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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

tube by pointing out necessary landmarks on the screen.[9] As the view of the larynx can be seen by trainee and trainer, and the technique can be optimized in real time, it is more likely that a trainee will be able to complete an intubation themselves without the trainer taking over.[23] This is especially useful for rapid sequence inductions and in patients at risk of hypoxia.[9] Whether the trainee is 'allowed' to see the screen or simply to use the videolaryngoscope for direct laryngoscopy (with reference to the screen only if difficulties are encountered) can be decided according to training aims. Five studies have now demonstrated that training novice intubators in direct laryngoscopy is more effective when the trainee uses a videolaryngoscope rather than a standard Macintosh laryngoscope.[7 9 24–27]

Thirdly, there are non-technical or human factors advantages associated with videolaryngoscopy, again seen best with devices that have a separate screen. The whole team can see the view of the larynx, improving teamwork and communication. The anaesthetic assistant can see when the intubator is struggling much earlier and can anticipate the 'next step', ensuring that the necessary equipment is immediately to hand.[7 9 23 26 27] When applying cricoid force, the anaesthetic assistant can assess whether this is improving the view of the larynx or, conversely, displacing or even compressing the larynx and making the view worse, and can immediately adjust the direction and degree of cricoid force as necessary.[23 26] Videolaryngoscopes can help trainee anaesthetic assistants to learn how to perform cricoid pressure, with their supervisor directly supervising them and helping them to adjust it as needed. The fact that the whole team can see the tracheal tube pass through the vocal cords, rather than only the intubator, provides clinical governance advantages. One author has described this as 'multi-person visualisation'.[7] In our experience, it simply changes difficult airway management from 'I' to 'we'.

Fourthly, the ability to record the intubation as a 'digital airway record' has advantages. It may be useful for training (to review with a trainee at leisure) or as part of the medicolegal records.[6 28] New medical diagnoses, such as vocal cord malignancies, have also been made with use of videolaryngoscopy during training.[29]

Finally, emerging evidence hints at benefits for the anaesthetist in addition to the patient. Grundgeiger and colleagues[30] demonstrated an improvement in the intubator's 'total body position' when using videolaryngoscopy compared with direct laryngoscopy.

As described, these advantages are likely to be even more important when intubating critically ill patients, such as in the intensive care unit, where airway management is especially high risk.[5 31 32] In the NAP4 report, complications of airway management were up to 60 times more likely to occur in the intensive care unit than in the operating room, and when they happened they were more likely to result in death or brain injury (61%) than incidents occurring in the operating room (14%).[33]

Types of videolaryngoscope

There are now a large number of videolaryngoscopes available, with the number constantly increasing and many existing devices being modified. Although this can create a confusing picture, the devices can be broadly classified into the following three groups: (i) devices with a Macintosh-like blade, such as AP Advance (Venner Medical International, St Helier, Jersey, UK), C-MAC (Karl Storz Endoscopy, Slough, Berkshire, UK), GlideScope MAC (Verathon Medical, Bothwell, WA, USA), and McGrath Mac (Aircraft Medical, Edinburgh, UK); (ii) devices with an extra-curved blade, such as AP Advance with difficult airway blade (Venner Medical), C-MAC D blade (Karl Storz Endoscopy), GlideScope (Verathon Medical), King Vision with standard blade (Ambu, St Ives, Cambridgeshire, UK), and McGrath Mac with curved blade (Aircraft Medical); or (iii) devices with a channelled blade (conduited VL), such as Airtraq (Teleflex, Morrisville, NC, USA), Pentax AWS (Ambu), and King Vision (Ambu).

It is highly likely that not all videolaryngoscopes are equal, and it is therefore important to understand which videolaryngoscopes perform better than others.[34] However, the current evidence base has focused on comparing videolaryngoscopy with direct laryngoscopy, and there is little high-quality evidence regarding the relative performance of different videolaryngoscopes at present. Mihai and colleagues[35] published a meta-analysis in 2008, but were unable to draw clear or useful conclusions regarding which performed best, reporting that most studies were of poor quality and that the vast majority of studies did not include truly difficult patients. A Cochrane meta-analysis on the topic is in progress.[36] Manikin studies and numerous small patient studies shed little light on the topic, and there are no large randomized controlled trials to date. Co-ordinated efforts to collect comparative clinical data would help to guide implementation.

Clinical pearls in videolaryngoscopy

Despite the many advantages described here, there are potential pitfalls that may be encountered when using videolaryngoscopy, most of which are readily avoided with care and knowledge. We propose the following 'rules of videolaryngoscopy' to help maximize the benefit the intubator can gain from using these devices.

Rule 1: experience with a standard Macintosh laryngoscope does not equate to skill with a videolaryngoscope

The technique for videolaryngoscopy (particularly with extra-curved and conduited blades) differs from that for direct laryngoscopy, and manufacturers' recommended techniques for many videolaryngoscopes differ from each other. This has important implications. Experienced anaesthetists, skilled at intubation using a Macintosh laryngoscope, cannot expect to be able to use a videolaryngoscope effectively without training and practice. Although some reports describe very short learning curves,[7 27] Lafferty and colleagues[15] reported that 76 intubations with a GlideScope were needed to achieve competence.[37] The 2015 DAS guidelines emphasize the need for all anaesthetists to be trained in the use of videolaryngoscopes. Given that trainee anaesthetists rotate to different hospitals, they will also need to be trained fully in the videolaryngoscope(s) available at each hospital.[2] This is likely to require an increase in formal training in these techniques.

Of note, videolaryngoscopes with a Macintosh-type blade can be used for both direct laryngoscopy and videolaryngoscopy and do use a similar technique, giving them an important advantage for training. The videolaryngoscope blade is inserted into the oral cavity using the standard direct laryngoscopy technique, and the glottis can then be seen either under direct vision or on a video screen.

Rule 2: experience with one type of videolaryngoscope does not equate to skill with all videolaryngoscopes

There are numerous different designs of videolaryngoscopes, and several require different techniques for use.[35] For example, the C-MAC is designed to be used as a standard Macintosh laryngoscope, while the GlideScope is inserted along the centre of the

tongue without the need for tongue displacement.[7] Insertion depth and direction of applied forces for the Airtraq and many extra-curved videolaryngoscopes differ markedly from direct laryngoscopy. These devices generally need to be inserted less far and require the blade to be lifted vertically once it is in the correct position, rather than along the axis of the laryngoscope handle, as with direct laryngoscopy. This again has implications for training and patient safety. Research to establish which videolaryngoscopes perform best would reduce this burden and, in the meantime, hospital networks may decide to unify choice of videolaryngoscopes to minimize training needs.

Rule 3: a good videolaryngoscopic view of the vocal cords does not guarantee easy intubation

This is true for all videolaryngoscopes,[7 15 31] but especially true for videolaryngoscopes with extra-curved and channelled blades.

Lafferty and colleagues[15] reported that 'gaining a view of the vocal cords "is the easy part" ' when using a videolaryngoscope. Training, regular practice, and use of device-specific adjuncts are required to ensure that an improved view of the larynx translates reliably into successful tracheal intubation.[2 38]

Extra-curved blades deliver an improved view of the larynx but also prevent direct visualisation of the larynx, which is one reason why they are useful for difficult intubations but slow down easy intubations. These devices require routine use of an intubating adjunct to deliver the tip of the tracheal tube to the larynx. Inexpert use of these devices may lead to intubation failure and airway trauma.[39] Some manufacturers specifically recommend and supply bespoke stylets.[40] However, use of stylets has perhaps fallen out of fashion in many countries, and poor use of stylets, particularly around the 'blind spot' found when using extra-curved videolaryngoscopes, may increase the risk of trauma during intubation.[39 41] New skills may be needed to use such stylets safely and effectively.[15] Other cost-effective options include tubes and stylets that can be flexed dynamically during intubation.[42–45]

Conduited devices with a channelled blade require not only 'a view of the larynx' but an 'optimal view of the larynx' because only this ensures that the tracheal tube is directed correctly through the guide channel towards the larynx. A partial or non-optimal view will lead to the conduit reliably directing the tube away from the larynx. These devices also require a tube of appropriate type and size for a given conduit for intubation to succeed.[46]

Rule 4: a bougie may not be the solution when there is difficulty

Although many anaesthetists will be familiar with using a bougie for assisting direct laryngoscopy, and its use with videolaryngoscopy has been advocated,[47 48] there are limitations to this technique. When using an extra-curved videolaryngoscope, the bougie has a tendency to uncurl during passage towards the larynx, leading to failure; this is particularly true when using modern disposable bougies, which often lack the plasticity ('memory') of the original gum elastic bougie.[49] The curvature of the tracheal tube may be maintained to match the shape of the blade with a curved stylet.[15 50–53]

A particular problem with a conduited videolaryngoscope is that, because of the small diameter of a bougie, it tends to cut across the curve of the conduit and pass posteriorly (as do smaller than intended tracheal tubes).[44] Perhaps counterintuitively, sometimes the solution to a posteriorly passing tracheal tube with a conduited device may be to change to a larger tracheal tube or smaller laryngoscope, both of which tend to increase anterior curvature of the tube during passage.

Rule 5: the videolaryngoscope chosen must be selected according to indication

There is little evidence about which device should be chosen for which situation;[7] however, we offer the following practical advice.

If a videolaryngoscope is being chosen to use as a rescue device when intubation with direct laryngoscopy is unsuccessful, it would be advisable to choose a videolaryngoscope with an extra-curved blade (with or without a conduit), which increases the chance of seeing 'round the corner' in this situation.

If, however, a videolaryngoscope is being used for training purposes (especially to train novices in direct laryngoscopy), we would suggest choosing one with a Macintosh-shaped blade, because direct laryngoscopy cannot be taught appropriately with an extra-curved device and such training is supported by evidence.[7 9 24–27] It would also be advisable to choose a videolaryngoscope with a screen separate from the laryngoscope handle in this situation, because this makes it easier for the trainer to observe the actions of the trainee and also enables teaching of other members of the theatre team.

If a videolaryngoscope is being used for general everyday practice, it may be best to choose a videolaryngoscope which has the option of using both a Macintosh-shaped blade and an extra-curved blade; at present, videolaryngoscopes from the manufacturers Aircraft Medical, Storz, Venner, and Verathon all provide both options.

If a videolaryngoscope is being used in a prehospital setting, a device where the screen is attached to the laryngoscope handle and one that has a screen that is visible in direct sunlight is likely to be more practical. Such devices include the Airtraq with iphone attachment, AP advance, C-MAC Pocket Monitor, King-Vision, McGrath Mac, and Pentax AWS.

If a videolaryngoscope is being used when there is blood in the airway or when the airway is heavily soiled, a videolaryngoscope that can be used for both direct laryngoscopy and videolaryngoscopy may be the most appropriate. The videolaryngoscope camera may become fogged or obstructed in this situation, but the operator may then fall back on the direct laryngoscopy function if necessary.[10]

Bearing in mind the advantages listed above, we agree with other authors that there is now a robust argument for videolaryngoscopy to be used for all intubations.[6 9 10] If videolaryngoscopy were used for all patients, experience and skill with the techniques would undoubtedly increase, and the evidence would suggest that the number of attempted intubations would decrease, complications of multiple attempts at intubation would reduce, and patient care would improve. The biggest impediment to this is likely to be cost.[6 9] However, when the costs of managing the delays, alternative techniques, and complications of difficult or failed intubation are considered, the gap is not as large as might be expected.[54]

In summary, videolaryngoscopy is a potential step change advance in anaesthesia, but its introduction needs to be accompanied by appropriate training of all anaesthetists; not only trainees, but also trained and experienced intubators. The potential benefits of videolaryngoscopy for patients are numerous and significant.

Authors' contributions

Preparation of first draft of manuscript and subsequent review of manuscript: F.E.K.
Review of manuscript: T.M.C.

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Declaration of interest

None declared.

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Is it time for airway management education to be mandatory?

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Complications secondary to airway management in anaesthesia are relatively rare but when they do occur, the causal and contributory factors are often attributed to human error related to inadequate training and poor judgement by the anaesthetist.[1] These complications continue to occur despite competency-based medical education curricula and detailed practice guidelines.

One criticism of competency-based medical education is that it applies primarily to trainees and focuses too much on the