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AIRWAY MANAGEMENT (LC BERKOW, SECTION EDITOR)

Airway Leads and Airway Response Teams: Improving Delivery of Safer Airway Management?

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Abstract

Purpose of Review Airway management remains a source of significant morbidity and mortality. This review considers recent summaries of complications and looks toward strategies to improve practice using a coordinated approach.

Recent Findings A safety gap can exist between national recommendations and local practice. A lack of attention to end tidal carbon dioxide has repeatedly contributed to airway mismanagement. Clinicians must be trained in newer airway devices (videolaryngoscopes or supraglottic airways) to use them effectively. Time must be found to teach rarely performed skills (e.g., front-of-neck access). Both larger and smaller hospitals have benefitted from an airway lead or response team, coordinating education programs, ensuring the adoption of guidelines, standardizing equipment, and recognizing the role of human factors and ergonomics.

Summary Even in the twenty-first century, the incidence of airway-related morbidity and mortality can be reduced, by an institutionally supported, coordinated approach to the whole process of airway care.

Keywords Airway safety · Airway leads · Airway response teams · Difficult tracheal intubation · Airway education and training · Human factors in airway management

Introduction

The importance of effective airway management, regardless of by whom or where this is performed, has been underlined in many publications [1–5]. Numerous guidelines have been issued and updated in several languages, all emphasizing the fundamental principle of patient oxygenation [6–16]. Despite this, reports of airway mismanagement continue to emerge [17–22]. Perhaps the most comprehensive report was the 4th National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society (NAP4) published in 2011 [23••]. It recorded the incidence of serious airway complications (death, brain damage, unanticipated ICU admission, and emergency front-of-neck access (eFONA) that occurred across three million anesthetics in the UK. A panel of experts analyzed the 184 cases that met these stringent criteria and made 168 recommendations across the fields of anesthesia, critical care, and emergency medicine for both adult and pediatric airway management to improve practice. In this article, we aim to describe systems in use around the world to help anesthesiologists and all who manage the airway, to integrate guidelines and new techniques safely and effectively into their clinical practice to deliver patient benefit.

Guidelines, Audits, and Analysis

Any airway guideline, audit, or analysis of practice represents a significant amount of work and contributes to our understanding of how airway management can best be conducted but also how it can go wrong and how people respond when it does. However, it is not possible to design randomized controlled trials of two different modes of airway management in an emergency situation. Analysis and audits can make recommendations, but these must be implemented to deliver effective change. A post-NAP4 survey demonstrated that many

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UK hospitals had implemented some of the suggested changes and recommendations but that there was still a "safety gap" between ideal and actual practice [24••]. Guidelines must not just be read and retained; guidelines must be delivered effectively in a time of crisis in order to ensure safe patient outcome [25]. The recent COVID-19 pandemic has produced a plethora of literature in the field of airway management, all of which try to guide safe practice [26–29]. These rapidly produced works are an important part of the response to the emergency situation. In themselves, they do not deliver safer airway management, but they must be used effectively in the clinical setting to improve care.

Lessons from Carbon Dioxide Monitoring

Not all improvements in patient care are new. Smalhout wrote his PhD thesis on capnography in 1967 [30]. The use of capnography was deemed mandatory by the Health Council of the Netherlands in 1978 [31]. "Failure to correctly interpret a capnograph trace led to several esophageal intubations going unrecognized in anesthesia." was a major finding in NAP4 [23••]. Despite this, further esophageal intubations have continued to occur, giving rise to the "no trace = wrong place" campaign which ran 50 years after the publication of Smalhout's thesis [32]. It reminded anesthetists that, even during a cardiac arrest, the presence of a completely flat capnograph trace mandates the exclusion of esophageal intubation. (The video can be viewed here https://www.youtube.com/watch?v=t97G65bignQ.) The benefit of capnography in detecting esophageal intubation is both simple and clear, and yet the message requires frequent reiteration.

Evidence-Guided Practice

The recent Cochrane review highlighted the benefits of videolaryngoscopy in performing successful tracheal intubation [33••]. However, surveys have revealed that not every hospital institution has access to these devices even in high- and upper middle-income countries [34–36]. Even when videolaryngoscopes are widely available, attitudes to their regular use vary among anesthetists in the same country [37, 38].

Adopting best practice in airway management must be a multifactorial process and is simplified in Fig. 1.

Using Training Time Wisely

The NAP4 report highlighted anesthetists' apparent inability or reluctance to perform eFONA in the Cannot Intubate, Cannot Oxygenate (CICO) scenario. Wong and colleagues suggested in 2003 that five manikin cannula cricothyrotomies

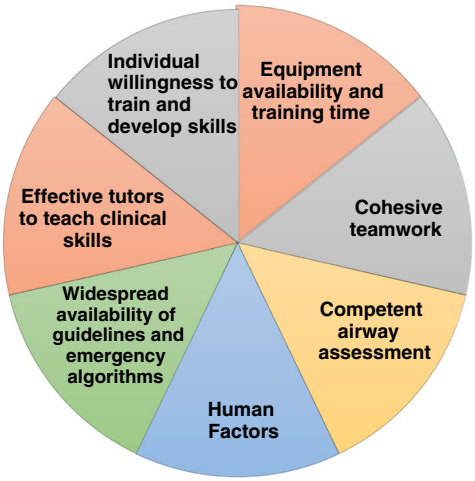

Fig. 1 Key steps in effective airway management

were a minimum training requirement [39]. McFetrich highlighted the potential role of simulation in rarely performed skills [40]. Harvey et al. demonstrated that having an action card helped candidates perform cannula cricothyrotomy in a high-fidelity simulation environment [41]. These findings have since been superseded by updated guidelines and meta-analysis which recommend scalpel-based techniques rather than cannula-based approaches [13, 42•]. This may require departments, individual airway managers, and their assistants to adopt a new skill for this rarely performed technique.

This creates at least four potential issues:

- The need to use the up-to-date available evidence to choose a deliverable technique.
- The need to teach the new scalpel-based technique to staff who may be comfortable with an alternative, but less effective, cannula-based technique.
- The need to release funding to replace one rarely used set of equipment with another rarely used set of equipment.
- The time spent teaching eFONA, while essential, reduces the length of time available for training and teaching in other skills such as supraglottic airway placement and videolaryngoscopy. These latter two skills if used effectively should reduce the likelihood of progressing to eFONA, leaving the tutor with the conundrum of balancing the allocation of teaching time between the three practical procedures.

Teaching awake tracheal intubation (ATI) also requires balancing education in two techniques. Evidence supports the use of videolaryngoscopy over conventional direct laryngoscopy, meaning that fewer difficult airways may be encountered. However, this success may decrease the opportunity to undertake the already infrequently practiced skill of ATI [33, 43, 44•].

Lessons from the American Society of Anesthesiologists' Closed Claims Project (ASACCP)

In Schroeder's 2018 series, the incidence of difficult tracheal intubation (DTI) appeared to be decreasing between 2002 and 2015 [45]. The rates of difficult and failed intubation fell from 6.6 (difficult) and 0.2 (failed) per 1000 cases between 2002 and 2008 to 1.6 (difficult) and 0.06 (failed) per 1000 cases between 2009 and 2015. This represents an approximate fourfold decrease. Was this due to improvements in provision of care, the adoption of guidelines, or the implementation of new technologies such as videolaryngoscopy? One way of assessing morbidity and mortality associated with airway management over time is by investigating the Anesthesia Closed Claims Database, a collection of closed anesthesia malpractice claims from the USA, established in 1985 [46].

Joffe et al. compared DTI closed claims occurring between 2000 and 2012 against those that had occurred between 1993 and 1999 [47••]. (This was the 2nd time period in the original closed claims analysis [22].) Events occurred throughout the course of anesthesia, with two-thirds of events, in both time periods, occurring around induction. This is not dissimilar to NAP4 where 52% of events occurred at induction. Considering just the 2000–2012 cohort, there are elements which further mirror themes in NAP4: awake tracheal intubation attempts failed and 20% of claims involved "systems" issues and lack of assistance, equipment, or effective communication about the airway. The ASACCP review panel felt inappropriate airway management was present in 73% of cases. Seventy-eight cases had verified predictors of difficulty, while 42 of these had two or more. The accompanying editorial concluded:

> "The majority of death or permanent brain damage related to difficult tracheal intubation occurred through insufficient knowledge (not recognizing risk factors for difficult airway management, and not knowing the guidelines), system failures (rescue equipment or people not being available), and delay in decision-making (such as progression to cricothyrotomy), and thus, these adverse outcomes could have been avoided" [48].

These are exactly the issues that difficult airway response teams and their airway lead counterparts should address. One must hope that a future closed claims analysis or NAP report would feature many fewer episodes related to failures in equipment provision, airway assessment, judgment, and equipment utilization.

Airway Leads and Airway Response Teams

An "airway representative" in every hospital to coordinate and improve airway training and practice was first suggested by Dr. Adrian Pearce in London in 2002, although it was not actioned until it reappeared as a NAP4 recommendation. The idea gained traction, and after endorsement by the Royal College of Anaesthetists, the Airway Leads Network was established in the UK [49]. Implementation of a network in Ireland and New Zealand followed, with a network under development in Australia [50, 51]. There is now a designated airway lead in over 97% of UK hospitals.

Separately, the concept of a Difficult Airway Response Team (DART) was being created in the USA [52]. Originally a quality improvement program, the first DART, was formed in 2005 at Johns Hopkins Hospital Baltimore, aiming to improve emergency airway management outside the operating room. From its inception, the DART was multidisciplinary and included anesthesiologists, surgeons from trauma and otolaryngology, emergency physicians, and risk managers.

The John Hopkins DART has an impressive track record [53••]. During the first 5 years (2008–2013), it was triggered 360 times, 29 emergency surgical airways were performed, and 62 patients were stabilized and transported to the OR for definitive airway management. There were no claims of malpractice, death, or morbidity lodged for adult patients with DART involvement. Programs similar to the DART have now been successfully implemented outside of Johns Hopkins including in pediatric hospitals [54–58].

Although the hospitals varied in size, all teams shared similar fundamental components:

- Multidisciplinary team
- Standardized airway cart
- Education program

The roles and responsibilities of Airway Leads and Airway Response Teams are similar and are compared in Table 1.

Although an Airway Lead is an individual, the role necessitates collaborative working. Just as a DART is multidisciplinary, airway education and equipment provision within a hospital require collaboration. Liaising with colleagues in the Critical Care and Emergency departments is a specific component of the airway lead role. This is not to dictate how airways are managed, but to promote the sharing of resources and expertise, improving airway management and standardizing airway rescue equipment everywhere. This allows for training material rationalization and more importantly allows one physician to assist another in managing an airway more effectively.

This can extend beyond an individual institution as hospitals in the same region, state, or teaching program can

Table 1 The roles of an Airway Response Team and an Airway Lead compared

Airway Response Teams [52, 53••, 54, 55]	Airway Lead duties [59]
• Coordinated response to difficult airway emergencies by: ○ Proactive identification of difficult airway patients ○ Delivery of standardized airway equipment within a specific timeframe ○ Utility of approved algorithms ○ Accurate documentation of events ○ Feedback and education to facilitate ongoing improvement • Reduction of morbidity and mortality from adverse airway events • Minimize liability of hospital from airway events • Enhanced education and communication • Disseminate information and evidence	• Oversee local airway training programs • Provision of, and easy access to, local algorithms for predictable difficult airways • Ensuring care providers airway assessment and planning are consistent • Establish consistency of equipment and practice across acute specialties (ICM/ED) • Participate in device procurement • Overseeing auditing of airway assessment, guidance adherence, and complications • Ensuring compliance with national airway audits • Evidence-based algorithm development for management of obese and aspiration risks

ICM intensive care medicine, *ED* emergency department

collaborate so their delivery of national guidelines uses similar devices. Commonly used devices such as second-generation supraglottic airways or bougies can have subtly different properties, and standardization removes the need to (re) learn their performance characteristics as staff rotate between hospitals [60, 61].

Human Factors and Effective Teamwork

One difficulty in the field of airway management is, although there is a clear binary outcome—successful or failed tracheal intubation—effective/ineffective ventilation of the lungs, the route to that position is very much dependent on teamwork and situational awareness particularly when difficulty is encountered [62•, 63]. It may be easier to teach a simple skill like the use of a videolaryngoscope with a part-task trainer, than engage in the complex task of understanding team dynamics. However, for successful airway management, the entire team must function as a unit—even though they may never have worked together before. This can be particularly true in a critical care unit where large teams of nurses are involved in the care of patients [64].

Human factors and effective teamwork might be considered as the same thing; however, we would argue that effective teamwork is the outcome when all of the factors that contribute to human factors in airway management are properly addressed. One example of this is to use the mnemonic ARACHNID:

- **A**lgorithms
- **R**esilience: prevent a critical incident occurring, deal with one when it does more effectively, and to manage the aftermath following an incident
- Cognitive **A**ids: structured pieces of information designed to enhance cognition and adherence to medical best practices
- **C**hecklists
- **H**andover tools
- **N**ontechnical skills, including communication, teamwork, situational awareness, avoidance of task fixation, leadership and followership, flattening hierarchy, and stress management
- **I**ncident investigation
- **D**esign of our operating rooms, theater suites, etc. to easily facilitate good practice

(The Airway Spider, after Kelly et al. [65])

While human factors and ergonomics are not specifically described in the role of an Airway Response Team or Airway Lead, they are an integral part of improving safety in airway management. Consider the investigation of an airway incident, this should be done by the Airway Lead or Airway Response Team. Additionally, they can offer support to the involved individuals and where necessary make decisions about the training and equipment provision within their hospital to minimize the risk of incident recurrence in the future.

Training and Education

Training is a fundamental component of both roles, and there are many strategies for engaging the medical learner [66]. This could range from clinical teaching within the OR to high-fidelity simulation. However, any institution must consider how it can most effectively educate its target group with the resources available.

High-fidelity simulation allows not just the demonstration of practical skills but also the integration of the whole team into the process and the development of nontechnical skills [67–69]. If time is available, the team can take turns at playing each other's roles in order to get an understanding of how an evolving airway emergency feels from another perspective. High-fidelity simulators are resource-intensive and require time away from the workplace for both staff and instructors, and the benefit to the organization must be carefully considered, especially as recent research has questioned the absolute benefit of high-fidelity simulation, at least in certain environments [70]. Lectures have the advantage of delivering educational content rapidly to a large group but do not allow the attendees the opportunity to practice with any airway equipment discussed or demonstrated.

In a busy department with an active interest in airway management, training may consist of a variety of workstations focusing on different aspects of airway management attended by a wide number of staff released from their normal duties. Smaller institutions, or those beginning their journey to improve practice, where tutors may neither be so confident nor in such plentiful supply, may instead choose to show a video on a particular airway technique and then discuss how it can be applied locally.

Simple educational interventions like the Bath Tea Trolley Project or Trachy Tracey are much lower cost solutions than immersive simulation [71, 72]. They were both small-group teaching tools tailored to overcome educational obstacles and knowledge gaps within the local clinical area. Both concepts could be delivered without the need to remove staff from the workplace meaning that many staff could be educated in a reasonably short space of time. However, even these approaches have drawbacks, as staff may not be totally focused on the teaching intervention as it is during clinical time. Conversely, staff who have engaged fully with the teaching episode may find it hard to immediately refocus on clinical issues.

Staff who attended an airway training event should always be asked to provide feedback. By including questions "What did you learn?", "What remains unclear?", and "What are you going to do? rather than just tutor ratings, it is easy to identify those areas where more educational input is required. Airway Leads must choose the right educational intervention to address the needs of staff that can be delivered in their institution for effective learning to take place.

The Role of the Institution

Despite adherence to national guidelines and agreed protocols, no hospital can be directly compared with another institution no matter how similar they may appear. For Airway Leads or Airway Response Teams to effectively improve airway management, they must have the support of their local hospital. Agreement from a hospital's senior management team will determine how much time staff are allowed away from clinical areas to participate in training and how much budgetary allocation is made not just for the purchase of new clinical equipment but also for the purchase of supporting training devices and manikins.

Where new equipment is purchased, the funding must include the cost of regular use in the clinical environment to allow staff training and familiarization. While new equipment may incur a cost, standardization of airway carts and trolleys may allow an institution to save money (stocking fewer pieces of equipment) while delivering a safety dividend—restricting the choice of devices available to clinicians in an airway emergency will increase the institutional understanding of the available equipment and clarify the decision-making pathways.

Similarly, institutional support is vital to allow the effective implementation of new or updated national guidelines (where capital purchases may have to be considered) or changes in local practice that come about because of an incident review or a morbidity and mortality meeting. Such incident reviews should also be used to identify examples of good practice that are as important to disseminate as those that cause morbidity.

Justifying the Establishment of the Role

While airway management is a core component of anesthetic practice, the establishment of a new team requires the investment of potentially limited resources to purchase potentially rarely used equipment as well as clinical time commitment. The need for this will rightly be challenged by hospital management committees and leadership. Many airway response teams arose from quality improvement initiatives, where the scale of the problem was identified and described before the establishment of a team could be considered. Any team must not replicate the roles of other hospital response teams but serve to meet a clinical need which will deliver patient benefit and potentially reduce adverse outcomes.

Similarly, hospital departments must be willing to share ownership of the team to realize the benefits of multidisciplinary teamwork, but also so that the financial burden of this improvement can be shared.

Ongoing audit of the team's activity is a vital part of any Airway Response Team's success. The team at Johns Hopkins collected demographic information, patient characteristics, potential risk factors for difficult airway, morbidity and mortality information, DART response time, communication processes, airway techniques used, equipment issues, sentinel events, and malpractice claims and demonstrated clear benefit [52]. This last field may be the most effective at demonstrating

team success to leadership, as a decreasing number of claims demonstrate patient benefit while also reducing hospital costs.

The Benefits of a Network

Although we have encouraged the idea that the Airway Lead or Response Team should represent a cohesive train of airway thought within an institution, they present an opportunity to share examples of best practice [73••]. Sharing local success stories allows good practice ideas and behaviors to flourish in other institutions but also allows them to be adapted to an individual hospital's requirements and capabilities. Airway Leads days have been held in the UK, Ireland, and New Zealand and have dealt with issues around training, procurement, and safety. Topics and ideas such as Trachy Tracey, the Bath Tea Trolley Project, the "no trace=wrong place" campaign, and even institutional preparedness for the pending COVID-19 pandemic were all shared, discussed, and disseminated at an Airway Leads meeting [32, 71, 72].

First Steps

Any program to improve airway management is multifactorial and multidisciplinary. Gathering clinicians from all specialties who have an interest in improving the standard of airway management across an institution is a necessary first step. This could be followed by a relevant audit of practice to identify areas where improvements to practice are needed. The so-called gap analysis described by Cook et al. [24••] is a good starting point—however, it is crucial that the early steps in the development of the program are achievable within a defined timescale. This will depend on the level of institutional preparedness and expectation and must be determined locally.

The incidence of adverse events in the field of airway management has been clearly documented in recent years. However, with the increasing uptake of Airway Leads programs and Airway Response Teams, there is a genuine opportunity to decrease the frequency of airway-associated morbidity and mortality, by improving the quality of airway education and training delivered locally, nationally, and internationally.

Conclusions

1. Despite the myriad of guidelines in airway management, analysis of adverse events shows that airway incidents still feature prominently.
2. Local implementation of strategies to improve airway care at an institutional, departmental, and a personal level is one way to address these issues and implement national advice.
3. An analysis of safety gap issues may be a good starting point.
4. Airway care providers come from a wide range of disciplines, and while a centralized individual (an Airway Lead or Airway Response Team) is a good idea, this is best delivered by multidisciplinary agreement.
5. Institutional acceptance of the need for such a program is important and allows for the provision of learning and teaching time, new equipment, and audit resources.
6. Human factors are an important feature of effective airway management, and novel ways of teaching them to everyone involved in the airway management team must be developed.
7. Although a local innovation, Airway Leads and difficult Airway Response Teams may be at their most effective when they collaborate and share learning nationally.

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Compliance with Ethical Standards

Conflict of Interest Carolyn Smith declares that she has no conflicts of interest. Alistair F. McNarry has received compensation from Medtronic for participation in an advisory board and an industry education session on videolaryngoscopy; has received reimbursement for travel expenses from Fisher & Paykel Healthcare; and is the Airway Leads Advisor of the Royal College of Anaesthetists and Difficult Airway Society.

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- •• Of major importance

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