Video laryngoscopy—is there evidence of improved outcomes?

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"Disruptive innovation transforms the market by introducing simplicity, convenience, accessibility and affordability where complication and high cost are the status quo?"—Clayton M. Christensen

Is video laryngoscopy (VL) disruptive, evolutionary, revolutionary or just a passing fancy? Does it re-invent laryngoscopy and intubation by improving meaningful clinical outcomes or simply increase the cost of providing care? We might compare direct laryngoscopy (DL) and VL to the stethoscope and ultrasound (US). We might also be tempted to think that ultrasound (or VL) may be appealing to the developed world but too expensive for emerging or less developed economies yet as pointed out in an editorial, US is used by the Himalayan Rescue Clinic, midwives in Rwanda, Zambia and Liberia, a refugee camp in Tanzania and was involved in approximately half of the clinical decisions following the Haitian earthquake in 2010.[1] Extending the analogy further, a recent article indicated that US has been adopted by 24 specialties and is part of the core competency in many training programs.[2] Likewise, some of the strongest advocates for VL have been non-anesthesiologists.[3-8] Is this technology better suited for non-experts or can we all benefit?

Early investigations of VL were difficult to interpret. Patient selection, operator training, different versions of devices, the professional relevancy of operators and clinical outcomes and non-standardized definitions all confounded interpretation. Many devices were evaluated on manikins and trials were conducted using naïve laryngoscopists. A 2008 meta-analysis found little evidence to support the replacement of DL by "non-standard laryngoscopes" for routine or difficult intubation[9] yet that same hospital did exactly that a few years later (*personal communication, TM Cook, April 2015*). The challenges in drawing conclusions and the need for better information was highlighted in a subsequent editorial.[10] Although the authors advocated wholesale data collection, it is important to appreciate that this approach may lead to unfortunate conclusions resulting in discarding useful devices because of inadequate prior training. We cannot assume that competency with DL automatically qualifies a user to perform with a VL. Provision of a superior laryngeal view is important but it is useless to an anesthesiologist if he is unable to intubate. On the other hand, intubation when the larynx cannot be visualized is largely a gamble, which we make on behalf of a non-consenting patient. Should VL be used for routine, difficult or rescue purposes? Should simulated difficult airways (e.g. MILS, cervical collar) be grouped with known difficult airways? What are the potential benefits and disadvantages of VL? Is it reasonable to consider all the devices as a

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common entity? How can we exploit the advantages and minimize the disadvantages? How do we obtain and maintain our expertise with old and new devices? What are meaningful outcomes?

What is a difficult intubation?

The definition of a difficult laryngoscopy is problematic. A dichotomous classification is misleading. Terms such as difficult and awkward are not standardized. Difficulty is probably best defined using multiple parameters along a continuum[11] that include but is not restricted to the laryngeal view. Adnet's Intubation Difficulty Scale (IDS) classified a moderately difficult intubation as a score of ≥ 5 which he encountered in 6.3% of OR intubations and 16% of attempts outside the OR. Regarding laryngoscopy, if it does not reveal the larynx, it is "not difficult"—it is a *failed laryngoscopy*, even if intubation succeeds. Blind success is largely good fortune. A meta-analysis involving 35 high-quality studies and over 50,000 adult laryngoscopies on patients with seemingly normal anatomy yielded no laryngeal view in 5.8% (95% CI 4.5-7.5) of attempts. Bedside predictors of difficulty had poor specificity and sensitivity.[12] More recently, a Danish study found that difficult intubations were unanticipated in 93% of over 3154 patients (of 180,000 attempts).[13] Expectations of difficulty were confirmed in 229/929 (25%) attempts.

Failed laryngoscopy is common. Expect the unexpected. Never fail to prepare for failure.[14]

What outcomes are meaningful?

Early studies assumed that if you could see the larynx, you could intubate it, however we found that 14/26 failed intubations (722 patients) occurred despite a good or excellent laryngeal view.[15] Although others have observed the same, it is my contention that for most, this problem largely disappears when the specific manual tasks are better understood.[16] Although some acquire this dexterity more readily, practice is important. Aziz demonstrated significantly better performance in OHSU (Portland OR) where the GlideScope was more frequently used, compared with UMHS (Ann Arbor MI).[17]

A good view is better than no view, but it's not enough.

Expertise is not acquired by proximity or osmosis. It requires practice.

Studies on plastic manikins are of limited value.[18] Manikins do not produce fogging, regurgitate or bleed; some have almost no vallecula, others have a floppy epiglottis or excessively compliant tongue; manikins from the same manufacturer (fraternal twins) or of the same design (identical twins) may differ; some become brittle and others more compliant with use. Manikins have some utility in helping new users acquire dexterity or simulating rare events but are of limited value when comparing devices.

Other outcomes have included overall success, time to tracheal intubation, the number of required attempts and the number of esophageal intubations. In the ICU[19] and the ER[20] first pass success (FPS) is associated with significantly fewer complications. This begs the question about whether a single, longer attempt is safer. Likely such an effort will depend upon the patient's ability to withstand apnea and the sustained stress of laryngoscopy. FPS is an important outcome but should not be considered in isolation.

Are the outcomes relevant to your practice?

Operators

How closely do the providers, match those of your institution?

Did an entire department participate and were the operators adequately trained and experienced with the device in question? It is not possible for the operator to be blinded to the device; investigator or operator bias may apply despite good intentions.

Patients

How congruent is the case mix with your own patients?

Were patients presumed to have difficult airways excluded? For example, were patients with "emergent airways", morbid obesity, cervical spine restrictions or obstetrical anesthesia represented? Was the device used as a primary or rescue device?

Among patients with seemingly normal anatomy, failure to intubate (in contrast to failure of laryngoscopy) is so infrequent that attempting to demonstrate superiority of an alternative device would require a very large study; a systematic review would likely encounter excessive heterogeneity to be meaningful. In patients believed to be at high-risk of a difficult DL, a systematic review of the literature found high-level evidence of a high *intubation* success rate with the Airtraq, C-Trach (discontinued), GlideScope, Pentax AWS and C-MAC (including earlier V-MAC and DCI versions) with weaker support for the Bonfils and Bullard and no support for the McGrath.[21] Compared with DL, the investigators also found high-level evidence of better *laryngeal views* using the Airtraq, C-Trach, GlideScope, AWS and C-MAC but not the Bonfils, Bullard or McGrath. When DL yielded a Cormack-Lehane $\geq$ 3, high-level evidence supported the use of the Airtraq, Bonfils, Bullard, C-Trach and GlideScope but this investigation was conducted prior to the introduction of the Storz D-blade.

Clinical context

How was the VL deployed?

Was VL used after DL had failed, when a difficult DL was predicted, or in special situations? Were emergent patients requiring RSI excluded? A retrospective review of 2,004 GlideScope uses was conducted at two institutions.[17] Although the GlideScope was used principally when difficult DL was anticipated or had failed, as a primary device success was experienced 98% of the time; when used to rescue failed DL, success was achieved 94% of the time.[*] As mentioned above, higher success rates were achieved at the institution with more experience.[β] Studies outside the OR have demonstrated that multiple laryngoscopic attempts were associated with increased morbidity.[19,20] This creates a compelling argument to strive for FPS using the device the laryngoscopist believes is most likely to achieve this rather than to resort to it after "multiple failed attempts" have been encountered. The Canadian Airway Focus Group guidelines

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[*] In this study, predictors of GlideScope failure included abnormal neck anatomy (scar, radiation, mass or thick neck), short TM distance, reduced cervical motion and employment at UMHS.

[β] This study also identified 10 patients in whom flexible bronchoscopic intubation failed, 8 of whom were rescued with the GlideScope. The two failed rescues were managed by DL.

advocates this approach; if difficulty is encountered with the primary technique, it is reasonable to persist only if there are grounds to believe that adjustments or adjuncts are more than likely to be successful.[22,23]

Aziz et al. randomized patients with at least one predictor of a difficult DL to intubation using a Macintosh DL or Storz C-MAC. Better laryngeal views and higher FPS was achieved with the C-MAC. In addition, both use of a gum-elastic bougie and the need for external laryngeal pressure were reduced with the C-MAC.[24] Recently, Storz introduced the D-blade, intended for more challenging airways. Aziz et al., in a study reported at the IARS in March 2015 compared the GlideScope and the D-blade in 1,100 patients with features predictive of difficult DL.[25] They hypothesized that the two devices would be equivalent but FPS, their primary outcome differed significantly at 93.4% vs. 90.3% for the GVL® and D-blade respectively. Both devices were comparable when more than one attempt was required.

Although the Cormack-Lehane classification has not been validated for VL, this author believes that it is legitimate to compare laryngeal views provided the device and other adjuncts are included in the description. It must be remembered that **the laryngeal view is an indication of the quality of laryngoscopy, not the ease of intubation**.

It is important to bear in mind that most studies have looked at the predictive power of the bedside assessments developed for DL. It appears that many of these have limited value for VL. It is likely that some features may prove predictive for specific devices but unhelpful with others. For example, patients with limited mouth opening are poorly suited for the bulkier channeled devices. Patients with an inability to prognath their mandible may be bad choices for Macintosh-style VL blades. It may also be true that frequent users of a device have found “fixes” that they have not published or may not even be aware they apply. Thus, generalizations are probably of limited value. The **best predictor of failure is infrequent use** leading to insufficient experience and unwise decision-making.

Even in the best of hands, any device or technique will have occasional failures. Complete reliance on a device—or even a class of devices—will ultimately create a situation without an escape. It is essential to maintain competence with a range of techniques including placement of a supraglottic airway, flexible endoscopic intubation and readiness to perform an invasive airway.

A full discussion of the role of VL is beyond the scope of this presentation but does appear elsewhere.[21,22,26-28] including its role in obstetrics,[29,30] trauma,[8] emergency medicine,[3,6,3,31] critical care,[32] pre-hospital care,[33] morbid obesity and bariatric anesthesia.[34] But any discussion would be incomplete if it did not consider the potential risks. Soft tissue injuries have been described[35] with all the indirect laryngoscopy devices.[26] These injuries result largely from faulty technique—blindly inserting the tracheal tube into and beyond the oropharynx while attention is directed to the monitor.[28]

Conclusions

It is generally conceded that VL improves the laryngeal view. More than 70 years after the introduction of the Macintosh laryngoscope, we have been provided with a revolutionary technology that enables us to reduce the frequency of unanticipated blind intubations from 6% to approximately 1%. Intubation often takes slightly longer although not all studies agree on this. Increasingly studies are demonstrating that in experienced

hands there is a higher FPS rate with fewer esophageal intubations. To the extent blind intubations and the number of required attempts are reduced, VL has the potential to significantly reduce morbidity and mortality. The interpretation of many of the reports is difficult because of the heterogeneity of devices, their continuous modification, the operators and their sufficiency of training, patient selection, potential for bias and lack of randomization and continuous modifications of the devices. DL is a difficult skill to acquire; it's easy to understand why non-anesthesiologists are so eager to embrace it.[3,7,32] But even for experienced laryngoscopists, there is a performance ceiling beyond which line-of-sight devices cannot improve. Since many of these patients cannot be anticipated, many are convinced that we have an opportunity to reduce significant morbidity and mortality by becoming more expert with non-line-of-sight devices. Such expertise comes only with constant practice and a continuous effort at quality improvement.

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