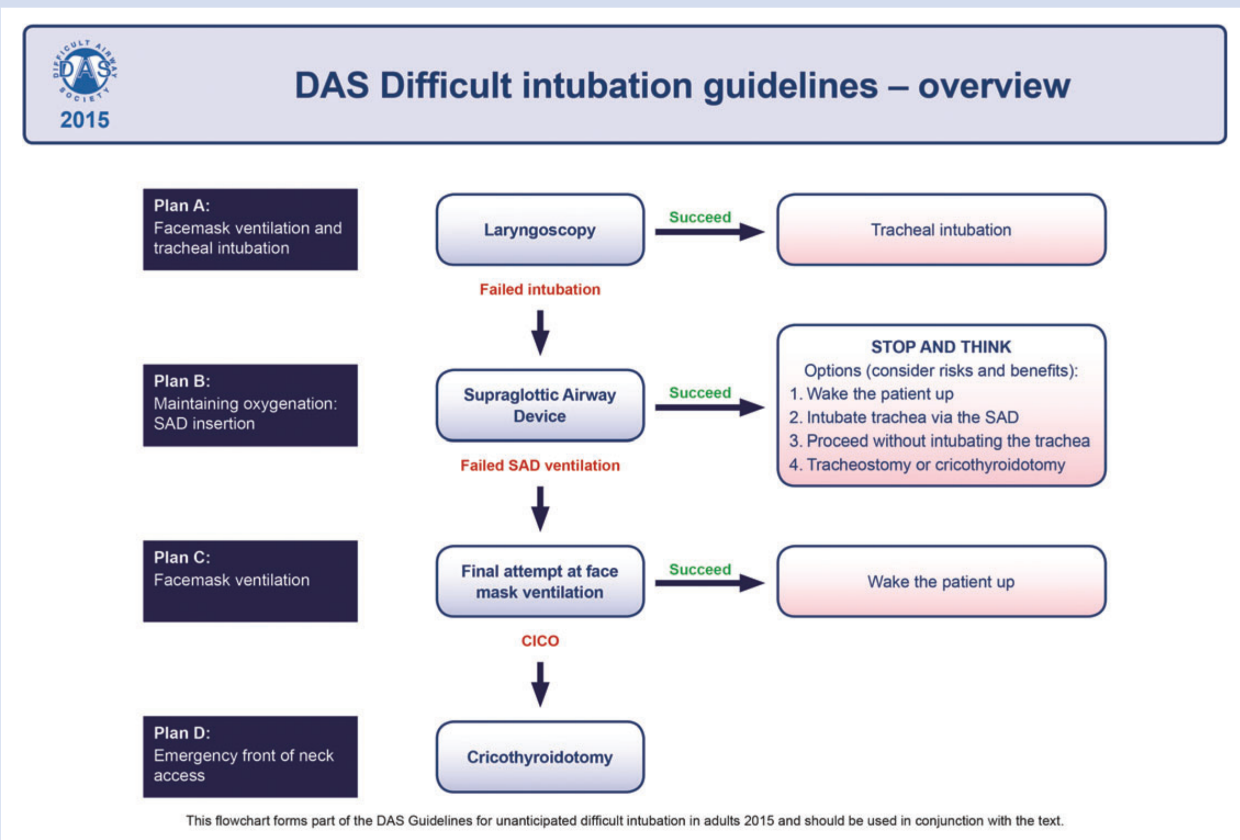

Fig 1 Difficult Airway Society difficult intubation guidelines: overview. Difficult Airway Society, 2015, by permission of the Difficult Airway Society. This image is not covered by the terms of the Creative Commons Licence of this publication. For permission to re-use, please contact the Difficult Airway Society.
CICO, can't intubate can't oxygenate; SAD, supraglottic airway device.

anaesthetic assistants using these guidelines must ensure that they are familiar with the equipment and techniques described. This may require acquisition of new skills and regular practice, even for experienced anaesthetists.

Methods

The Difficult Airway Society commissioned a working group to update the guidelines in April 2012. An initial literature search was conducted for the period January 2002 to June 2012 using databases (Medline, PubMed, Embase, and Ovid) and a search engine (Google Scholar). The websites of the American Society of Anesthesiologists (http://www.asahq.org), Australian and New Zealand College of Anaesthetists (http://www.anzca.edu.au), European Society of Anesthesiologists' (http://www.esahq.org/euroanaesthesia), Canadian Anesthesiologists' Society (http://www.cas.ca), and the Scandinavian Society of Anesthesiology and Intensive Care Medicine (http://ssai.info/guidelines/) were also searched for airway guidelines. English language articles and abstract publications were identified using keywords and filters. The search terms were as follows: 'Aintree intubating catheter', 'Airtraq', 'airway device', 'airway emergency', 'airway management', 'Ambu aScope', 'backward upward rightward pressure', 'Bonfils', 'Bullard', 'bronchoscopy', 'BURP manoeuvre', 'can't intubate can't ventilate', 'can't intubate can't oxygenate', 'C-Mac', 'Combitube', 'cricoid pressure', 'cricothyroidotomy', 'cricothyrotomy', 'C trach', 'difficult airway', 'difficult intubation', 'difficult laryngoscopy', 'difficult mask ventilation', 'difficult ventilation', 'endotracheal intubation', 'esophageal intubation', 'Eschmann stylet', 'failed intubation', 'Fastrach', 'fiber-optic scope', 'fibreoptic intubation', 'fiberoptic scope', 'fibreoptic stylet', 'fibrescope' 'Frova catheter', 'Glidescope', 'gum elastic bougie', 'hypoxia', 'i-gel', 'illuminating stylet', 'jet ventilation catheter', 'laryngeal mask', 'laryngeal mask airway Supreme', 'laryngoscopy', 'lighted stylet', 'light wand', 'LMA Supreme', 'Manujet', 'McCoy', 'McGrath', 'nasotracheal intubation', 'obesity', 'oesophageal detector device', 'oesophageal intubation', 'Pentax airway scope', 'Pentax AWS', 'ProSeal LMA′', 'Quicktrach', 'ramping', 'rapid sequence induction', 'Ravussin cannula', 'Sanders injector', 'Shikani stylet', 'sugammadex', 'supraglottic airway', 'suxamethonium', 'tracheal introducer', 'tracheal intubation', 'Trachview', 'Tru view', 'tube introducer', 'Venner APA', 'videolaryngoscope', and 'videolaryngoscopy'.

The initial search retrieved 16 590 abstracts. The searches (using the same terms) were repeated every 6 months. In total, 23 039 abstracts were retrieved and assessed for relevance by the working group; 971 full-text articles were reviewed. Additional articles were retrieved by cross-referencing the data and hand-searching. Each of the relevant articles was reviewed by at least two members of the working group. In areas where the evidence was insufficient to recommend particular techniques, expert opinion was sought and reviewed.[8] This was most notably the situation when reviewing rescue techniques for the 'can't intubate can't oxygenate' (CICO) situation.

Opinions of the DAS membership were sought throughout the process. Presentations were given at the 2013 and 2014 DAS Annual Scientific meetings, updates were posted on the DAS website, and members were invited to complete an online survey about which areas of the existing guidelines needed updating. Following the methodology used for the extubation guidelines,[5] a draft version of the guidelines was circulated to selected members of DAS and acknowledged international experts for comment. All correspondence was reviewed by the working group.

Disclaimer

It is not intended that these guidelines should constitute a minimum standard of practice, nor are they to be regarded as a substitute for good clinical judgement.

Human factors

Human factors issues were considered to have contributed to adverse outcomes in 40% of the instances reported to NAP4; however, a more in-depth analysis of a subset of patients identified human factor influences in every instance. Flin and colleagues[9] identified latent threats (poor communication, poor training and teamwork, deficiencies in equipment, and inadequate systems and processes) predisposing to loss of situation awareness and subsequent poor decision-making as a precursor to final action errors.

Adoption of guidelines and a professional willingness to follow them are not enough on their own to avoid serious complications of airway management during anaesthesia. All the instances reported to NAP4 occurred despite widespread dissemination of the original DAS guidelines, which had been published in 2004. The complexities of difficult airway management cannot be distilled into a single algorithm, and even the best anaesthetic teams supported by the best guidelines will still struggle to perform optimally if the systems in which they operate are flawed.[10] The 2015 guidelines acknowledge this.

During a crisis, it is common to be presented with more information than can be processed.[11] This cognitive overload impairs decision-making and can cause clinicians to 'lose sight of the big picture' and become fixated on a particular task, such as tracheal intubation or SAD placement. These guidelines provide an explicit instruction for the team to 'stop and think' to help reduce this risk.

Poor anaesthetic decision-making secondary to cognitive errors and the impact of human factors in emergency airway management has recently been discussed.[12] Cognitive aids are increasingly being used by clinicians during unfolding emergencies;[13] for example, the Vortex Approach has been devised to support decision-making during difficult airway management.[14] The algorithms that accompany these guidelines are intended as teaching and learning tools and have not been specifically designed to be used as prompts during an airway crisis.

For any plan to work well in an emergency, it must be known to all members of the team and should be rehearsed. For rare events, such as CICO, this rehearsal can be achieved with simulation training, as has recently been included in the Australian and New Zealand College of Anaesthetists continuing professional development requirements.[15 16] This also provides the opportunity to develop non-technical skills, such as leadership, team coordination, communication, and shared understanding of roles, which has been shown to improve performance in intensive care and trauma teams.[17 18]

Structured communication between anaesthetists and anaesthetic assistants could help prepare for and deal with airway difficulties. Talking before every patient, or at least before every list, about the plan to manage difficulties should they develop is good practice. At a minimum, this involves thinking about the challenges that might be encountered and checking that the appropriate equipment is available.

If airway management does become difficult after induction of anaesthesia, a clear declaration of failure at the end of each plan will facilitate progression through the airway strategy. The use of a structured communication tool, such as PACE (Probe, Alert, Challenge, Emergency), can aid communication of concerns when cognitive overload and hierarchical barriers might otherwise make this difficult.[19]

Our profession must continue to acknowledge and address the impact of environmental, technical, psychological, and physiological factors on our performance. Human factors issues at individual, team, and organizational levels all need to be considered to enable these 2015 guidelines to be as effective as possible.

Preoperative assessment and planning

Airway management is safest when potential problems are identified before surgery, enabling the adoption of a strategy, a series of plans, aimed at reducing the risk of complications.[2]

Preoperative airway assessment should be performed routinely in order to identify factors that might lead to difficulty with face-mask ventilation, SAD insertion, tracheal intubation, or front-of-neck access.

Prediction of difficulty in airway management is not completely reliable;[20–22] the anaesthetist should have a strategy in place before the induction of anaesthesia, and this should be discussed at the team brief and the sign-in (pre-induction) phase of the WHO Surgical Safety Checklist.[23 24]

Assessment of the risk of aspiration is a key component of planning airway management. Steps should be taken before surgery to reduce the volume and pH of gastric contents by fasting and pharmacological means. Mechanical drainage by nasogastric tube should be considered in order to reduce residual gastric volume in patients with severely delayed gastric emptying or intestinal obstruction.[2]

Rapid sequence induction

The placement of a cuffed tube in the trachea offers the greatest protection against aspiration. Suxamethonium is the traditional neuromuscular blocking agent of choice because its rapid onset allows early intubation without the need for bag–mask ventilation. Several studies have compared suxamethonium with rocuronium for rapid sequence induction, and although some have shown better intubating conditions with suxamethonium, others have found that after rocuronium 1.2 mg kg^{-1} the speed of onset and intubation conditions are comparable.[25–30] Suxamethonium-induced fasciculation increases oxygen consumption during apnoea, which may become relevant in the event of airway obstruction.[31 32] The ability to antagonize the effect of rocuronium rapidly with sugammadex may be an advantage,[30] although it should be remembered that this does not guarantee airway patency or the return of spontaneous ventilation.[33 34] If rapid antagonism of rocuronium with sugammadex is part of the failed intubation plan, the correct dose (16 mg kg^{-1}) must be immediately available.[35 36]

Cricoid pressure is applied to protect the airway from contamination during the period between loss of consciousness and placement of a cuffed tracheal tube. This is a standard component of a rapid sequence induction in the UK.[37] It is often overlooked that cricoid pressure has been shown to prevent gastric distension during mask ventilation and was originally described for this purpose.[38 39] Gentle mask ventilation after the application of cricoid pressure and before tracheal intubation prolongs the time to desaturation. This is most useful in those with poor respiratory reserve, sepsis, or high metabolic requirements and also provides an early indication of the ease of ventilation. A force of 30 N provides good airway protection, while minimizing the risk of airway obstruction, but this is not well tolerated by the conscious patient.[40]

Cricoid pressure should be applied with a force of 10 N when the patient is awake, increasing to 30 N as consciousness is lost.[41 42] Although the application of cricoid pressure creates a physical barrier to the passage of gastric contents, it has also been shown to reduce lower oesophageal sphincter tone, possibly making regurgitation more likely.[43 44] Current evidence suggests that if applied correctly, cricoid pressure may improve the view on direct laryngoscopy.[45] However, there are many reports demonstrating that it is often poorly applied, and this may make mask ventilation, direct laryngoscopy, or SAD insertion more difficult.[46–52] If initial attempts at laryngoscopy are difficult during rapid sequence induction, cricoid pressure should be released. This should be done under vision with the laryngoscope in place and suction available; in the event of regurgitation,[41] cricoid pressure should be immediately reapplied.

Second-generation SADs offer greater protection against aspiration than first-generation devices and are recommended should intubation fail during a rapid sequence induction.

Plan A. Mask ventilation and tracheal intubation

The essence of Plan A (Table 1) is to maximize the likelihood of successful intubation at the first attempt or, failing that, to limit the number and duration of attempts at laryngoscopy in order to prevent airway trauma and progression to a CICO situation.

All patients should be optimally positioned and preoxygenated before induction of anaesthesia. Neuromuscular block facilitates face-mask ventilation[53 54] and tracheal intubation. Every attempt at laryngoscopy and tracheal intubation has the potential to cause trauma. A suboptimal attempt is a wasted attempt and having failed, the chance of success declines with each subsequent attempt.[55 56] Repeated attempts at tracheal intubation may reduce the likelihood of effective airway rescue with a SAD.[57] These guidelines recommend a maximum of three attempts at intubation; a fourth attempt by a more experienced colleague is permissible. If unsuccessful, a failed intubation should be declared and Plan B implemented.

Table 1 Key features of Plan A

- Maintenance of oxygenation is the priority
- Advantages of head-up positioning and ramping are highlighted
- Preoxygenation is recommended for all patients
- Apnoeic oxygenation techniques are recommended in high-risk patients
- The importance of neuromuscular block is emphasized
- The role of videolaryngoscopy in difficult intubation is recognized
- All anaesthetists should be skilled in the use of a videolaryngoscope
- A maximum of three attempts at laryngoscopy are recommended (3+1)
- Cricoid pressure should be removed if intubation is difficult

Position

Good patient positioning maximizes the chance of successful laryngoscopy and tracheal intubation. In most patients, the best position for direct laryngoscopy with a Macintosh-style blade is achieved with the neck flexed and the head extended at the atlanto-occipital joint; the classic 'sniffing' position.[58–60] In the obese patient, the 'ramped' position should be used routinely to ensure horizontal alignment of the external auditory meatus and the suprasternal notch because this improves the view during direct laryngoscopy.[61–64] This position also improves airway patency and respiratory mechanics and facilitates passive oxygenation during apnoea.[65 66]

Preoxygenation and apnoeic techniques to maintain oxygenation

All patients should be preoxygenated before the induction of general anaesthesia.[67] De-nitrogenation can be achieved with an appropriate flow of 100% oxygen into the breathing system, maintaining an effective face-mask seal[68] until the end-tidal oxygen fraction is 0.87–0.9.[69] Many other preoxygenation techniques have been described.[70–79]

Preoxygenation increases the oxygen reserve, delays the onset of hypoxia, and allows more time for laryngoscopy, tracheal intubation,[65 69] and for airway rescue should intubation fail. In healthy adults, the duration of apnoea without desaturation (defined as the interval between the onset of apnoea and the time peripheral capillary oxygen saturation reaches a value of ≤90%) is limited to 1–2 min whilst breathing room air, but can be extended to 8 min with preoxygenation.[69] Preoxygenation using a 20–25° head-up position[80 81] and continuous positive airway pressure has been shown to delay the onset of hypoxia in obese patients.[82–84] The duration of apnoea without desaturation can also be prolonged by passive oxygenation during the apnoeic period (apnoeic oxygenation). This can be achieved by delivering up to 15 litres min^{-1} of oxygen through nasal cannulae, although this may be uncomfortable for an awake patient.[65 85 86] Nasal Oxygenation During Efforts Of Securing A Tube (NODESAT) has been shown to extend the apnoea time in obese patients and in patients with a difficult airway.[87] Transnasal humidified high-flow oxygen (up to 70 litres min^{-1}) via purpose-made nasal cannulae has been shown to extend the apnoea time in obese patients and in patients with difficult airways,[88] although it's efficacy as a means of preoxygenation has not been evaluated fully.[89 90] Apnoeic oxygenation is an area of recent research interest about which further evidence is awaited. The administration of oxygen by nasal cannulae in addition to standard preoxygenation and face-mask ventilation is recommended in high-risk patients.

Choice of induction agent

The induction agent should be selected according to the clinical condition of the patient. Propofol, the most commonly used induction agent in the UK, suppresses laryngeal reflexes and provides better conditions for airway management than other agents.[91–93]

The 5th National Audit Project of the Royal College of Anaesthetists highlighted the relationship between difficult airway management and awareness.[94] It is important to ensure that the patient is adequately anaesthetized during repeated attempts at intubation.

Neuromuscular block

If intubation is difficult, further attempts should not proceed without full neuromuscular block. Neuromuscular block abolishes laryngeal reflexes, increases chest compliance, and facilitates face-mask ventilation.[53 54 95] Complete neuromuscular block should be ensured if any difficulty is encountered with airway management.[96] Rocuronium has a rapid onset and can be antagonized immediately with sugammadex, although the incidence of anaphylaxis may be higher than with other non-depolarizing neuromuscular blocking agents.[97–99]

Mask ventilation

Mask ventilation with 100% oxygen should begin as soon as possible after induction of anaesthesia. If difficulty is encountered, the airway position should be optimized and airway manoeuvres such as a chin lift or jaw thrust should be attempted. Oral and nasopharyngeal airways should be considered, and a four-handed technique (two-person or pressure-controlled mechanical ventilation) should be used.[100] The 'sniffing' position increases the pharyngeal space and improves mask ventilation.[101] Inadequate anaesthesia or inadequate neuromuscular block make mask ventilation more difficult.[102 103]

Choice of laryngoscope

The choice of laryngoscope influences the chance of successful tracheal intubation. Videolaryngoscopes offer an improved view compared with conventional direct laryngoscopy and are now the first choice or default device for some anaesthetists.[104–113] Regular practice is required to ensure that the improved view translates reliably into successful tracheal intubation.[114] All anaesthetists should be trained to use, and have immediate access to, a videolaryngoscope.[115] The flexible fibrescope or optical stylets, such as Bonfils (Karl Storz), Shikani (Clarus Medical), or Levitan FPS scope™ (Clarus Medical), may be the preferred choice for individuals who are expert in their use.[116–122] The first and second choice of laryngoscope will be determined by the anaesthetist's experience and training.

Tracheal tube selection

Tracheal tubes should be selected according to the nature of the surgical procedure, but their characteristics can influence the ease of intubation. A smaller tube is easier to insert because a better view of the laryngeal inlet is maintained during passage of the tube between the cords. Smaller tubes are also less likely to cause trauma.[123] 'Hold-up' at the arytenoids is a feature of the left-facing bevel of most tracheal tubes, and can occur particularly whilst railroading larger tubes over a bougie, stylet, or fibrescope.[124 125] This problem can be overcome by rotating the tube anticlockwise to change the orientation of the bevel or by preloading the tube so that the bevel faces posteriorly and by minimizing the gap between the fibrescope and the tube during fibre-optic intubation.[125–127] Tubes with hooded, blunted, or flexible tips, such as the Parker Flex-Tip™ (Parker Medical), and tubes supplied with the Intubating LMA® (Teleflex Medical Europe Ltd) have been designed to reduce the incidence of this problem.[128–132]

Laryngoscopy

In these guidelines, an attempt at laryngoscopy is defined as the insertion of a laryngoscope into the oral cavity. Every attempt should be carried out with optimal conditions because repeated attempts at laryngoscopy and airway instrumentation are associated with poor outcomes and the risk of developing a CICO situation.[56 133–136] If difficulty is encountered, help should be summoned early, regardless of the level of experience of the anaesthetist.

If intubation is difficult, there is little point in repeating the same procedure unless something can be changed to improve the chance of success. This may include the patient's position, the intubating device or blade, adjuncts such as introducers and stylets, depth of neuromuscular block, and personnel. The number of attempts at laryngoscopy should be limited to three. A fourth attempt should be undertaken only by a more experienced colleague.

External laryngeal manipulation

External laryngeal manipulation applied with the anaesthetist's right hand or backward, upward, and rightward pressure (BURP) on the thyroid cartilage applied by an assistant may improve the view at laryngoscopy.[137–142] A benefit of videolaryngoscopy is that the anaesthetic assistant is also able to see the effects of laryngeal manipulation.[143]

Use of a bougie or stylet

The gum elastic bougie is a widely used device for facilitating tracheal intubation when a grade 2 or 3a view of the larynx is seen during direct laryngoscopy.[144–146] Pre-shaping of the bougie facilitates successful intubation.[147] It can also be helpful during videolaryngoscopy.[148 149] Blind bougie insertion is associated with trauma and is not recommended in a grade 3b or 4 view.[150–155] The 'hold-up' sign may signal the passage of the bougie as far as small bronchi,[156] but it is associated with risk of airway perforation and trauma, especially with single-use bougies.[153 157–159] Forces as little as 0.8 N can cause airway trauma.[153] The characteristics of bougies vary, and this may affect their performance.[153] Once the bougie is in the trachea, keeping the laryngoscope in place enhances the chance of successful intubation.[129] Non-channelled videolaryngoscopes with angulated blades necessitate the use of a pre-shaped stylet or bougie to aid the passage of the tracheal tube through the cords.[160–163] When using a videolaryngoscope, the tip of the tube should be introduced into the oropharynx under direct vision because failure to do so has been associated with airway trauma.[163–167]

Tracheal intubation and confirmation

Difficulty with tracheal intubation is usually the result of a poor laryngeal view, but other factors, such as tube impingement, can hinder the passage of the tube into the trachea.

Once tracheal intubation has been achieved, correct placement of the tube within the trachea must be confirmed. This should include visual confirmation that the tube is between the vocal cords, bilateral chest expansion, and auscultation and capnography. A continuous capnography waveform with appropriate inspired and end-tidal values of CO_2 is the gold standard for confirming ventilation of the lungs. Capnography should be available in every location where a patient may require anaesthesia.[2 168]

Absence of exhaled CO_2 indicates failure to ventilate the lungs, which may be a result of oesophageal intubation or complete airway obstruction (rarely, complete bronchospasm).[2] In such situations, it is safest to assume oesophageal intubation. Videolaryngoscopy, examination with a fibrescope, or ultrasound can be used to verify that the tube is correctly positioned.[169–171]

Plan B. Maintaining oxygenation: supraglottic airway device insertion

In these guidelines (Fig. 2), the emphasis of Plan B (Table 2) is on maintaining oxygenation using an SAD.

Successful placement of a SAD creates the opportunity to stop and think about whether to wake the patient up, make a further attempt at intubation, continue anaesthesia without a tracheal tube, or rarely, to proceed directly to a tracheostomy or cricothyroidotomy.

If oxygenation through a SAD cannot be achieved after a maximum of three attempts, Plan C should be implemented.

Supraglottic airway device selection and placement

As difficulty with intubation cannot always be predicted, every anaesthetist should have a well-thought-through plan for such an eventuality. The decision about which SAD to use for rescue should have been made before induction of anaesthesia, and this choice should be determined by the clinical situation, device availability, and operator experience.

NAP4 identified the potential advantages of second-generation devices in airway rescue and recommended that all hospitals have them available for both routine use and rescue airway management.[2] Competence and expertise in the insertion of any SAD requires training and practice.[172–176] All anaesthetists should be trained to use and have immediate access to second-generation SADs.

Cricoid pressure and supraglottic airway device insertion

Cricoid pressure decreases hypopharyngeal space[177] and impedes SAD insertion and the placement of both first- and second-generation devices.[178–181] Cricoid pressure will have been removed during Plan A if laryngoscopy was difficult and (in the absence of regurgitation) should remain off during insertion of a SAD.

Second-generation supraglottic airway devices

It has been argued that second-generation SADs should be used routinely because of their efficacy and increased safety when compared with first-generation devices.[182] Several second-generation SADs have been described,[183–191] and it is likely that during the lifetime of these guidelines many similar devices will appear.

The ideal attributes of a SAD for airway rescue are reliable first-time placement, high seal pressure, separation of gastrointestinal and respiratory tracts, and compatibility with fibre-optically guided tracheal intubation. These attributes are variably combined in different devices.[182] Of those currently available, only the i-gel™ (Intersurgical, Wokingham, UK), the Proseal™ LMA® (PLMA; Teleflex Medical Europe Ltd, Athlone, Ireland), and the LMA Supreme™ (SLMA; Teleflex Medical Ltd) have large-scale longitudinal studies,[192–195] literature reviews,[196] or meta-analyses in adults[197–200] supporting their use. A number of studies have compared second-generation SADs,[201–224] but it is important to recognize that the experience of the operator with the device also influences the chance of successful insertion.[225]

Limiting the number of insertion attempts

Repeated attempts at inserting a SAD increases the likelihood of airway trauma and may delay the decision to accept failure and move to an alternative technique to maintain oxygenation.

Successful placement is most likely on the first attempt. In one series, insertion success with the PLMA™ was 84.5% on the first attempt, decreasing to 36% on the fourth attempt.[193] In the series of Goldmann and colleagues,[194] only 4.2% of devices were placed on the third or fourth attempt. Three studies report that a third insertion attempt increased overall success rate by

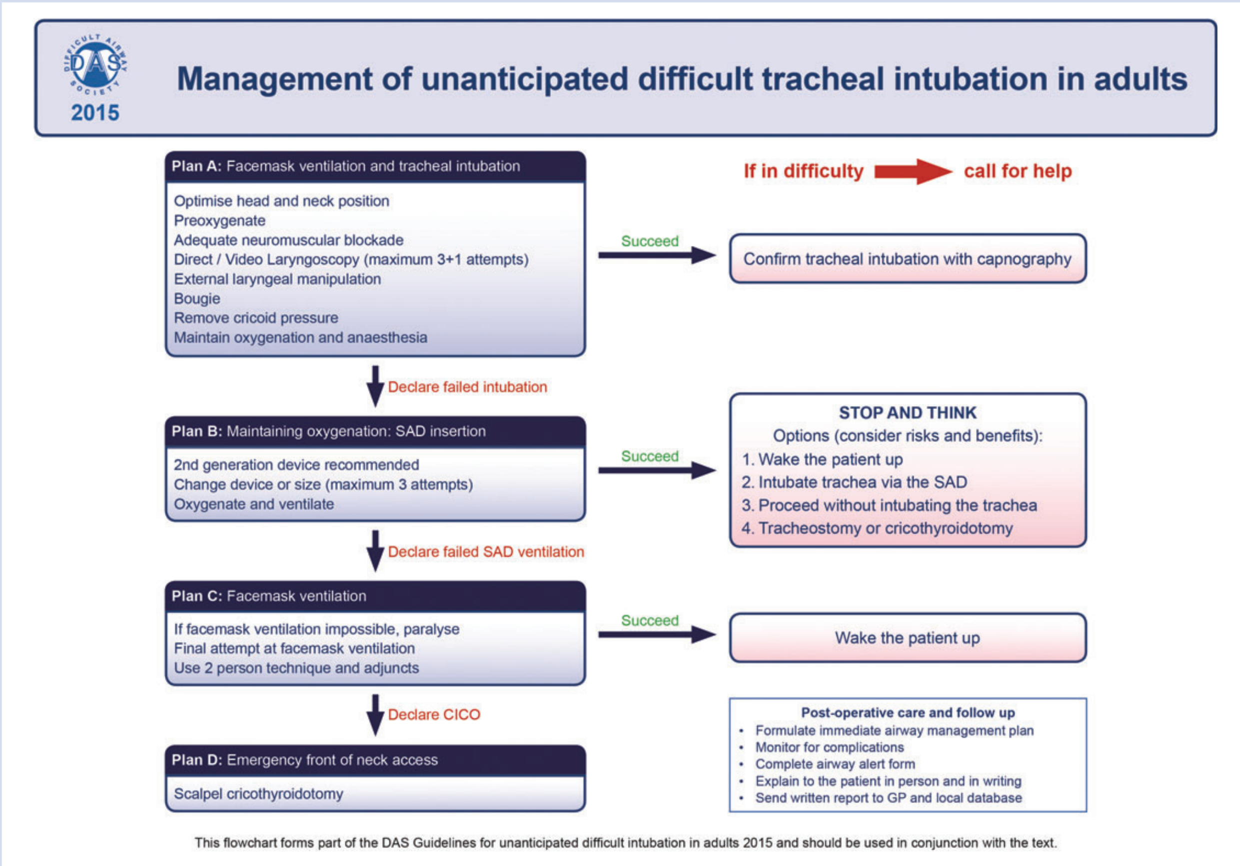

Fig 2 Management of unanticipated difficult tracheal intubation in adults. Difficult Airway Society, 2015, by permission of the Difficult Airway Society. This image is not covered by the terms of the Creative Commons Licence of this publication. For permission to re-use, please contact the Difficult Airway Society.
SAD, supraglottic airway device.

Table 2 Key features of Plan B.
SAD, supraglottic airway device

- Failed intubation should be declared
- The emphasis is on oxygenation via a SAD
- Second-generation SADs are recommended
- A maximum of three attempts at SAD insertion are recommended
- During rapid sequence induction, cricoid pressure should be removed to facilitate insertion of a SAD
- Blind techniques for intubation through a SAD are not recommended

more than 5%; however, one was conducted with operators who had minimal experience, and the other two used the Baska® mask (Baska Versatile Laryngeal Mask, Pty Ltd, Strathfield, NSW, Australia).[189 214 226] Changing to an alternative SAD has been shown to be successful.[192 193 211 216 218 223 224] A maximum of three attempts at SAD insertion is recommended; two with the preferred second-generation device and another attempt with an alternative. An attempt includes changing the size of the SAD.

Even supraglottic airways can fail.[227 228] If effective oxygenation has not been established after three attempts, Plan C should be implemented.

Guided supraglottic airway device placement

Bougie-aided placement of the PLMA has been described as improving first-time placement.[229] In comparison studies, the bougie-guided technique was 100% effective at achieving first-time placement and more effective than digital insertion or insertion with the introducer tool.[230 231] Bougie-aided placement provides better alignment of the drain port and a better fibre-optic view of the cords through the PLMA than the introducer tool method.[232] Patients with a history of difficult tracheal intubation or predicted difficulty were excluded from these studies, making it unclear how effective this technique would be in this situation. The technique has been used effectively in a simulated difficult airway in patients wearing a hard collar,[233] but again patients with predicted difficulty were excluded. A comparative study between the i-gel and the PLMA using a guided technique with a duodenal tube[234] showed both devices to have a first-time insertion success rate of >97%. An orogastric tube has also been used effectively to facilitate PLMA placement in 3000 obstetric patients.[235] Despite the apparent benefit, bougie- and gastric tube-guided placement of second-generation devices are not guaranteed to be successful.[193 221] The technique requires experience, it may cause trauma,[150] and it is not listed in the current PLMA instruction manual.[236]

Successful supraglottic airway device insertion and effective oxygenation established: ‘stop and think’

Clinical examination and capnography should be used to confirm ventilation. If effective oxygenation has been established through a SAD, it is recommended that the team stop and take the opportunity to review the most appropriate course of action.

There are four options to consider: wake the patient up; attempt intubation via the SAD using a fibre-optic scope; proceed with surgery using the supraglottic airway; or (rarely) proceed to tracheostomy or cricothyroidotomy.

Patient factors, the urgency of the surgery, and the skill set of the operator all influence the decision, but the underlying principle is to maintain oxygenation while minimizing the risk of aspiration.

Wake the patient up

If the surgery is not urgent then the safest option is to wake the patient up, and this should be considered first. This will require the full antagonism of neuromuscular block. If rocuronium or vecuronium has been used, sugammadex is an appropriate choice of antagonistic agent. If another non-depolarizing neuromuscular blocking agent has been used then anaesthesia must be maintained until paralysis can be adequately antagonized. Surgery may then be postponed or may continue after awake intubation or under regional anaesthesia.

If waking the patent up is inappropriate (for example, in the critical care unit, in the emergency department, or where life-saving surgery must proceed immediately), the remaining options should be considered.

Intubation via the supraglottic airway device

Intubation through a SAD is only appropriate if the clinical situation is stable, oxygenation is possible via the SAD, and the anaesthetist is trained in the technique. Limiting the number of airway interventions is a core principle of safe airway management; repeated attempts at intubation through a SAD are inappropriate.

Intubation through an intubating laryngeal mask airway (iLMA™; Teleflex Medical Ltd) was included in the 2004 guidelines.[1] Although an overall success rate of 95.7% has been reported in a series of 1100 patients using a blind technique,[237] first-attempt success rates are higher using fibre-optic guidance,[238 239] and a guided technique has been shown to be of benefit in patients with difficult airways.[240] The potential for serious adverse outcomes associated with blind techniques remains.[241] With the need for repeated insertion attempts to achieve success[238] and a low first-time success rate[240 242] (even with second-generation devices[243]), the blind technique is redundant.

Direct fibre-optically guided intubation has been described via a number of SADs, although this may be technically challenging.[244–248] Fibre-optically guided tracheal intubation through the i-gel has been reported with a high success rate.[249 250] Second-generation SADs specifically designed to facilitate tracheal intubation have been described,[190 251 252] but data regarding their efficacy are limited.

The use of an Aintree Intubation Catheter™ (AIC; Cook Medical, Bloomington, USA) over a fibre-optic scope allows guided intubation through a SAD where direct fibre-optically guided intubation is not possible.[248 253] The technique is described on the DAS website.[254] Descriptions of AIC use include a series of 128 patients with a 93% success rate through a classic Laryngeal Mask Airway.[255] The patients in whom the technique was successful included 90.8% with a grade 3 or 4 Cormack and Lehane view at direct laryngoscopy and three patients in whom mask ventilation was reported to be impossible.

Aintree Intubation Catheter™-facilitated intubation has also been described with the PLMA[256 257] and the i-gel.[258] Aintree Intubation Catheter™-guided intubation through an LMA Supreme™ has been reported,[259] but it is unreliable[260] and cannot be recommended.[261]

Proceed with surgery using the supraglottic airway device

This should be considered as a high-risk option reserved for specific or immediately life-threatening situations and should involve input from a senior clinician. The airway may already be traumatized from several unsuccessful attempts at intubation and may deteriorate during the course of surgery because of device dislodgement, regurgitation, airway swelling, or surgical factors. Rescue options are limited given that tracheal intubation is already known to have failed.

Although waking a patient up after failed intubation is most often in their best interest, this is a difficult decision for an anaesthetist to take, especially during a crisis.[241 262]

Proceed to tracheostomy or cricothyroidotomy

In rare circumstances, even when it is possible to ventilate through a SAD, it may be appropriate to secure the airway with a tracheostomy or cricothyroidotomy.

Plan C. Final attempt at face-mask ventilation

If effective ventilation has not been established after three SAD insertion attempts, Plan C (Table 3) follows on directly. A number of possible scenarios are developing at this stage. During Plans A and B, it will have been determined whether face-mask ventilation was easy, difficult, or impossible, but the situation may have changed if attempts at intubation and SAD placement have traumatized the airway.

If face-mask ventilation results in adequate oxygenation, the patient should be woken up in all but exceptional circumstances, and this will require full antagonism of neuromuscular block.

If it is not possible to maintain oxygenation using a face mask, ensuring full paralysis before critical hypoxia develops offers a final chance of rescuing the airway without recourse to Plan D.

Table 3 Key features of Plan C. CICO, can’t intubate can’t oxygenate; SAD, supraglottic airway device

- Failed SAD ventilation should be declared
- Attempt to oxygenate by face mask
- If face-mask ventilation is impossible, paralyse
- If face-mask ventilation is possible, maintain oxygenation and wake the patient up
- Declare CICO and start Plan D
- Continue attempts to oxygenate by face mask, SAD, and nasal cannulae

Sugammadex has been used to antagonize neuromuscular block during the CICO situation but does not guarantee a patent and manageable upper airway.[34 263–266] Residual anaesthesia, trauma, oedema, or pre-existing upper airway pathology may all contribute to airway obstruction.[33]

Plan D: Emergency front-of-neck access

A CICO situation arises when attempts to manage the airway by tracheal intubation, face-mask ventilation, and SAD have failed (Table 4). Hypoxic brain damage and death will occur if the situation is not rapidly resolved.

Current evidence in this area comes either from scenario-based training using manikin, cadaver, or wet lab facilities or from case series, typically in out-of-hospital or emergency department settings.[267–272] None of these completely replicates the situation faced by anaesthetists delivering general anaesthesia in a hospital setting.

NAP4 provided commentary on a cohort of emergency surgical airways and cannula cricothyroidotomies performed when other methods of securing the airway during general anaesthesia had failed.[2] The report highlighted a number of problems, including decision-making (delay in progression to cricothyroidotomy), knowledge gaps (not understanding how available equipment worked), system failures (specific equipment not being available), and technical failures (failure to site a cannula in the airway).

After NAP4, discussion largely focused on the choice of technique and equipment used when airway rescue failed, but the report also highlighted the importance of human factors.[2 273–275]

Regular training in both technical and non-technical elements is needed in order to reinforce and retain skills. Success depends on decision-making, planning, preparation, and skill acquisition, all of which can be developed and refined with repeated practice.[276 277] Cognitive processing and motor skills decline under stress. A simple plan to rescue the airway using familiar equipment and rehearsed techniques is likely to increase the chance of a successful outcome. Current evidence indicates that a surgical technique best meets these criteria.[2 269 273 278]

A cricothyroidotomy may be performed using either a scalpel or a cannula technique. Anaesthetists must learn a scalpel technique and have regular training to avoid skill fade.[279]

Scalpel cricothyroidotomy

Scalpel cricothyroidotomy is the fastest and most reliable method of securing the airway in the emergency setting.[269 278 280] A cuffed tube in the trachea protects the airway from aspiration, provides a secure route for exhalation, allows low-pressure ventilation using standard breathing systems, and permits end-tidal CO_2 monitoring.

A number of surgical techniques have been described, but there is a lack of evidence of the superiority of one over another.[268 281–283] The techniques all have steps in common: neck extension, identification of the cricothyroid membrane, incision through the skin and cricothyroid membrane, and insertion of a cuffed tracheal tube. In some descriptions, the skin and cricothyroid membrane are cut sequentially; in others, a single incision is recommended. Many include a placeholder to keep the incision open until the tube is in place. Some use specialist equipment (cricoid hook, tracheal dilators etc).

A single stab incision through the cricothyroid membrane is appealing in terms of its simplicity, but this approach may fail in the obese patient or if the anatomy is difficult, and a vertical skin incision is recommended in this situation. The approach recommended in these guidelines is a modification of previously described techniques.

Table 4 Key features of Plan D. CICO, can't intubate can't oxygenate

• CICO and progression to front-of-neck access should be declared
• A didactic scalpel technique has been selected to promote standardized training
• Placement of a wide-bore cuffed tube through the cricothyroid membrane facilitates normal minute ventilation with a standard breathing system
• High-pressure oxygenation through a narrow-bore cannula is associated with serious morbidity
• All anaesthetists should be trained to perform a surgical airway
• Training should be repeated at regular intervals to ensure skill retention

Airway rescue via the front of neck should not be attempted without complete neuromuscular block. If sugammadex has been administered earlier in the strategy, a neuromuscular blocking agent other than rocuronium or vecuronium will be required.

Oxygen (100%) should be applied to the upper airway throughout, using a SAD, a tightly fitting face mask, or nasal insufflation.

The use of the 'laryngeal handshake' as described by Levitan[281] (Fig. 3) is recommended as the first step because it promotes confidence in the recognition of the three-dimensional anatomy of the laryngeal structures; the conical cartilaginous cage consisting of the hyoid, thyroid, and cricoid. The laryngeal handshake is performed with the non-dominant hand, identifying the hyoid and thyroid laminae, stabilizing the larynx between thumb and middle finger, and moving down the neck to palpate the cricothyroid membrane with the index finger.

Standardization is useful in rarely encountered crisis situations. It is recommended that the technique described below is adopted. The technique relies on the correct equipment being immediately available. Operator position and stabilization of the hands is important.

Equipment

1. Scalpel with number 10 blade; a broad blade (with the same width as the tracheal tube) is essential.
2. Bougie with coude (angled) tip.
3. Tube, cuffed, size 6.0 mm.

Patient positioning

The sniffing position used for routine airway management does not provide optimal conditions for cricothyroidotomy; in this situation, neck extension is required. In an emergency, this may be achieved by pushing a pillow under the shoulders, dropping the head of the operating table, or by pulling the patient up so that the head hangs over the top of the trolley.

Cricothyroid membrane palpable: scalpel technique (Fig. 4; 'stab, twist, bougie, tube')

1. Continue attempts at rescue oxygenation via upper airway (assistant).
2. Stand on the patient's left-hand side if you are right handed (reverse if left handed).

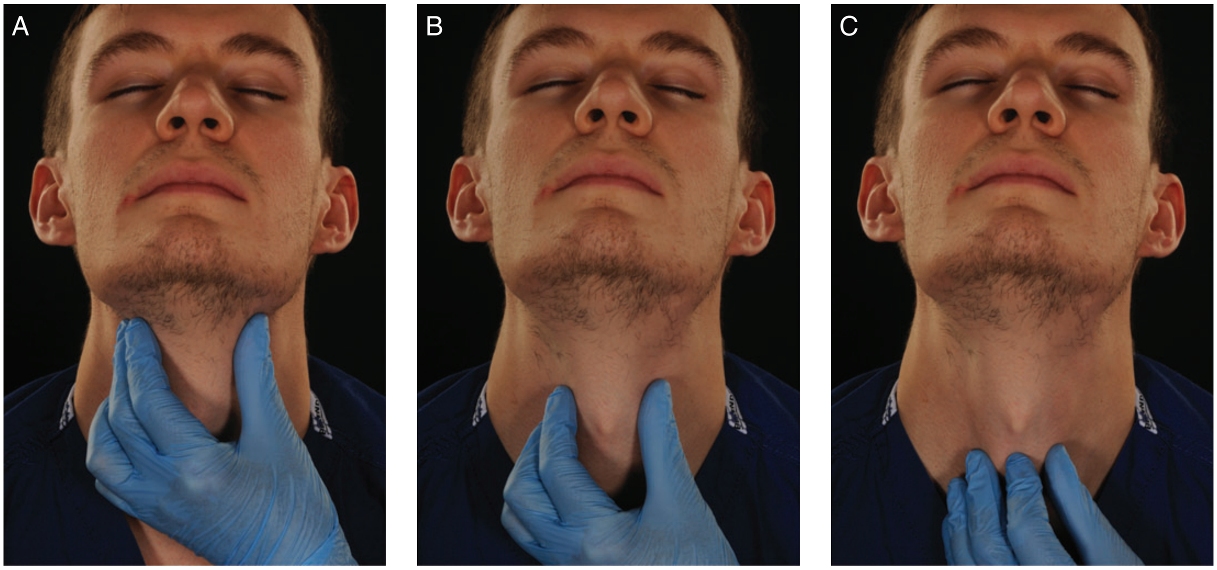

Fig 3 The laryngeal handshake. (A) The index finger and thumb grasp the top of the larynx (the greater cornu of the hyoid bone) and roll it from side to side. The bony and cartilaginous cage of the larynx is a cone, which connects to the trachea. (B) The fingers and thumb slide down over the thyroid laminae. (C) Middle finger and thumb rest on the cricoid cartilage, with the index finger palpating the cricothyroid membrane.

3. Perform a laryngeal handshake to identify the laryngeal anatomy.
4. Stabilize the larynx using the left hand.
5. Use left index finger to identify the cricothyroid membrane.
6. Hold the scalpel in your right hand, make a transverse stab incision through the skin and cricothyroid membrane with the cutting edge of the blade facing towards you.
7. Keep the scalpel perpendicular to the skin and turn it through 90° so that the sharp edge points caudally (towards the feet).
8. Swap hands; hold the scalpel with your left hand.
9. Maintain gentle traction, pulling the scalpel towards you (laterally) with the left hand, keeping the scalpel handle vertical to the skin (not slanted).
10. Pick the bougie up with your right hand.
11. Holding the bougie parallel to the floor, at a right angle to the trachea, slide the coude tip of the bougie down the side of the scalpel blade furthest from you into the trachea.
12. Rotate and align the bougie with the patient's trachea and advance gently up to 10–15 cm.
13. Remove the scalpel.
14. Stabilize trachea and tension skin with left hand.
15. Railroad a lubricated size 6.0 mm cuffed tracheal tube over the bougie.
16. Rotate the tube over the bougie as it is advanced. Avoid excessive advancement and endobronchial intubation.
17. Remove the bougie.
18. Inflate the cuff and confirm ventilation with capnography.
19. Secure the tube.

If unsuccessful, proceed to scalpel–finger–bougie technique (below).

Impalpable cricothyroid membrane: scalpel–finger–bougie technique

This approach is indicated when the cricothyroid membrane is impalpable or if other techniques have failed.

Equipment, patient, and operator position are as for the scalpel technique (Fig. 5)

1. Continue attempts at rescue oxygenation via upper airway (assistant).
2. Attempt to identify the laryngeal anatomy using a laryngeal handshake.
3. If an ultrasound machine is immediately available and switched on, it may help to identify the midline and major blood vessels.
4. Tension skin using the left hand.
5. Make an 8–10 cm midline vertical skin incision, caudad to cephalad.
6. Use blunt dissection with fingers of both hands to separate tissues and identify and stabilize the larynx with left hand.
7. Proceed with 'scalpel technique' as above.

Note that a smaller cuffed tube (including a Melker) can be used provided it fits over the bougie. The bougie should be advanced using gentle pressure; clicks may be felt as the bougie slides over the tracheal rings. 'Hold-up' at less than 5 cm may indicate that the bougie is pre-tracheal.

Cannula techniques

Narrow-bore (<4 mm) cannula

Cannula techniques were included in the 2004 guidelines and have been advocated for a number of reasons, including the fact that anaesthetists are much more familiar with handling cannulae than scalpels. It has been argued that reluctance to use a scalpel may delay decision-making and that choosing a cannula technique may promote earlier intervention.[268]

Whilst narrow-bore cannula techniques are effective in the elective setting, their limitations have been well described.[2 284 285] Ventilation can be achieved only by using a high-pressure source, and this is associated with a significant risk of barotrauma.[2 268 286] Failure because of kinking, malposition, or displacement of the cannula can occur even with purpose-

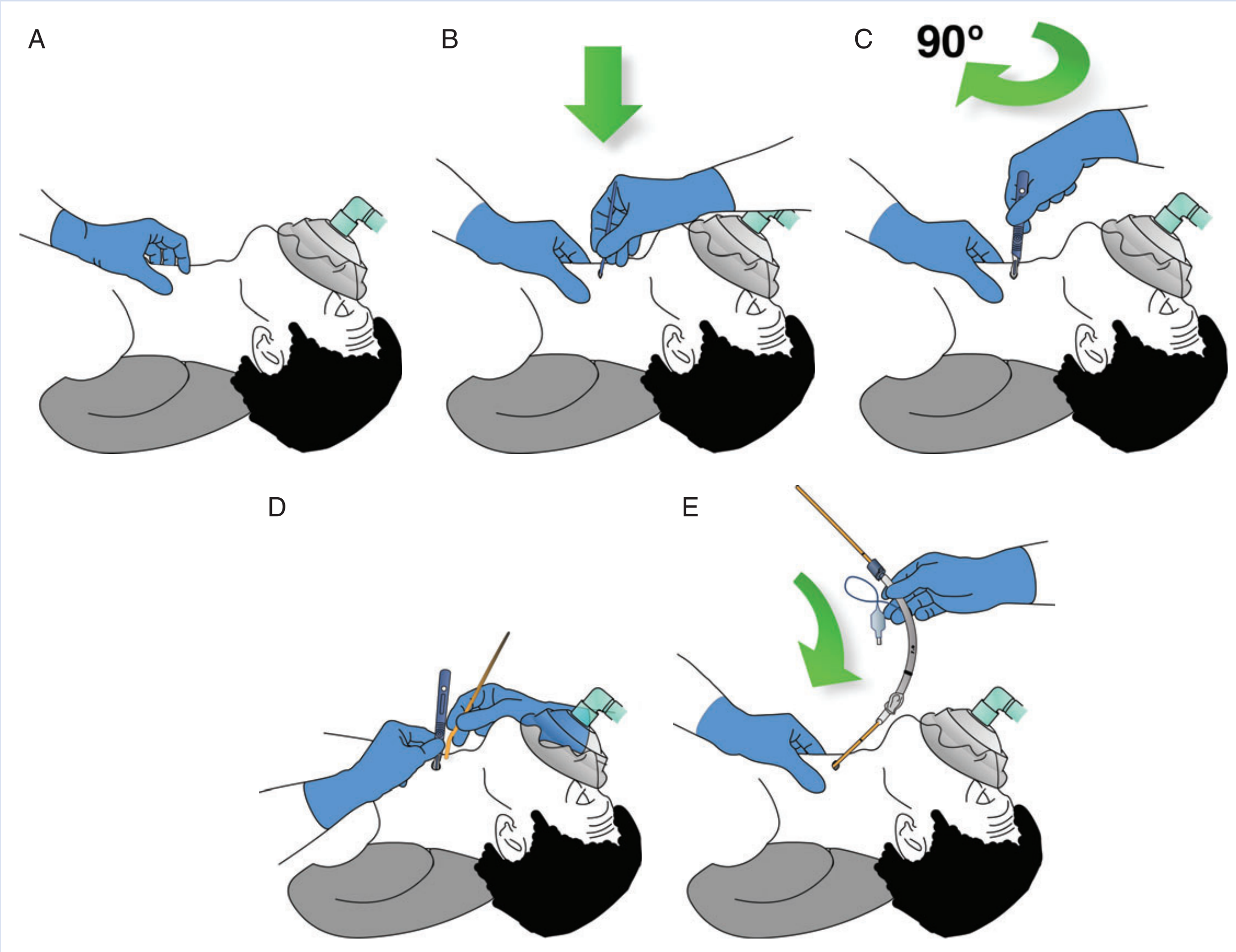

Fig 4 Cricothyroidotomy technique. Cricothyroid membrane palpable: scalpel technique; 'stab, twist, bougie, tube'. (A) Identify cricothyroid membrane. (B) Make transverse stab incision through cricothyroid membrane. (C) Rotate scalpel so that sharp edge points caudally. (D) Pulling scalpel towards you to open up the incision, slide coude tip of bougie down scalpel blade into trachea. (E) Railroad tube into trachea.

designed cannulae, such as the Ravussin™ (VBM, Sulz, Germany).[2 268] High-pressure ventilation devices may not be available in all locations, and most anaesthetists do not use them regularly. Their use in the CICO situation should be limited to experienced clinicians who use them in routine clinical practice.

Experience of training protocols carried out using high-fidelity simulation with a live animal model (wet lab) suggest that performance can be improved by following didactic teaching of rescue protocols.[287] Wet lab high-fidelity simulation is unique because it provides a model that bleeds, generates real-time stress, and has absolute end-points (end-tidal CO_2 or hypoxic cardiac arrest) to delineate success or failure. After observation of >10 000 clinicians performing infraglottic access on anaesthetized sheep,[268 288] Heard has recommended a standard operating procedure with a 14 gauge Insyte™ (Becton, Dickinson and Company) cannula technique, with rescue oxygenation delivered via a purpose-designed Y-piece insufflator with a large-bore exhaust arm (Rapid-O_2™ Meditech Systems Ltd UK). This is followed by insertion of a cuffed tracheal tube using the Melker® wire-guided kit. An algorithm, a structured teaching programme, competency-based assessment tools, and a series of videos have been developed to support this methodology and to promote standardized training.[287]

Further evidence of the efficacy of this technique in human practice is needed before widespread adoption can be recommended.

Wide-bore cannula over guidewire

Some wide-bore cannula kits, such as the Cook Melker® emergency cricothyrotomy set, use a wire-guided (Seldinger) technique.[289] This approach is less invasive than a surgical cricothyroidotomy and avoids the need for specialist equipment for ventilation. The skills required are familiar to anaesthetists and intensivists because they are common to central line insertion and percutaneous tracheostomy; however, these techniques require fine motor control, making them less suited to stressful situations. Whilst a wire-guided technique may be a reasonable alternative for anaesthetists who are experienced with this method, the evidence suggests that a surgical cricothyroidotomy is both faster and more reliable.[288]

Non-Seldinger wide-bore cannula

A number of non-Seldinger wide-bore cannula-over-trochar devices are available for airway rescue. Although successful use has been reported in CICO, there have been no large studies of these devices in clinical practice.[275] The diversity of

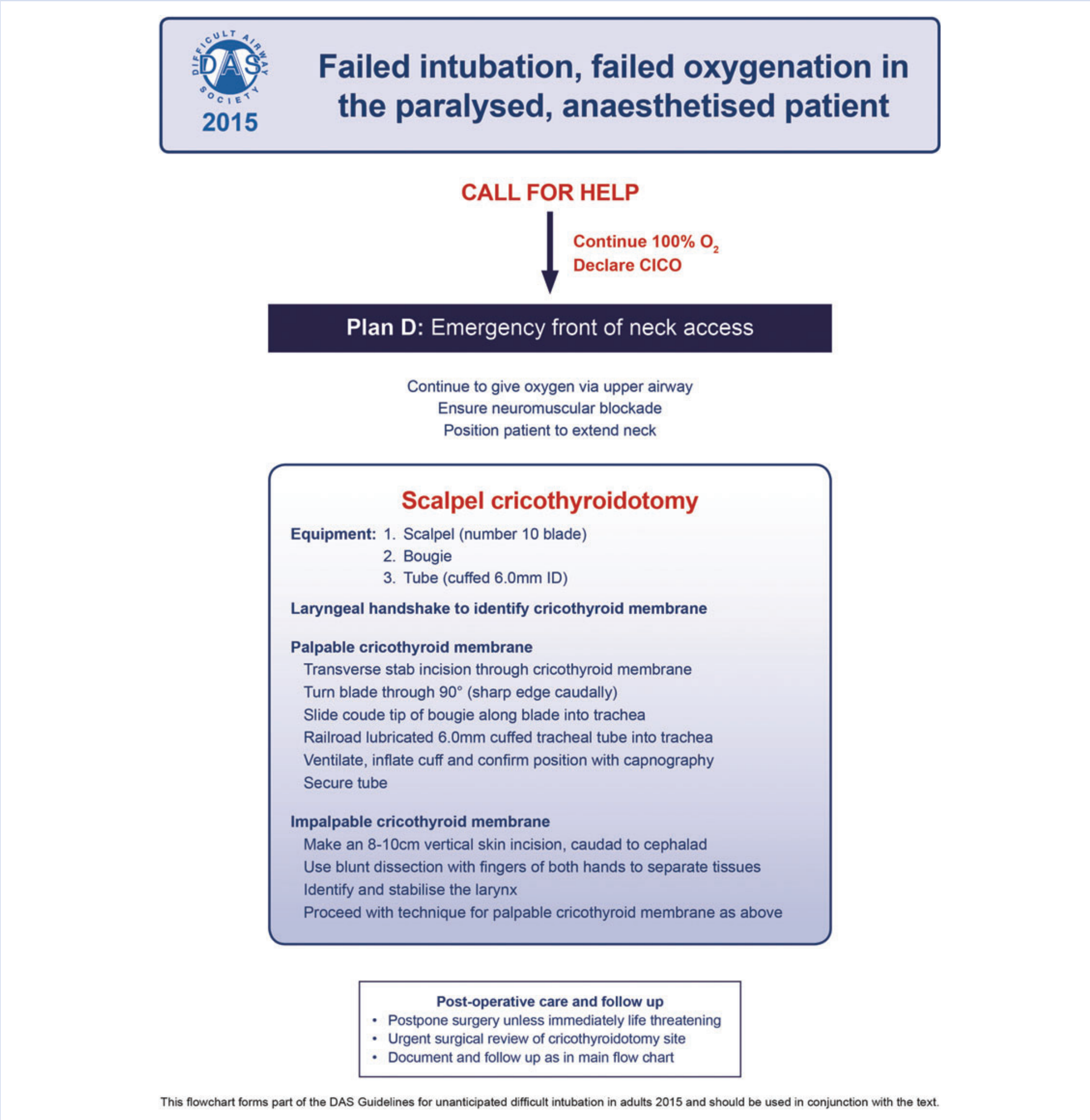

Fig 5 Failed intubation, failed oxygenation in the paralysed, anaesthetized patient. Technique for scalpel cricothyroidotomy. Difficult Airway Society, 2015, by permission of the Difficult Airway Society. This image is not covered by the terms of the Creative Commons Licence of this publication. For permission to re-use, please contact the Difficult Airway Society.

commercially available devices also presents a problem because familiarity with equipment that is not universally available challenges standardization of training.

The role of ultrasound

It is good practice to attempt to identify the trachea and the cricothyroid membrane during the preoperative assessment.[273] If this is not possible with inspection and palpation alone, it can often be achieved with ultrasonography.[171 290] The role of ultrasound in emergency situations is limited. If immediately available and switched on it may help to identify key landmarks but should not delay airway access.[171 291 292] Airway evaluation using ultrasound is a valuable skill for anaesthetists,[292] and training in its use is recommended.[273 293]

Postoperative care and follow-up

Difficulties with airway management and the implications for postoperative care should be discussed at the end of the procedure during the sign-out section of the WHO checklist.[294] In addition to a verbal handover, an airway management plan should be documented in the medical record. Many airway guidelines and airway interest groups[169 295 296] (including the DAS

Extubation and Obstetric Guidelines[4 5]) recommend that patients should be followed up by the anaesthetist in order to document and communicate difficulties with the airway. There is a close relationship between difficult intubation and airway trauma;[297 298] patient follow-up allows complications to be recognized and treated. Any instrumentation of the airway can cause trauma or have adverse effects; this has been reported with videolaryngoscopes,[163 166] second-generation supraglottic devices,[192 193 195] and fibre-optic intubation.[299] The American Society of Anesthesiologists closed claims analysis suggests that it is the pharynx and the oesophagous that are damaged most commonly during difficult intubation.[298] Pharyngeal and oesophageal injury are difficult to diagnose, with pneumothorax, pneumomediastinum, or surgical emphysema present in only 50% of patients.[5] Mediastinitis after airway perforation has a high mortality, and patients should be observed carefully for the triad of pain (severe sore throat, deep cervical pain, chest pain, dysphagia, painful swallowing), fever, and crepitus.[297 300] They should be warned to seek medical attention should delayed symptoms of airway trauma develop.

Despite these recommendations, communication is often inadequate.[301–304] The DAS Difficult Airway Alert Form is a standard template with prompts for documentation and communication.[305] The desire to provide detailed clinical information must be balanced against the need for effective communication. At present, there is no UK-wide difficult airway database, although national systems such as Medic Alert have been advocated[306] and can be accessed for patients with 'Intubation Difficulties'.[307]

Coding is the most effective method of communicating important information to general practitioners; the code for 'difficult tracheal intubation' is Read Code SP2y3[303 308] and should be included on discharge summaries. Read Codes in the UK will be replaced by the international SNOMED CT (Systematized Nomenclature of Medicine–Clinical Terms) by 2020.

Every failed intubation, emergency front-of-neck access, and airway-related unplanned admission should be reviewed by departmental airway leads and should be discussed at morbidity and mortality meetings.

Discussion

Complications of airway management are infrequent. The NAP4 project estimated that airway management resulted in one serious complication per 22 000 general anaesthetics, with death or brain damage complicating 1:150 000. It is not possible to study such rare events in prospective trials, so our most valuable insights come from the detailed analysis of adverse events.[2 241 262]

Guidelines exist to manage complex emergency problems in other areas of clinical practice, with cardiopulmonary resuscitation guidelines being an obvious example. Standardized management plans are directly transferable from one hospital to another and make it less likely that team members will encounter unfamiliar techniques and equipment during an unfolding emergency. These guidelines are directed at anaesthetists with a range of airway skills and are not specifically aimed at airway experts. Some anaesthetists may have particular areas of expertise, which can be deployed to supplement the techniques described.

The guidelines are directed at the unanticipated difficult airway, where appropriately trained surgeons may not be immediately available, so all anaesthetists must be capable of performing a cricothyroidotomy. There are some situations where these guidelines may be loosely followed in the management of patients with a known or suspected difficult airway, and in these circumstances a suitably experienced surgeon with appropriate equipment could be immediately available to perform the surgical airway on behalf of the anaesthetist.

Complications related to airway management are not limited to situations where the primary plan has been tracheal intubation; 25% of anaesthesia incidents reported to NAP4 started with the intention of managing the airway using a SAD. Whilst the key principles and techniques described in these guidelines are still appropriate in this situation, it is likely that at the point of recognizing serious difficulty the patient may not be well oxygenated or optimally positioned.

These guidelines have been created for 'unanticipated difficulty' with airway management, and it is important that whatever the primary plan may be, a genuine attempt has been made to identify possible difficulties with the generic Plans A, B, C, and D. Assessing mouth opening, neck mobility, and the location of the cricothyroid membrane before surgery will help to determine whether some rescue techniques are unlikely to be successful.

There are randomized controlled trials and meta-analyses supporting the use of some airway devices and techniques,[197–200] but for others no high-grade evidence is available and recommendations are necessarily based on expert consensus.[8] In this manuscript, individual techniques have not been listed against their levels of evidence, although other groups have taken this approach.[309]

Implementation of the guidelines does not obviate the need for planning at a local level. The training required to develop and maintain technical skills has been studied in relation to various aspects of airway management, including videolaryngoscopy and cricothyroidotomy.[109 276 310–313] To achieve and maintain competence with devices such as videolaryngoscopes and second-generation SADs and drugs such as sugammadex, they need to be available for regular use, and local training will be necessary. New airway devices will continue to be developed and introduced into clinical practice; their place in these guidelines will need to be evaluated. Even when no single device or technique has a clear clinical benefit, limiting choice simplifies training and decision-making. In the area of airway rescue by front-of-neck access, feedback from DAS members and international experts suggested that there was a need to unify the response of anaesthetists to the 'CICO' emergency and to recommend a single pathway. While UK anaesthetists are required to revalidate every 5 yr and advanced airway management features in the Royal College of Anaesthetists CPD matrix[314] (2A01), there is currently no specific requirement for training or retraining in cricothyroidotomy. A consistent local effort will be required to ensure that all those involved in airway management are trained and familiar with the technique. These guidelines recommend the adoption of scalpel cricothyroidotomy as a technique that should be learned by all anaesthetists. This method was selected because it can be performed using equipment available at almost every location where an anaesthetic is performed and because insertion of a large-bore cuffed tube provides protection against aspiration, an unobstructed route for exhalation and the ability to monitor end-tidal CO_2. There are, however, other valid techniques for front-of-neck access, which may continue to be provided in some hospitals where additional equipment and comprehensive training programmes are available. It is incumbent on the anaesthetic community to ensure that data from all front-of-neck access techniques are gathered and are used to inform change when these guidelines are next updated.

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Front-of-neck access: a practical viewpoint, from experience

M. A. Henderson

Glasgow, UK

E-mail: markhenderson@nhs.net

Editor—The cogent editorial by Timmermann and colleagues[1] deeply resonated with me. As an anaesthetic core trainee, I was called upon to obtain front-of-neck access in an emergency, using a scalpel and Mini-Trach kit (Portex, Smiths Medical, USA). The scenario was a cardiac arrest attributable to anaphylaxis and upper airway obstruction in the Emergency Department of a District General Hospital. Despite receiving excellent airway teaching and previous practice in simulation, I was psychologically unprepared for the practicalities. With no surgical training, it was unlike any task that I had previously performed, and I had no confidence in performing it proficiently. I was surprised by the bleeding, which inevitably occurred, and when the procedure proved to be difficult, I had no real-life experience with which to troubleshoot.

In contrast, as an anaesthetist, I am experienced in cannulation and Seldinger procedures, which are core translational skills. I am saddened to see valuable airway rescue equipment, such as the Melker Universal Cricothyrotomy Catheter Set (Cook Medical, Bloomington, IN, USA), being removed from airway rescue trolleys after the publication of the current Difficult Airway Society guidelines.[2] Although simulation may allow one to rehearse front-of-neck access, I do not believe it is possible to simulate difficulty in a way that facilitates proficiency. After this experience, I had abandoned the thought of a surgical airway and resolved to use a Seldinger approach if the need arose; I would prefer to rely on my proven skills to take me into the unknown.

Declaration of interest

None declared.

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Human factors can't intubate can't oxygenate (CICO) bundle is more important than needle *versus* scalpel debate

A. W. G. Booth* and K. Vidhani

Brisbane, Queensland, Australia

*E-mail: anton_booth@health.qld.gov.au

Editor—We believe best practice for front-of-neck access will be achieved when using human factors engineering principles, optimizing the interaction between people (most skilled airway manager available) and clinical decision-making (using Help to overcome cognitive bias and perform the task) in an environment using standardized equipment following a practised algorithm regardless of the technical approach taken.[1]

Moneypenny[2] correctly points out that a human factors approach to a 'can't intubate, can't oxygenate' (CICO) scenario should move beyond the human/anaesthetist viewpoint. We agree with this and suggest that addressing the cognitive aspects of clinical decision-making along with an organizational approach is what is required to solve the problem of optimal practice for front-of-neck access. Although Moneypenny[2] provides a compelling argument that a 'wider' human factors approach to a CICO scenario favours the use of a scalpel-only technique, we suggest that this approach can equally support the use of a cannula-only technique. The decision-making part of a human factors approach would suggest that the individual performing the front-of-neck access should not be the individual who has failed to secure the airway initially. In line with intuitive *vs* analytical thinking,[3] we would suggest it is easier for the 'Help' to perform this task whichever approach is favoured, because they will not be locked into the intuitive cycle of task fixation or other cognitive bias that may occur while managing the crisis.

The ongoing discussion about which CICO technique is better is unresolvable until we define in the literature the level of airway skills the participants have: novice (medical students), trainee-junior (<2 yr), trainee-senior (>2 yr), and trained consultant. This information is not provided in the Fourth National Audit Project (NAP4) from the UK.[4] It is likely that an experienced anaesthetist is far more adept at a Seldinger needle method than a novice airway manager who has minimal Seldinger technique skills (as noted by Henderson[5] in his correspondence). However, in lieu of Difficult Airway Society guidelines suggesting three attempts plus one by a more experienced anaesthetist at intubation,[6] it follows that for the front-of-neck access the most senior skilled airway manager should be performing the procedure (who was not involved in the initial failed intubation, as described before).

Particularly unhelpful are the studies using novice airway managers,[7] for which opinions/guidelines are translated to all levels of airway skills.[8] The personnel should be nominated in a team approach to determine which person should gain front-of-neck access; in our department, it is the most senior airway manager available at the scene. On an organizational level, our institution endorses a cannula cricothyroidotomy/tracheotomy as its first-line technique for emergency front-of-neck access in a CICO scenario.

Rather than primarily focusing on education and training, we also implemented a comprehensive human factors programme in an effort to optimize its success. Our human factors approach was to deliver the combination of guidelines, equipment, and training as a 'CICO bundle'. Underpinning our human factors approach was the development of a CICO algorithm and a CICO equipment kit, which have been precisely matched (Fig. 1). This satisfies the fundamental concept in human factors of improving interactions between people and their environment. The CICO algorithm is based on that published by Royal Perth Hospital;[9] however, it has been modified to match the specific equipment used at our institution. Our CICO kits are standardized and organized so that the equipment required for each step in the algorithm is easily identifiable and sequentially accessible. The CICO kits are located on every anaesthetic machine, making them immediately available. We have regular education and training sessions for all staff members, which involve both low- and high-fidelity simulation using the algorithm and real equipment in the kits.

Despite the NAP4 findings, feedback from participants through our CICO programme has been overwhelmingly positive in favour of a cannula-first approach. The standardized approach to our initial technique choice and use of equipment avoids indecision and benefits the human factors relating to 'task' and 'person'. The standardized equipment and training also benefits both the 'person' and 'team'. On an 'organizational' level, the implementation of our CICO algorithm and kit has facilitated funding for the required equipment, and ongoing training has benefits for both participants and facilitators within our department. We have also gained accreditation to deliver CICO emergency response training programmes to anaesthetists external to our institution in accordance with our National Continuing Professional Development requirements.

Rather than debate which of these techniques should be used first for emergency front-of-neck access, we think that a greater focus should be placed on maximizing success when either of these techniques is required. The role of human factors to maximize a successful outcome in a CICO scenario is well established.[4 10] These effectors of human performance will, however,

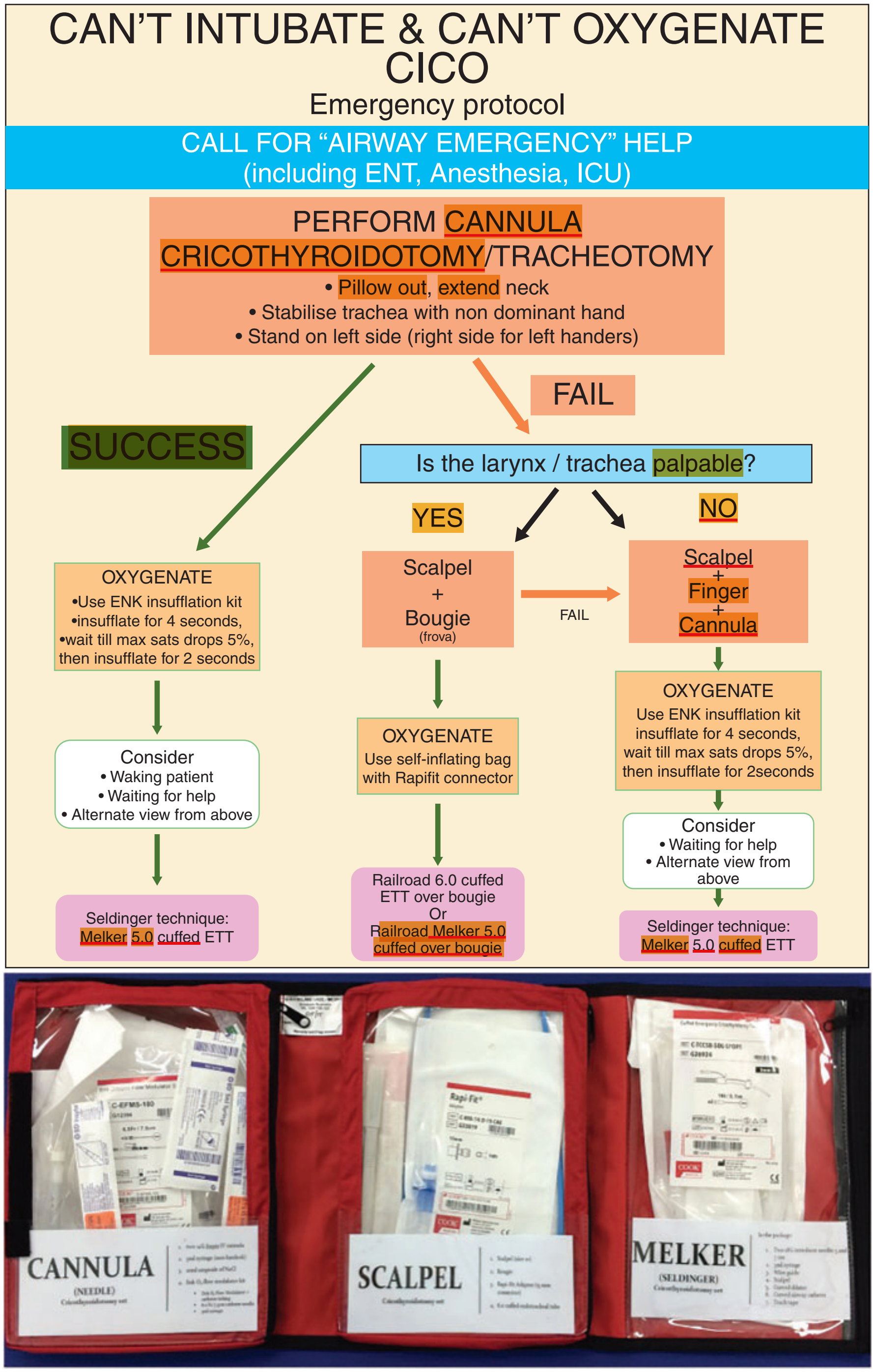

Fig 1 Princess Alexandra Hospital 'CICO' equipment kit matched to 'CICO' algorithm.

be subject to variation at an individual/institutional level and should therefore guide which initial technique should be selected. A CICO bundle of care consisting of (i) an institution standardized CICO kit used by (ii) appropriately trained personnel with a defined level of airway expertise who (iii) have an awareness of clinical decision-making through repeated simulation satisfies a complete human factors approach. The technical aspect of which method to use is thus redundant, and this debate is resolved.

Declaration of interest

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M. A. Henderson

Glasgow, UK

E-mail: markhenderson@nhs.net

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When are 'human factors' not 'human factors' in can't intubate can't oxygenate scenarios? When they are 'human' factors

M. J. Moneypenny

Falkirk, UK

E-mail: mmoneypenny@nhs.net

Editor—Timmermann and colleagues[1] raise valid concerns about the recommendation by the Difficult Airway Society (DAS) to use a scalpel cricothyroidotomy as the sole technique in a can't intubate can't oxygenate (CICO) scenario.[2] However, their argument falls short on a number of levels. First, although the Fourth National Audit Project (NAP4) has its drawbacks, it is the best snapshot ever created of current anaesthetic practice with respect to complications of airway management.[3] NAP4 tells us what is happening now, in the real world, not in a hypothetical reality where 'dedicated training programme(s)' have been instituted. In the real world, anaesthetists cause morbidity and mortality with a cannula technique. In addition, advocating cannula use because it can be practised on real patients is to obfuscate the issue. Awake fibreoptic intubations, which in some institutions are relatively rare themselves, do not need transtracheal blocks because the airway can be anaesthetized with less invasive means. Nor is the pre-emptive use of cannula cricothyroidotomy likely to catch on. Second, a 'human factors' approach to the CICO problem needs to move beyond the human/anaesthetist viewpoint and look at the wider picture. The authors concentrate on the anaesthetic practitioner in terms of familiarity, training, and pre-emptive use. Human factors is the science of improving human performance and well-being by examining all the effectors of human performance. A 'scalpel only' technique, when viewed using a human factors approach, has a number of benefits, as follows.

i. Task. Equipment can be minimized and standardized, with no need to decide between 'the Enk Oxygen Flow Modulator (Cook Medical, Bloomington, IN, USA), the Rapid-O2 (Meditech Systems Ltd, Shaftesbury, UK), or the Ventrain (Dolphys Medical BV, Eindhoven, The Netherlands)'.
ii. Person. In the crisis, there is no need for the anaesthetist to waste time making a decision between cannula and surgical cricothyroidotomy. Precious training time can be focused on the one technique.
iii. Team. In the crisis, the team will know what equipment to get. There is no need to wonder whether the anaesthetist has chosen the correct technique for this patient. Precious team training time can be focused on the one technique
iv. Organization. The organization can use implementation of the DAS guidelines as part of its governance procedures. The anaesthetic department can use the DAS guidelines to make a case for equipment and training.
v. Socio-cultural. The adoption of a sole technique means that future reviews of difficult airway management can focus on best practice with the scalpel technique.

Third, better education and training, which seems to be the approach advocated by the authors, are the least effective mitigation interventions.[4] Standardization and simplification are, from a human factors perspective, much more likely to effect desirable changes. Fourth, when considering what to do in a CICO technique, a human factors approach would explore what and why the anaesthetist thinks is the 'better' technique. The authors quote a number of papers (including the NAP4 study itself) to show that anaesthetists preferred a cannula technique. However, the abysmal failure rate of the cannula technique in NAP4 is likely to mean that anaesthetists who are aware of the results are more likely to prefer the scalpel technique. When considering 'human factors', advocating a single scalpel technique for CICO therefore has a number of advantages, and the DAS is to be commended for its pragmatic, realistic approach.

Declaration of interest

None declared. (The views expressed are the author's own and do not represent those of his employers or the Scottish Centre for Simulation and Clinical Human Factors.)

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