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Respiration and the Airway

RESPIRATION AND THE AIRWAY

The evolution of airway management – new concepts and conflicts with traditional practice

A. F. McNarry[1,*] and A. Patel[2]

[1]NHS Lothian, Edinburgh, UK and [2]Royal National Throat Nose and Ear Hospital and University College London Hospital, London, UK

*Corresponding author. E-mail: althegasman@btinternet.com

Abstract

In the last 25 yr, there have been several advances in the safe management of the airway. Videolaryngoscopes and supraglottic airways, now in routine use by new trainees in anaesthesia, have had their genesis in the recent past. The 4th National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society published in 2011 a seminal report that has influenced airway management worldwide . Understanding how the report's recommendations were constructed and how clinical guidelines compliment rather than contradict them is important in understanding the tenets of safe airway management. Over the last 25 yr there has been an increasing understanding of the effects of human factors in anaesthesiology: we may not perform in a predictable or optimal manner when faced with unusual and threatening challenges. The place of cricoid pressure in anaesthetic practice has also evolved. Current recommendations are that it be applied, but it should be released rapidly should airway difficulty be encountered. The need to prevent hypoxaemia by preoxygenation has long been recognized, but the role of high-flow nasal oxygen in anaesthesia is now being realized and developed. Clinicians must decide how novel therapies and long-standing practices are adapted to best meet the needs of our patients and prevent harm during airway management.

Key words: airway management; laryngeal mask airway; oxygen, Inhalation therapies; intubation, endotracheal

Airway management is the cornerstone of anaesthetic practice, and virtually every anaesthetic innovation in the past 25 yr has had an impact on some aspect of airway care. Pulse oximetry, sevoflurane, remifentanil, disposable equipment, rocuronium and sugammadex have all altered clinical practice. The challenge when considering these innovations is knowing how they will effect clinical practice in the next 25 yr.

Supraglottic airway devices

Brain's description of the classic Laryngeal Mask Airway[1] (cLMA, manufactured by Bivona and initially distributed by Colgate Medical) in the *British Journal of Anaesthesia* in 1983 was not the first description of a supraglottic airway,[2] but it was and still remains a revolution in safe airway management. In Verghese and Brimacombe's 1993 study[3] the cLMA was being used in almost one third of cases with a success rate of 99.8%. They noted that fewer than 5% of patients had a laryngeal mask *in situ* for procedures lasting more than two hours. By the time of the 4th National Audit Project (NAP4), supraglottic airway devices (SADs) were being used in 56.2% of general anaesthetics.[4] In 2017, a case series described SAD use in patients for up to 11 h.[5]

Similar SADs were developed by other companies, and an entirely new nomenclature based on the seal of the mask with the oropharynx (oropharyngeal leak pressure) was created.[2 6 7] Underlining its place in safe airway management, the term

Laryngeal Mask Airway became a MeSH keyword in 1993. Brimacombe reported there were 295 articles, abstracts or chapters featuring the cLMA in 1994 alone.[2]

Supraglottic airway devices enable anaesthetists to be hands-free during a procedure, but the cLMA's success was as a result of more than its labour-saving properties. Brain stated it is likely to be 'of particular value where difficulty is experienced in maintaining the airway'. The increased interest in the potential of day surgery[8] and the availability of propofol as an emulsion in 1986 were also major contributors to the success of the device (the original description recommended its use after thiopental and alcuronium 0.2 mg kg^{-1}). By 1988 the benefit propofol offered in terms of suppression of pharyngeal and laryngeal reactivity over thiopental was reported,[8] and its use advocated.[9] Brain's contribution to anaesthetic practice has already been celebrated as the cLMA reached its 30th birthday,[10 11] and the impact of his innovation cannot be overstated. This article, however, looks forward to the next 25 years.

Amidst the technological and clinical research that underpinned the development of SADs some simpler innovations have also revolutionised anaesthetic practice. The Aintree Catheter facilitates tracheal intubation through a SAD.[12–16] It was originally described as a 'disposable plastic tube', although it was cleverly designed to be just shorter (by 3 cm) than the length of the cord on a fibrescope allowing continued manoeuvrability of the fibrescope tip.[17] A guide to its use can be found at *http://www.das.uk.com/files/AIC_abbreviated_Guide_Final_for_DAS.pdf* (accessed 7 October 2017). Supraglottic airway devices can also be used to facilitate tracheal intubation directly[18–20] and have an important role in rescuing failed intubation.[21 22] Since the manufacture of the LMA Proseal, various devices have also offered enhanced separation of the respiratory and gastrointestinal tracts. They have even been used as the primary airway for Caesarean section.[23] Although blind intubation techniques are possible through devices such as the intubating laryngeal mask,[24] reports of harm[25] and the wide availability of fibreoptic equipment in the UK,[26] have made such techniques redundant.

Examples of SAD use in 'extreme circumstances' such as a bridge to extubation in the ICU,[27] managing the airway for cardiac surgery,[28] or for surgery in the prone position both electively[29 30] and with unexpected extubation[31] are reported. Clinicians must decide when to choose a specific device, not just based on how it works, but on how likely it is to fail.[32] Individual anaesthetists must combine their knowledge of a device's performance alongside their ability to use that device effectively in each situation.

Ramachandran's study[33] of 15,795 uses of the LMA Unique reported a failure rate of 1.1%, but if an anaesthetist does around 400 cases per yr and works for 30 yr as a consultant, it will take years for one individual to generate adequate data to prove the safety profile of a single device. Cook suggested a scoring system for choosing the best SAD[34] based on seven factors from the presence of a sore throat to overall insertion success. With the perpetual advent of new devices, findings rapidly become out of date but it is the methodology that must be retained.

The Difficult Airway Society's ADEPT (Airway Device Evaluation Project Team) process[35] set out a framework whereby airway equipment should be evaluated using at least level 3b (single case control or historical control) evidence. This level of evidence could then be used to inform purchasing decisions, based on properly conducted trials rather than evaluations with small numbers. Despite interest and ongoing work in this area, a UK-based study specifically using the ADEPT methodology has yet to be published.

How then does the clinician proceed? For instance, is the LMA Protector[36] a better device than the Intubating Laryngeal Tube with Drain Tube (iLTS-D; https://www.vbm-medical.com/products/airway-management/intubating-laryngeal-tube-ilts-d/; accessed 7 October 2017)? Does the Baska Mask[37 38] with its self-sealing cuff provide a better airway than any other? Which is the best SAD to use for airway rescue after failed tracheal intubation? Is one family of devices as effective in adults and children?

Clinicians must prioritise three issues: 1. Effective oxygenation and ventilation; 2. Minimizing aspiration risk; and 3. Ability to insert the device effectively without resorting to complex methods or repeated attempts. Cost, educational opportunities and the likelihood of airway trauma also inform any choice. Regular rehearsal and clinical experience with any device will improve its utility. Brimacombe found that as many as 750 LMA insertions were required to overcome the long-term learning curve of the cLMA.[39]

Videolaryngoscopy

Many regard Jack Pacey, the vascular surgeon who invented the Glidescope[40–42] in 2001, as the father of videolaryngoscopy (VL). However, optical devices designed to facilitate difficult tracheal intubation existed before this date. Katz and Berci[43] coined the phrase Optical Stylet in 1979. Regardless of their history, videolaryngoscopes are effective. A retrospective analysis by the Multicenter Perioperative Outcomes Group[44] reported 92% success using a videolaryngoscope as a rescue device after failed intubation. A Cochrane Review[45] comparing videolaryngoscopy with direct laryngoscopy stated 'statistically significantly fewer failed intubations were reported when a videolaryngoscope was used', and 'there were fewer failed intubations in those with an anticipated difficult airway when using a videolaryngoscope'. Reassuring as these statements appear, they were made based on 38 studies with 4127 participants and six studies with 830 participants, making the average number of participants per study 108 and 138, respectively.

Studies of videolaryngoscopy generate their own issues. Studies using tracheal intubation success as their primary outcome measure require many subjects (>1,000) in each arm to effectively demonstrate superiority of one device over another, if the VLs studied are 98% - 99% effective. This need for large numbers has led to several studies that looked at surrogates of intubation difficulty, such as time to intubation,[46 47] or the success rates of novices or medical students.[48] Similarly, given the relatively low incidence of difficult intubation in the general population, studies have chosen to use manikins,[49 50] simulated difficulty,[51 52] or anticipated difficulty rather than actual difficulty. This myriad of inclusion criteria has led to some potentially conflicting results. For instance, a meta-analysis of the Pentax AWS[53] *vs* Macintosh laryngoscope in 2014 suggested that despite a superior laryngeal view, the Pentax Airway Scope provided little clinical benefit over a conventional laryngoscope.

Cook's suggestion[54] that devices should be studied sequentially from manikin to human subject has merit, although this is perhaps not directly applicable to VLs. In a meta-analysis,[55] only 13% of 'non-standard' laryngoscopes had been tested on patients with anticipated or known difficult airways. Mihai and colleagues[55] then suggested that multicentre collaborations are likely to be needed, studying known difficult patients to fully understand these devices. A taxonomy describing VLs has been developed[56] by Healy and colleagues (Fig. 1). While some parts of this are already redundant (the Ctrach, a laryngeal mask with a camera