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Airway management in the critically ill: the same, but different

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Airway management has had a central role in intensive care medicine even from its origins. When Danish Anaesthetist Björn Ibsen applied his airway skills to victims of the 1952–3 Copenhagen poliomyelitis epidemic, the era of Critical Care Medicine was born.[1] The

importance of advanced airway management in the care of the critically patient is one reason why modern Intensive Care Medicine is still closely allied to Anaesthesia in many countries.

In many ICUs there has recently been a move to more multispecialty and even multidisciplinary staffing, both at a senior and trainee level, meaning advanced airway skills may not be reliably available. Staff are faced with increasingly obese patients with deranged baseline physiology and complex conditions who are disproportionately likely to experience airway difficulty, presenting challenges to airway safety in ICU.[2 3]

The 4th National Audit Project of the Royal College of Anaesthetists and Difficult Airway Society (NAP4)[3] highlighted the difficulties, and sometimes failings, of airway management in ICU and showed it to be a place of 'increased airway danger' compared with the operating theatre. However there are also opportunities: in the last decade airway management in anaesthesia has changed significantly. Adoption of appropriate technical and non-technical advances by the intensive care community from anaesthesia is likely to provide benefit. With updated airway management guidelines in Canada,[4] USA,[5] Germany[6] and the UK[7] in recent years, now is a good time to reflect on both the challenges and opportunities facing those managing the airway in ICU. It is also time to consider whether difficult airway guidelines developed primarily for an anaesthetic setting are appropriate for airway management of critically ill patients, both inside and outside the ICU.

Why is ICU airway management different?

It is well recognized that in special circumstances different airway management approaches are needed, reflected by a range of published strategies and algorithms for adult, paediatric, obstetric, emergency and pre-hospital populations. Airway management in the critically ill patient may occur on the ICU itself or almost anywhere else in the hospital environment. Many of these locations are remote, none are designed with airway management primarily in mind and they all present logistical challenges. While some airway interventions will be planned, most are reactive and emergent, often with the intubating team called urgently to a rapidly deteriorating patient.

Patient factors often contribute to difficulty. In the emergency setting and with a patient who may be hypoxic, obtunded, combative or all three, airway assessment is difficult and often cannot be performed to the highest standards. Rapid sequence induction will be considered appropriate in most of these patients because of lack of starvation, intra-abdominal pathology or functional gastric stasis. The vast majority will have unstable physiology – even before anaesthesia is induced. This includes pre-existing hypoxia, ventilation-perfusion mismatch that impairs preoxygenation, absolute or relative hypovolaemia and an increased risk of myocardial impairment. This lack of cardiorespiratory reserve increases the risk of profound hypoxia, hypotension, arrhythmia, cardiac arrest and death.[8 9] Induction of anaesthesia is complex, requiring modification of normal drug choices and doses. Airway management needs to be prompt and successful to prevent physiological decline. Rapid desaturation from a hypoxic baseline creates time pressure and demands rapid action. Even when airway management is successful the initiation of positive pressure ventilation may also be poorly tolerated and lead to immediate or delayed deterioration.[10]

Of note the incidence of difficult airways in the critically ill is also likely increased. Patients with known airway difficulty are often admitted to the ICU for monitoring and management including intubation, extubation or observation. Astin's UK survey[11] reported that one in 20 UK adult ICU admissions were for management of a primary airway problem and one in 16 patients had a predicted difficult airway. More pertinently, one in four of the ICUs surveyed had a patient admitted with a primary airway problem and 40% were managing at least one patient with a predicted difficult airway. Critical illness and its management can also render an anatomically 'normal' airway 'difficult' with fluid resuscitation, capillary leak syndromes, prone ventilation and long periods of intubation all contributing to airway oedema and distortion.

Importantly, but little discussed, the lack of skilled assistance and adequate equipment when managing the airways of critically ill patients may also impact on delivery of prompt, safe, skilled airway management – especially when difficulty occurs and non-standard plans are required.[3]

What then are the impacts of these multifactorial issues on the outcomes of airway management in ICU? Firstly, failure to intubate is much more likely when inducing anaesthesia in the critically ill. Failure at the first intubation attempt can be expected in 10–12%, significantly higher than during anaesthetic practice.[12–14] Complications and cardiac arrests increase significantly as the number of intubation attempts increases.[12]

Cardiac arrest during intubation on ICU is not infrequent. Over a 12 year period, with all intubations performed by an airway operator with a minimum of six months anaesthetic training, Mort reported 60 cardiac arrests occurring during 3035 out-of-theatre intubations (2%).[15] Eighty-three percent of patients who arrested experienced severe hypoxaemia (SpO_2< 70%) during intubation, including all those patients requiring ≥3 intubation attempts. Patients developing severe hypoxia required an average of almost four attempts, while those without hypoxia were nearly all intubated first time. Oesophageal intubation increased risk of cardiac arrest more than 15-fold.

Other complications are common during ICU intubation attempts. In Nolan and Kelly's 2011 review of critical care airway literature[16] the reported rates of complications included: ≥3 intubation attempts 10%, severe hypoxaemia 7%, severe hypotension 17%, oesophageal intubation 5.3%, aspiration 2.6% and cardiac arrest 2.1%. In a study of seven French units staffed by residents with a minimum of one year's experience, Jaber found that at least one severe complication occurred in 28% of intubations, including severe hypoxaemia in 26%, and cardiac arrest in 1.6%.[10] The main risk factors were pre-procedural respiratory failure and shock, whilst the presence of two operators reduced risk. The authors highlight that the use of neuromuscular blocking agents for intubation in their study (62%) was in the middle of an extremely wide spectrum quoted in the international literature (ranging from 22–80%) and attributed the wide variety of practice to a regrettable lack of recommendations for airway management in critically ill patients.[10 13]

There are of course clear differences in the post-intubation management of patients on ICU compared with anaesthetic practice. ICU patients may remain intubated for weeks and, in contrast to theatre, most ICU airway incidents take place after the airway has been secured. The UK National Reporting and Learning Centre identified that 82% of ICU airway incidents occurred after intubation, with 25% contributing to the patient's death.[17] All invasively ventilated ICU patients are subject to procedures, complex nursing care and repositioning which requires a high degree of vigilance to maintain the airway device, with success dependent on the performance of the multidisciplinary team, rather than one constantly present anaesthetist. Because of this, airway displacement and subsequent re-intubation is a constant danger in ICU, associated with high complication rates, including

mortality.[3 18] Tracheostomies are used to manage around 10–19% of level 3 ICU admissions in Europe and the US, and these patients occupy a disproportionately high number of ventilator bed days.[18] The 2014 UK NCEPOD report into tracheostomy care reported complications in 23.6% of tracheostomized ICU patients, with nearly 30% of patients experiencing multiple complications.[19] In keeping with previous reports, tube displacement, obstruction, pneumothorax and major haemorrhage were the commonest themes.[18]

It is clear that the caseload, physiology, environment, staffing, airway devices and airway pathologies in the critically ill are significantly different to those addressed by existing guidelines.

What does NAP 4 tell us about ICU airways?

In contrast to the enormous literature on anaesthetic airway management, that focusing on airway management in ICU is rather modest. The NAP4 study is therefore important as it identified an increased rate of major airway events on ICU compared with anaesthesia (approximately 50- to 60-fold higher) and a notably worse outcome for patients who experienced these events (61% mortality on ICU vs 14% during anaesthesia).[3] It is important to emphasize that the NAP4 inclusion criteria were only the major complications of airway management: death, brain injury, emergent surgical airway and new (or prolongation of) ICU admission. In total 36 events were reported from ICUs (approximately one major event for every six ICUs in one year) and 18 of the 38 deaths reported to NAP4 occurred in ICU. The NAP4 report was explicit in stating that avoidable airway deaths occurred. The project identified several issues of concern. Compared with the operating theatre setting, ICU was notable for failure to identify high-risk patients, higher rates of night-time events, management by unskilled trainees without a senior clinician, for failure to adhere to a structured guideline or plan of airway management and for a lack of (sometimes standard) equipment. The quality of airway management was judged to be poor during more events on ICU than in anaesthesia: including half of deaths

What should a specific ICU guideline address?

Firstly, when initial airway assessment suggests difficulty, the gold standard technique in anaesthetic practice is awake fibreoptic intubation.[20] This is rarely practical in patients who may already have acquired dependency on non-invasive pressure support, or who are confused, agitated, unstable or unconscious. Current anaesthetic airway guidance does not address either airway assessment or induction, in patients already dependent on advanced oxygenation techniques.

High-flow devices can deliver adequately heated and humidified oxygen at up to 70 L/min flow and may have a number of physiological benefits, including reduction of anatomical dead space, a continuous positive airways pressure (CPAP) effect and delivery of constant fraction of inspired oxygen.[21] In the anaesthetic setting high-flow nasal CPAP has acquired the acronym Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE), but this is the same technology as has been widely used for hypoxic critically ill patients for several years. In the elective setting there has recently been great interest in its ability to increase the period of apnoea before hypoxia occurs. This has enabled difficult airway management to be carried out unhurriedly, or even obviated the need to secure the airway during surgery.[22] However its effectiveness in preventing or delaying hypoxia during airway management in the critically ill is unproven. The published literature is limited in extent and quality.[23] Whether THRIVE and/or other methods of potentially prolonging safe apnoea time should be recommended requires careful consideration.[21]

In NAP4 the primary event leading to a major complication on ICU involved difficult or delayed intubation in almost half of the patients. In the ICU setting difficult and delayed intubation is often accompanied by rapid desaturation and instability. It would seem logical to start with the intubation strategy that most readily achieves laryngeal view and first attempt intubation. Videolaryngoscopy has been proposed as a standard of care by some authors but its implementation even in anaesthetic practice is limited, with predominant use as a rescue tool. Studies consistently demonstrate an improved view of the larynx with videolaryngoscopy, but the relationship between this and ease and speed of intubation is more complex.[24 25] Many current international (anaesthesia) guidelines advocate videolaryngoscopy use only when mask ventilation is adequate and an attempt to intubate using direct laryngoscopy has failed. On the one hand it seems logical to make your 'first go' your 'best go' and videolaryngoscopy has the potential to improve laryngeal view.[25] However videolaryngoscopy may slow intubation. This may be of little importance in the elective anaesthetic setting but in hypoxic critically ill patients the few extra seconds taken may contribute to significant hypoxia[24] and potentially worsen outcomes.[26]

The DAS 2015 guidelines place much emphasis on waking the patient when intubation fails. For the critically ill this is often simply not an option. While this may seem a small point, this entirely changes the intubation strategy, as once the patient is anaesthetized the intubator is committed to securing a definitive airway 'come what may'. This simple change of emphasis may have an impact on the choice of anaesthetic induction agent, neuromuscular blocking agent, primary intubation attempts and rescue techniques.

When airway management fails, the final common pathway is the front of neck airway (FONA). The DAS 2015 guidelines make a case for a standardized approach to FONA with the scalpel cricothyroidotomy, as it is judged to be likely the fastest and most reliable method of securing the airway.[7] Things may not be quite so clear-cut in the ICU. A significant number of patients will be managed at some point during their ICU stay with a tracheostomy, and this stoma may be an appropriate rescue route. Intensivists are also likely to be familiar with percutaneous tracheostomies and cricothyroidotomy and these skills may offer additional options when difficulty is encountered. Needle cricothyroidotomy and narrow-bore cannula techniques may be inadequate rescue therapies in the critically ill, as baseline physiological derangements may render the patient dependent on high levels of PEEP, inspired oxygen and inspiratory pressure to ensure adequate oxygenation.

Human factors and team dynamics are always important in management of crises.[3] Guidelines and cognitive aids are an opportunity to codify best practice into a digestible format, for the increasingly complex environment of our critical care units. The multidisciplinary nature of the ICU team provides numerous challenges including the potential interaction between junior and senior colleagues from different base-specialties. The DAS 2015 guidelines recommend a maximum of three attempts at intubation, accepting a fourth attempt by a more experienced colleague. In ICU the senior colleague may not be an airway expert (even if a consultant), expertise may arrive late to the event and appropriate actions may differ compared with the anaesthetic setting.

The development of new guidelines

Current anaesthetic guidelines for management of airway difficulty are not universally applicable to the critical care setting. There have been appropriate calls for guidance specific to critical care and currently no such national guidelines exist.[10 27] As part of the Royal College of Anaesthetists and The Difficult Airway Society's (DAS) response to NAP4, a multidisciplinary working party with representation from the Faculty of Intensive Care Medicine, The Intensive Care Society, DAS, the National Tracheostomy Safety Project, the British Association of Critical Care Nursing and the College is currently drafting such guidance. Further details of the project can be found at www.das.uk.com. We anticipate the guidance will be available in 2017.

Importantly, the lack of guidance may be contributing to morbidity and mortality, highlighted by a recent Coroner's report after an inquest into fatal failed intubation on ICU. The Coroner believed there is a risk of other deaths occurring in similar circumstances, mandating a response from stakeholders under regulation 28 (prevention of future deaths). The aim of new guidelines is to improve the safety of airway management in the critically ill, as it is clear that we cannot continue to manage the airways of elective day case patients and those at the margins of survival in exactly the same manner.

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Seeing is believing: getting the best out of videolaryngoscopy

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Almost half of all incidents reported to the 4th National Audit Project (NAP4) of the Royal College of Anaesthetists and the Difficult Airway Society (DAS) described airway complications that followed primary problems with intubation, including failed tracheal intubation, delayed tracheal intubation, and 'can't intubate can't oxygenate' (CICO) situations.[1] In addition, considerably more than half of the incidents reported to NAP4 involved problems with intubation as the airway incident progressed.[1] The recently published DAS 2015 guidelines emphasize the importance of the first attempt at laryngoscopy, with the aim of Plan A being to 'maximize the likelihood of successful intubation at first attempt, or failing that, to limit the number and duration of attempts at laryngoscopy, to prevent airway trauma and progression to a CICO situation.'[2] It is recognized that a suboptimal attempt at laryngoscopy is a 'wasted attempt' and that, if intubation fails, the chance of success declines with each subsequent attempt at laryngoscopy.[2–4] The importance of first-pass success is arguably even greater in the critically ill patient, when multiple attempts at intubation lead to high rates of severe hypoxia and other life-threatening (or life-ending) complications.[5]

Benefits of videolaryngoscopy

Videolaryngoscopy is undoubtedly one of the major advances in practical anaesthesia in recent years. At present, the main challenges are to determine to what extent it should penetrate routine clinical practice and to determine which devices are best. The progression from standard Macintosh laryngoscopes to videolaryngoscopes has been likened to the advance from standard mobile cell phones to smart phones.[6] Several editorialists have called for videolaryngoscopy to be a first-line technique for airway management.[7–10] Importantly, the role of videolaryngoscopy in difficult intubation has recently been recognized in the DAS 2015 guidelines, which recommend that all anaesthetists are trained in videolaryngoscopy and that all anaesthetists have immediate access to a videolaryngoscope at all times.[2] Videolaryngoscopy has been recommended for intubating obese patients,[3 11 12] a group known to have a higher risk of complications associated with airway management.[1 2] Beyond anaesthesia, predictions have been made that videolaryngoscopy will dominate the field of emergency airway management in the future.[4 7 13] It seems that cost is the main consideration holding back the tide.[7 9]

There are many reasons for such enthusiasm. Firstly, there are numerous technical benefits. Videolaryngoscopy gives the user a better view of the larynx than with a standard Macintosh laryngoscope (direct laryngoscopy).[2 6–8 12] This improved laryngeal view is the result of two factors: for videolaryngoscopes with Macintosh-shaped blades, a camera on the distal end of the blade gives an increased field of view compared with direct laryngoscopy, whereas for videolaryngoscopes with extra-curved blades, this increased field of view is augmented by the capacity to 'see around the corner' and gain a view of structures that are beyond the reach of Macintosh-style blades.[6] This improved view of the larynx is seen even with only minimal head and neck manipulation.[7 12]Appropriately chosen videolaryngoscopes are therefore beneficial for the management of both anticipated and unanticipated difficult laryngoscopy.[7 14 15] The force required when intubating with a videolaryngoscope is less than that required for direct laryngoscopy, resulting in less risk of trauma to soft tissues and teeth,[14 16–19] and a reduced incidence of sore throat.[18 19] Several videolaryngoscopes have a higher rate of successful intubation when used as a rescue device when direct laryngoscopy fails.[2 20–22] As most difficult intubations are not anticipated,[14 15] first-line use of videolaryngoscopy not only reduces the risk of difficulty, but, when this occurs, eliminates the need for the intubator to swap to another device when time and oxygenation are critical. The number of attempts at laryngoscopy can be kept to a minimum, and it is highly likely that unanticipated difficult intubation would be less frequent if videolaryngoscopes were used as a first-line technique.[7]

Secondly, there are significant training advantages associated with using videolaryngoscopes, though perhaps restricted to videolaryngoscopes that have a remote screen rather than one attached to the laryngoscope handle. When the trainer can observe the larynx on a screen while the trainee performs laryngoscopy, the trainer can help the trainee to optimize the blade position and advise the trainee on where to place the tracheal