

Should the Glidescope video laryngoscope be used first line for all oral intubations or only in those with a difficult airway? A review of current literature

RUSSELL, Terrie-Marie and HORMIS, Anil

Available from Sheffield Hallam University Research Archive (SHURA) at:

<http://shura.shu.ac.uk/22170/>

This document is the author deposited version. You are advised to consult the publisher's version if you wish to cite from it.

Published version

RUSSELL, Terrie-Marie and HORMIS, Anil (2018). Should the Glidescope video laryngoscope be used first line for all oral intubations or only in those with a difficult airway? A review of current literature. *Journal of perioperative practice*, 28 (12), 322-333.

Copyright and re-use policy

See <http://shura.shu.ac.uk/information.html>

Should the Glidescope video laryngoscope be used first line for all oral intubations or only in those with a difficult airway? A review of current literature

Abstract

The purpose of this study was to review literature that looked into the efficacy of the Glidescope video laryngoscope versus the Macintosh laryngoscope in oral endotracheal intubations. We aimed to answer the question 'Should video laryngoscopes be used as first line intubation aids or only in the difficult airway?' A systematic search of electronic databases was made. The inclusion criteria included: Glidescope, video laryngoscope, and Macintosh laryngoscope in human studies. The study aimed to compare first attempt success rate, glottic view and intubation time in papers dating between 2009 and 2017. Eleven trials with a total of 7,919 patients with both difficult and normal airways were included. The trials showed an improvement in first attempt success rate and glottic view with the Glidescope video laryngoscope especially in those with difficult airways. Overall time to intubate showed no significant differences between the Glidescope video laryngoscope and the Macintosh laryngoscope although it was identified that with increased training and experience with the Glidescope video laryngoscope, intubation time was reduced. Glidescope video laryngoscopes show advantages over the Macintosh laryngoscopes in obtaining better glottic views in those with difficult airways. However its use is not supported in all routine intubations.

<A>Background

According to the 4th National Audit Project (NAP4) of the Royal College of Anaesthetists (RCA 2011) in 2011, 2.9 million general anaesthetics are administered each year in the NHS of which 38% utilise tracheal intubations. Chaparro-Mendoza (2015) states that the leading cause of morbidity and mortality in general anaesthesia is the failure to intubate the trachea successfully. The NAP4 report goes further to state that aspiration is the single most common cause of death during anaesthesia; this is due to poor judgement and the failure to use alternative techniques and equipment to aid in successful intubation.

Whilst there has been an evolution in the types and variety of supra glottic airway devices, eg 2nd generation laryngeal mask airways (LMA), there is also a need to develop the next step in advanced laryngoscopy that will encourage safer and more effective methods of intubation in those patients who present with a difficult airway. Channa (2011) identified that failed intubations occurred in around 0.05% Or 1: 2230 of surgical patients, with this incidence being higher in patients intubated in areas such as accident and emergency. Cook et al (2011) stated that the most frequent reported

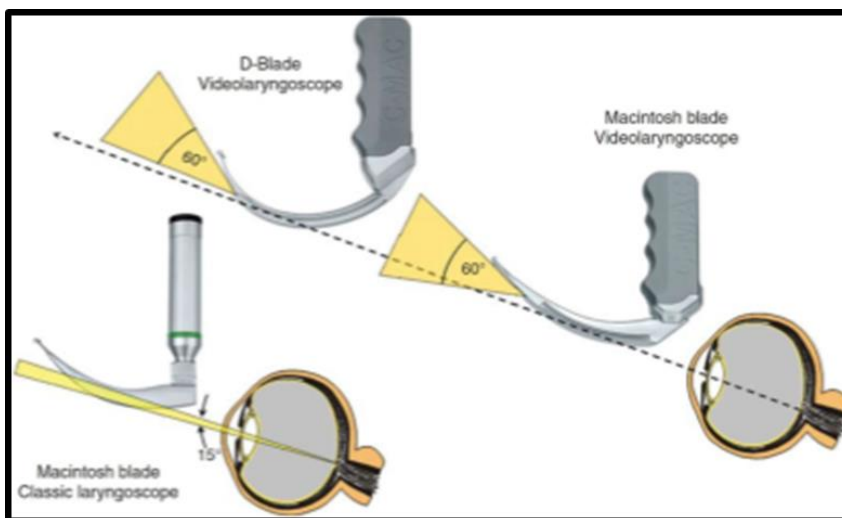
complication of airway management found by the NAP4 report was failed intubation. Failed intubation can lead to cerebral hypoxia and death (Ilyas et al 2014).

The Association of Anaesthetists of Great Britain and Ireland (AAGBI 2010) published a guideline called *The anaesthetic team*. This document states that the anaesthetic assistant (either ODP or nurse) should be appropriately skilled and adequately trained to assist anaesthetists during the intubation of patients, in both elective and emergency situations. It is the responsibility of the ODPs to be skilled and up to date with any advances in airway management and the introduction of new equipment into theatres. ODPs also require knowledge of non-technical skills, for example help with decision making and offering alternative suggestions in situations such as managing the difficult airway. ODPs must have the knowledge on how to assemble and use these devices especially when working with junior inexperienced anaesthetists (Rutherford et al 2011). Keeping up to date with current literature and studies helps facilitate this learning.

Over the last decade the introduction of video laryngoscopes as an alternative method for the management of suspected difficult intubations has become popular with anaesthetists (Healy et al 2012). In 2015 the Difficult Airway Society (DAS) introduced video laryngoscopes into their flow chart for managing the unanticipated difficult tracheal intubation in adults (Frerk et al 2015).

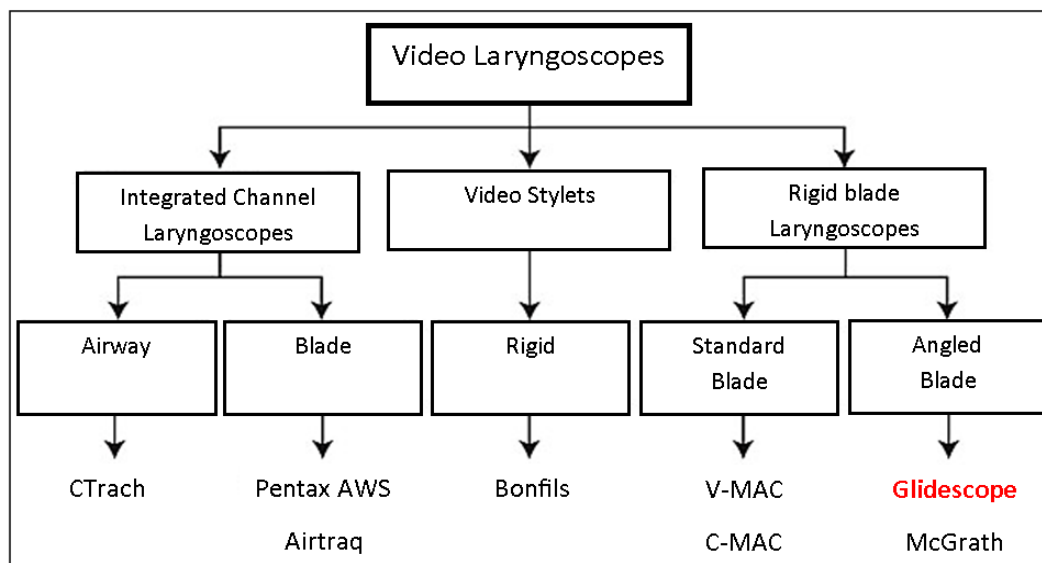
The principle of all the video laryngoscopes is the same, they use video technology to produce an image of the laryngeal inlet independent of the line of sight, and the image is displayed on a small monitor either attached to the laryngoscope or on a remote screen (Voelcheck 2013). The range of view on a video laryngoscope is increased to 60 degrees compared to that of standard Macintosh laryngoscope (ML) which gives a view of 15 degrees as shown in Figure 1.

Figure 1 Angle of vision comparing video laryngoscopes to Macintosh classic laryngoscope. Image taken from Zundert et al (2012)



The theory behind this suggests that the improved view will increase the chances of first attempt intubation in those with a difficult airway. The types of video laryngoscopes available can be seen in Figure 2.

Figure 2 A classification of video laryngoscopes, adapted from Healy et al (2012)



The Glidescope is a commonly used video laryngoscope. The purpose of this review was to establish whether there is any indication that first attempt intubation success in the normal airway could be improved with the Glidescope video laryngoscope (GVL) compared to standard Macintosh blades and whether we should be using the GVL as a first line technique for all intubations.

<A>Methodology

A systematic search of literature found in the following electronic databases PubMed, CINAHL and the CENTRAL was conducted to identify studies that compared Macintosh standard laryngoscope blade with the Glidescope video laryngoscope regarding successful first attempt intubation, glottic view and or time taken to intubate.

During the electronic search a total of 84 studies and reviews were identified; two of these were found in CENTRAL, 61 in PubMed and 21 in CINAHL. Of these, 11 studies and reviews were included in this paper totalling 7919 patients (Appendix 1). Any studies that included elements such as force applied when using laryngoscopes or changes in hemodynamic were included and the relevant data for this study was extracted. Although inexperienced users were included in the search, nurses and

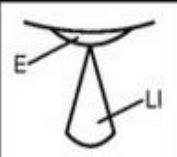




students were excluded from the final selection and only medical/anaesthetic trainees were included in the non-experienced category.

A manual search of current guidelines and recommendations relevant to the search was included. This was also restricted to the time period, 2009 to 2017, and included the term Glidescope intubation. The collected data was screened and articles and reviews were included that contained any of the following criteria:

- Comparison of GVL to direct laryngoscopy
- Adult patients and contained any areas of interest such as the Cormack-Lehane view
- First time intubation success rates
- Time taken to successful intubation.

To ensure a wide range of results all types of studies were included. Experts and non-experts were included in the study and previous training in the use of video laryngoscopes was not essential. To gain a broader range of results all types of oral intubations were considered, including normal and difficult, based on the Cormack-Lehane (CL) view shown in Figure 3.

Figure 3 Cormack-Lehane scoring system. Adapted from Cormack and Lehane (1984)

Original Cormack-Lehane system	I Full view of The Glottis	II Partial view of the glottis or arytenoids		III Only epiglottis visible	IV Neither glottis nor epiglottis visible
View at Laryngoscopy					

In the NAP4 report (2011), one in four major airway events that were reported came from the emergency department (ED) or the intensive care unit (ICU). For this reason outside areas as well as theatre settings were included in the search. All papers included had gained prior ethics committee approval for the research. Informed consent was obtained in all studies where intubation was elective. For those requiring emergency intubation the approval committee agreed that consent could not be gained and overall patient care was not altered in any way. All data collected was input into a table and summarised to extract relevant data using a modified Cormack (2000) system (see Appendix 1).

<A>Results

Literature search

The assessment of the research is summarised in Table 1 using a modified Critical Appraisal Skills Programme (CASP) tool and an adapted model used by Lu et al (2011). This was due to the varying types of research conducted in the studies.

Table 1 Summary of research studies analysed

Included studies	Clear description of study purpose and objective	Randomised	Concealment of allocation	Contained more than one criterion	All types of airway included	Approval granted
Ahmadi et al 2004	Y	N	N	Y	Y	Y
Aqil et al 2006	Y	Y	N	Y	N	Y
Ayoub et al 2010	Y	Y	Y	Y	N	Y
Cortellazzi et al 2014	Y	Y	Y	Y	N	Y
Ibinson et al 2014	Y	N	Y	N	Y	Y
Misirlioglu and Sen 2016	Y	Y	Y	Y	N	Y
Mosier et al 2012	Y	Y	N	Y	Y	Y
Parasa et al 2016	Y	Y	Y	Y	N	Y
Platts-Mills 2009	Y	Y	N	Y	Y	Y
Sakles et al 2011	Y	Y	N	Y	Y	Y
Sakles and Mosier 2014	Y	Y	N	Y	Y	Y

The studies have been grouped using a thematic analysis to identify any patterns. The results are presented in Tables 2-4 to highlight the relevant information gathered and divided into areas of interest: first attempt success rate, glottic view and intubation time.

Table 2 Research papers that documented first attempt success rates

User type	Expert of trainee	Conducted in theatre	Conducted in outside areas such as the ED	GVL first time success rate	ML first attempt success rate	Papers excluding known difficult airway
Qualified expert user	3	3	0	2	1	2
Trainee	8	3	5	5	2	3
Total	11	6	5	7	3	5

Table 2 summaries that of the 11 research papers, six were conducted in the theatre setting and five in outside areas such as emergency departments (ED). Three were based on an expert user and eight were trainees performing the intubation.

Two papers with the qualified expert users recorded an improvement in first time intubation success rate with the GVL compared to one paper which documented that use of the ML provided a higher rate of successful first attempt intubation. With trainee users five compared to two papers favoured the GVL over the ML, although one paper found that with the GVL first attempt success rate was only significant higher in difficult airways.

One paper concluded that no significant difference was found between the GVL and the ML; this study had excluded known difficult airways (Aqil et al 2016). Of the 11 papers, five excluded all known difficult airways from their results. In one study using trainees it was documented that although first attempt success rate was higher with ML, the intubation success rate with GVL improved as the number of performed intubations increased.

Table 3 Research papers that documented improved glottic view

User type	Expert or trainee	Research conducted in theatre	Research conducted in outside area such as ED	Improved glottic view with GVL	Improved glottic view with ML	Papers excluding known difficult airway
Qualified expert user	2	2	0	2	0	2
Trainee	4	2	2	3	0	2
Total	6	4	2	5	0	4

Of the included 11 studies only six included glottic view into their findings: four were conducted in theatre and two in outside areas. These results are summarised in Table 3. Glottic view was improved in all six studies using the GVL compared to the ML; this was evident in both difficult and normal airways and across all areas of expertise.

Table 4 Research papers that documented improved intubation times

User type	Expert or trainee	Research conducted in theatre	Research conducted in outside areas such as ED or ICU	GVL improved intubation time	ML improved intubation time	Papers excluding known difficult airway
Qualified expert user	2	2	0	0	2	2
Trainee	5	3	2	4	1	4
Total	7	5	2	4	3	6

Regarding time taken to successfully intubate the patient (see Table 4) shows that only seven out of the 11 papers included this result: five were conducted in the theatre setting and two in outside areas. Expert users found that intubation time was quicker using the ML compared to the GVL. The trainees found that intubation time was quicker using the GVL. In one of the studies using trainees the improvement in time taken to intubate was only quicker in those with difficult airways, those with normal airways showed no significance difference between the GVL and MLs (Ahmadi 2014).

<A>Discussion

Healy et al (2016) recommended that, when comparing the performance of video laryngoscopes to direct laryngoscopes, studies must rely on three main outcomes. The first outcome is the overall success of the device, the second is the incidence of first attempt intubation and lastly the time taken to achieve intubation. For the purpose of this study, glottic view has also been included. Healy et al (2016) highlighted that, although glottic view maybe an important consideration, a classified difficult view (Cormack-Lehane 3-4) (Cormack and Lehane 1984) does not necessarily indicate that a successful and timely intubation is not possible.

First attempt success rate findings

All 11 papers included first attempt success rate in their study; the overall outcome showed that intubation success was improved with the Glidescope compared to the ML in the majority of the studies. This outcome was measured in theatres and outside areas such as EDs and ICUs and by both expert and trainee users. Ahmadi (2014) noted that, although first attempt success rates were improved with the GVL compared to the ML, the difference was only significant in those with difficult airways. This comparison was also noted by Mosier et al (2011) and Ibinson et al (2014) who

furthered this by stating that the GVL was used as a successful rescue device when direct laryngoscopy failed on first attempt.

Sakles et al (2011) found that first attempt success rates were higher with the use of the GVL especially in those with a predicted difficult airway. The authors concluded that any failed first attempt with the GVL was down to factors such as operator inexperience and the inability to direct the endotracheal tube into place. A further study in 2014 by Sakles and Mosier concluded that first attempt successful intubation rates with the GVL improved with the number of intubations performed and experience in both difficult and normal airways. This is confirmed by Mosier et al (2011), Misirlioglu and Sen (2016) and Cortellazzi et al (2015) who stated that there is a steep learning process required in the use of video laryngoscopes for both experienced anaesthetists and trainees. More training and use of video laryngoscopes will increase confidence and first attempt successful intubations in all airways.

Cortellazini et al (2015) concluded that, although first attempt success rate was higher with the ML as with the Sakles and Mosier (2014) study, the first attempt success rate with the GVL improved as the number of intubations performed increased. Griesdale et al (2012) and Chaparro-Mendoza et al (2015) documented in their systematic reviews of GVLs vs direct laryngoscopes that overall intubation success rates were higher in those with predicted difficult airways and when performed by trainees. Both concluded that no significant difference between laryngoscopes was recorded by experienced anaesthetists.

Improved glottic view findings

All the studies that included glottic view into their findings concluded that the overall view was improved with the GVL compared with the ML in all settings and by all users. Aqil et al (2016) highlighted that a good view of the glottis is essential for successful intubation. Parasa et al (2016) and Thong and Goh (2013) argued that a grade 1 or 2 CL view using the GVL does not guarantee first attempt intubation success. Healy et al (2012) and Voelckel (2013) supported this finding by stating that a good view of the glottis does not guarantee a successful intubation on first attempt and often it is down to operator experience with the laryngoscope that contributes to success.

Sakles et al (2011) documented that, although overall view was improved using the GVL, if the view became contaminated due to secretions etc then the laryngoscope ultimately became unusable and direct laryngoscopy was used to facilitate intubation. All studies found that a difficult view using the Macintosh might be improved with the backwards-upwards-rightwards-pressure (BURP) manoeuvre, but no benefit was found when using the GVL.

Although all the studies showed an improvement in the glottic view with the Glidescope, whether in normal or difficult airways, only Aqil et al (2016) concluded that the use of GVLs would be beneficial in the normal airway. The remaining studies concluded that the overall benefit of the Glidescope would be seen in those with difficult airways. Griesdale et al (2012) drew the same conclusion in their systematic review. Further studies agreed with this finding. Niforopoulou et al (2010) stated that those patients with CL views of 3-4 would benefit from the use of the GVL, as the 'blind' intubation would be converted into an intubation with a view and increase the rate of success.

Intubation time findings

When comparing GVL and the ML in relation to time to successful intubation, there was no consensus in the research. Studies concluded that the Glidescope intubation time was quicker in those with a difficult airway, but no significant difference was found in patients with a normal airway. However, comparing the results between the studies was difficult due to the difference in the definition of intubation time.

All studies began timing from the moment the laryngoscope passed the lips. The difference occurred at the end point: three studies classified successful intubation stopped timing once CO₂ was recorded on the monitor via the capnography (Aqil et al 2016, Ayoub et al 2010 and Parasa et al 2016). However, one study stopped the timing at the point where the first successful forced inspiration was achieved (Platts-Mills 2009). One study recorded the total time once the cuff was inflated (Cortellazzi et al 2015). The remaining studies calculated the total time once the endotracheal tube was passed through the vocal cords (Ahmadi et al 2014, Misirlioglu & Sen 2016). It could be argued that uniformity in end time could produce a different outcome in the results and give a better comparison between the two devices.

Sakles et al (2013) and Bernhard et al (2015) argued that intubation time between the two devices was irrelevant and that in emergency situations first attempt success rate is more essential for securing a definitive airway. They found in both of their studies that the incidence of adverse events such as hypoxia was increased with each additional attempt at intubation. Ultimately time taken would also increase with repeated attempts to successfully intubate, as well as the incidence of airway trauma, odema, aspiration, hypoxia and cardiac arrest (NAP4) (AAGBI 2011). Therefore we should also consider which type of device would provide a higher first attempt success rate in both normal and difficult airways.

Sakles et al (2013) and Paolini et al (2013) predicted that eventually video laryngoscopes will dominate the field of dealing with emergency airways and that availability and training in the use of these should be implemented in all trusts and departments. Kelly and Cook (2014) stated that the

training in the use of video laryngoscope should also include the ODP. A recent study by Pallister et al (2015) assessing the knowledge and skills of ODPs in setting up video laryngoscopes concluded that not all ODPs knew where the video laryngoscopes were located and how many they had in their trust. The study did highlight that those ODPs who had attended in house airway training sessions were more confident in the setting up of video laryngoscopes and offering them as an alternative during difficult airway situations. This skill is relevant in outside areas such as the ED and 'out of hours' intubations which are often performed by junior anaesthetists who rely on the knowledge and experience of the ODP.

The advantage of the GVL is that it allows the ODP to see the image on the screen and as such can respond much earlier to a situation when the intubator may be struggling. It gives the ODP the chance to anticipate the next step and have the necessary equipment to hand to offer alternative solutions to aid intubation. Video laryngoscopes provide human factor advantages by enabling the whole team to see what the person intubating is seeing which moves the management of an airway from an 'I to a we' scenario. (Kelly & Cook 2016). If cricoid pressure is required the ODP will be able to see the effect that the pressure is having on the view and adjust placement and pressure as needed (Kaplan 2002). If a trainee ODP is performing the cricoid pressure the supervising ODP can visualise and advise how to adjust their technique, making the GVL a useful training aid.

<A>Recommendations and conclusion

From this review it is clear that the Glidescope laryngoscope is a useful intubation aid for those with a difficult airway for both experienced and trainee users. None of the studies supported the idea that the use of the GVL would be beneficial in all routine intubations. Zaouter et al (2015) and Paolini et al (2013) recommended that all intubations should be performed using video laryngoscopes, to reduce the number of attempts and the time taken to establish a definitive airway, especially in those with an unpredicted airway. They concluded that only a cost issue is stopping this from occurring.

The Difficult Airway Society (DAS) 2015 guidelines are shown in Figure 4. It is now recommended that all anaesthetists are trained in the use of video laryngoscopes and have access to them at all times (Frerk et al 2015). Kelly and Cook (2014) furthered this by stating that routine use of video laryngoscopes is a vital part of training for trainees involved in airway management. More training and the use of video laryngoscopes will increase confidence and first attempt successful intubations in all airways.

<A>Considerations for future practice

Although it is still unclear whether there are any overall advantages in the routine use of video laryngoscopes, the question still remains: Are video laryngoscopes the best care in all cases? This review does highlight a need for them during difficult intubations. This is indicated in the NAP4 and DAS recommendations. The question needs to be: Are we as ODPs adequately trained in the use of the video laryngoscopes? There is often no formal training in the workplace, even though such programmes would be beneficial for both qualified and trainee ODPs as well as junior anaesthetists. The introduction of a structured training package including simulation scenarios run in-situ would be beneficial to both ODPs and trainee anaesthetists. Another option would be to run dedicated airway lists whereby all patients on these lists would be intubated using the GVL. This would provide realism for the ODP and the trainees and give them the opportunity to use the GVL in a controlled and supervised situation.

References

- Ahmadi K, Ebrahimi M, Hashemian AM et al 2014 Glidescope video laryngoscope for difficult intubation in emergency patients: a quasi-randomized controlled trial *Acta Medica Iranica* 53 (12) 738-42
- Aqil M, Khan MU, Hussain A et al 2016 Routine use of Glidescope and Macintosh laryngoscope by trainee anaesthetists *Journal of the College of Physicians and Surgeons Pakistan* 26 (4) 245-49
- Association of Anaesthetists of Great Britain and Ireland 2005 **The anaesthesia team-revised 2005** Available from: <http://www.aagbi.org/sites/default/files/anaesthesiateam05.pdf>
- Association of Anaesthetists of Great Britain and Ireland 2010 **The anaesthesia team** Available from: https://www.aagbi.org/sites/default/files/anaesthesia_team_2010_0.pdf [Accessed May 2018]
- Ayoub CM, Kanazi GE, Al Alami A et al 2010 Tracheal intubation following training with the glidescope compared to direct laryngoscopy *Journal of the Association of Anaesthetists of Great Britain and Ireland* 65 674-78
- Bernhar M, Becker TK, Gries A et al 2015 **The first shot is often the best shot: First-pass intubation success in emergency airway management** Available from: <http://www.aimeairway.ca/uploads/articles/55.pdf> [Accessed May 2018]
- Bulatovic R, Taneja R 2015 Videolaryngoscopy: for all intubations? *British Journal of Anaesthesia* 115 (1) 135-36
- Critical Appraisal Skills Programme **CASP checklists** Available from: <http://www.casp-uk.net/casp-tools-checklists> [Accessed May 2018]
- Chapparro-Mendoza K, Luna-Montufar CA, Gomez JM 2015 Videolaryngoscopes: The solution for difficult airway management or just another strategy? Non systematic review *Columbian Journal of Anesthesiology* 43 (3) 225-23
- Channa BA 2011 Video Laryngoscopes *Saudi Journal of Anaesthesia* 5 (4) 357-59

Cook TM, Woodall N, Harper J, Benger J 2011 Major complications of airway management in the UK: Results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: Intensive care and emergency department *British Journal of Anaesthesia* 106 632-42

Cooper RM, Pacey JA, Bishop MJ, McClusky SA 2005 Early clinical experience with a new videolaryngoscope (Glidescope) in 728 patients *Canada Journal of Anesthesia* 52 191-98

Collins SR 2014 Direct and indirect laryngoscopy: Equipment and techniques *Respiratory Care* 59 (6) 850-64

Cormack D 2000 **The research process in nursing** Oxford, Blackwell Science

Cormack RS, Lehane J 1984 Difficult tracheal intubation in obstetrics *Anaesthesia* 39 1105-11

Cortellazzi P, Caldiroli D, Byrne A et al 2015 Defining and developing expertise in tracheal intubation using a Glidescope for anaesthetists with expertise in Macintosh direct laryngoscopy: An in-vivo longitudinal study *Anaesthesia* 70 290-95

Difficult Airway Society 2015 **DAS guidelines for the management of unanticipated difficult intubation in adults 2015** Available from:

https://www.das.uk.com/guidelines/das_intubation_guidelines [Accessed April 2018]

Frerk C, Mitchell VS, McNarry AF et al 2015 Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults *British Journal of Anaesthesia* 115 (6) 827-48

Griesdale DE, Liu D, McKinney J, Choi PT 2012 Glidescope videolaryngoscopy versus direct laryngoscopy for endotracheal intubation: Systematic review and meta-analysis *Canada Journal of Anaesthesia* 59 41-52

Healy DW, Matis O, Hovord D, Kheterpal S 2012 A systematic review of the role of videolaryngoscopy in successful orotracheal intubation *BMC Anesthesiology* 12 (32) 1471-2253

Hsiao WT, Lin YH, Wu HS, Chen CL 2005 Does new videolaryngoscope (Glidescope) provide better glottic exposure? *Acta Anaesthesiologica Taiwanica* 43 147-51

Ibinson JW, Ezaru CS, Cormican DS, Mangione MP 2014 Glidescope use improves intubation success rates: An observational study using propensity score matching *BMC Anaesthesiology* 14 (101) 1-8

Ilyas S, Symons J, Bradley WPL et al 2014 A prospective randomised controlled trial comparing tracheal intubation plus manual in-line stabilisation of the cervical spine using the Macintosh laryngoscope vs the McGrath Series videolaryngoscope *Anaesthesia* 69 (10) 1345-50

Kaplan MB, Ward DS, Berci G 2002 A new videolaryngoscope: An aid to intubation and teaching *Journal of Clinical Anaesthesia* 14 620-26

Karalpillai D, Darvall J, Mandeville J et al 2016 **A review of video laryngoscopes relevant to the intensive care unit** Available from <http://www.ijccm.org> *Indian Journal of Critical Care Medicine* 18 (7) 442-52

Kelly FE, Cook TM 2014 Randomised controlled trials of videolaryngoscopy vs direct laryngoscopy on intensive care are needed *Intensive Care Medicine* 40 765

Lafferty BD, Ball DR, Williams D 2016 Videolaryngoscopy as a new standard of care *British Journal of Anaesthesia* 115 (1) 136-37

Lu Y, Jiang H, Zhu YS 2011 Airtraq laryngoscope versus conventional Macintosh laryngoscope: a systematic review and meta-analysis *Journal of the Association of Anaesthetists of Great Britain and Ireland* 66 1160-67

- Misirlioglu G, Sen O 2016 Comparison of Glidescope video laryngoscopy and Macintosh laryngoscope in ear-nose and throat surgery *Irish Journal of Medical Science* 185 729-33
- Mosier JM, Stolz U, Chiu S, Sakles JC 2012 Difficult airway management in the emergency department: Glidescope videolaryngoscope compared to direct laryngoscopy *Journal of Emergency Medicine* 42 (6) 629-34
- Norskov AK, Rosenstock CV, Wetterslev J et al 2015 Diagnostic accuracy of anaesthesiologists' prediction of difficult airway management in daily clinical practice: a cohort study of 188,064 patients registered in the Danish Anaesthesia Database *Anaesthesia* 70 272-81
- National Institute of Health and Care Excellence 2012 **Depth of anaesthesia monitors: Bispectral Index (BIS), E-Entropy and Narcotrend-Compact M** Available from: <https://www.nice.org.uk/guidance/dg6/chapter/3-Clinical-need-and-practice> [Accessed May 2018]
- Niforopoulou P, Pantazopoulous I, Demestiha T et al 2010 Video-laryngoscopes in the adult airway management: A topical review of the literature *Acta Anaesthesiologica Scandinavica* 54 1050-61
- Pallister E, Achuthan S, Mendonca C 2015 Knowledge and skills in setting up videolaryngoscopes *Journal of Anaesthesia Practice* Available from: <http://jappractice.co.uk/2015/11/videolaryngoscopes/11618> [Accessed May 2018]
- Paolini JB, Donati F, Drolet P 2013 Video laryngoscopy: Another tool for difficult intubation or a new paradigm in airway management *Canadian Journal of Anaesthesia* 60 184-91
- Parasa M, Vardhan S, Vemuri NN, Shaik MS 2016 Comparison of Glidescope video laryngoscope with Macintosh laryngoscope in adult patients undergoing elective surgical procedures *Anesthesia Essays and Researches* 10 (2) 245-49
- Platts-Mills TF, Campagne D, Chinnock B et al 2009 A comparison of glidescope video laryngoscope versus direct laryngoscopy intubation in the emergency department *Academic Emergency Medicine* 16 (9) 866-71
- Royal College of Anaesthetists 2011 **4th National Audit Project** Available from: <https://www.rcoa.ac.uk/nap4> [Accessed April 2018]
- Rutherford JS, Flin R, Mitchell L 2012 Non-technical skills of anaesthetic assistants in the perioperative period: A literature review *British Journal of Anaesthesia* 109 (1) 21-27
- Sakles JC, Mosier JM, Chiu S, Keim SM 2011 Tracheal intubation in the emergency department: A comparison of Glidescope video laryngoscopy to direct laryngoscopy in 822 intubations *Journal of Emergency Medicine* 42 (4) 400-05
- Sakles JC, Chiu S, Mosier JM et al 2013 The importance of first pass success when performing orotracheal intubation in the emergency department *Academic Emergency Medicine* 20 71-78
- Sakles JM, Mosier J 2014 Improvement in Glidescope video laryngoscope performance over a seven year period in an academic department *Internal Emergency Medicine* 9 789-94
- Santy J, Kneale C 2000 Critiquing quantitative research *Journal of Orthopaedic Nursing* 2 77-83
- Soliz J, Sinha A, Thakar D 2001 Airway management: A review and update *Internet Journal of Anesthesiology* 6 (1) Available from: <http://ispub.com/IJA/6/1/12227#> [Accessed May 2018]
- Thong SY, Goh SY 2013 Reported complications associated with the use of GlideScope® video laryngoscope: How can they be prevented? *OA Anaesthetics* 1 (1) 1-6
- Voelckel WG 2013 What is the role of video laryngoscopy in pre-hospital care? *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* 2 (1) 1-8

Xue FS, Zhang GH, Liu J et al 2007 The clinical assessment of Glidescope in orotracheal intubation under general anaesthesia *Minerva Anestesiologica* 73 (9) 451-57

Zaouter C, Calderon J, Hemmerling TM 2015 Videolaryngoscopy as a new standard of care ***British Journal of Anaesthesia*** 114 (2) 181-83

Zundert AV, Pieters B, Doerges V, Gatts S 2012 Videolaryngoscopy allows a better view of the pharynx and larynx than classic laryngoscopy ***British Journal of Anaesthesia*** 109 (6) 1014-15

APPENDIX 1 Table of results from literature search, adapted from Cormack 2000

Author	Objective	Method	Sample	Conditions	Results	Implications
Ahmadi et al 2014	To compare GVL and DL with regard to: 1. first attempt success rate 2. Time taken to intubate	Quasi-randomised clinical trial Quantitative study	97 patients in a single institution	Emergency intubations. Both easy and difficult airway included Intubations performed by trainees	1. Higher first attempt success rate with GVL in difficult airway, no significant difference in normal airway 2. Shorter intubation time in difficult airway with GVL, no significant difference in normal airway	The use of the Glidescope is recommended in emergency situations, in the difficult airway
Aqil et al 2016	To compare GVL and DL with regard to: 1. first attempt success rate 2. Glottic view 3. Time taken to intubate	Prospective randomised cohort study Intubations carried out by anaesthetic trainees	80 patients aged, in a single institution	Elective surgery, only normal airways included in study Intubation performed by anaesthetic trainees	1. No significant difference in intubation success 2. Improved glottic view with GVL 3. Shorter intubation time with GVL	Results suggest that GVL would provide a more rapid and easier intubation for trainee anaesthetists in patients with normal airways
Ayoub et al 2010	To compare GVL and DL with regard to: 1. first attempt success rate. 2. Time taken to intubate.	Observational study	126 patients, in a single institution	Elective surgery, only normal airways included in study Intubation performed by medical trainees	1. Higher first attempt success rate with GVL 2. Shorter intubation time with GVL	Study highlights that students with little or no experience with intubations can achieve higher success rates with GVL compared to DL

Cortellazzi et al 2014	To compare GVL and DL with regard to: 1. first attempt success rate 2. Glottic view 3. Time taken to intubate.	Observational study	962 patients in a single institution	Elective surgery, only normal airways included in study Intubation performed by trainees using GVL for first line intubation	1. Higher first attempt success rate with DL, however the first attempt success rate with GVL improved as number of intubations performed increased 2. Improved glottic view with GVL 3. Intubation time improved with number of intubations performed with GVL	Study highlights that video laryngoscopy is a complex skill and relevant training should be provided to users to improve intubation success rate and time
Ibinson et al 2014	To compare the first time success rate of the GVL and DL	Observational study	3831 aged 18 and over	Elective surgery	Greater first attempt success rate found in the GVL group compared with the DL group. The GVL was also used in 86 patients as a rescue attempt when DL failed	Study highlights that first attempt success rate is higher with GVL especially in difficult airway situations and should be used as a rescue device if DL fails
Misirlioglu and Sen 2016	To compare GVL and DL with regard to: 1. first attempt success rate 2. Glottic view 3. Time taken to intubate	Randomised study	100 patients aged 18-65 in single institution	Elective surgery. No difficult intubations included	1. first attempt success rate higher in GVL. 2. Improved glottic view with GVL 3. Intubation time shorter with DL	Advantages for users in patients with predicted difficult airways. Study highlighted an indication for further training on GVL to improve intubation times

Mosier et al 2011	To compare success rates of GVL vs DL in the emergency department	Qualitative study. Prospectively collected data immediately after intubation	772 consecutive intubations	All patients requiring intubation in the emergency department. Intubations were performed by trainees	<ol style="list-style-type: none"> 1. First attempt success rate higher in GVL 2. Rescue attempts more success rate with GVL. 3. Higher intubation success rate in predicted difficult airway with GVL 	The failure to intubate with the GVL was due to the inability to direct the endotracheal tube rather than restricted view, indications for more training in technique is evident
Parasa et al 2016	To compare GVL and DL with regard to: <ol style="list-style-type: none"> 1. first attempt success rate 2. Glottic view 3. Time taken to intubate 	Randomised comparative study	60 patients aged 18-65, in a single institution	Elective surgery. No difficult intubations included	<ol style="list-style-type: none"> 1. First attempt success rate higher in DL 2. Mean intubation time shorter with DL 3. Improved glottic view with GVL 	Even though glottic view was improved with GVL, it did not reduce time taken to intubate. It is thought that this is due to the difficulty in directing the ET tube into position. Therefore it is advised that the GVL would be beneficial for use only in known difficult airway situations
Platts-Mills et al 2009	To compare GVL and DL with regard to: <ol style="list-style-type: none"> 1. first attempt success rate 2. Time taken to intubate 	Prospective observational study	280 patients in the ED of a trauma center	Emergency intubations Both easy and difficult airway included Intubations performed by trainees	<ol style="list-style-type: none"> 1. First attempt success rate higher in DL 2. Shorter intubation time with DL 	Overall view is that the GVL would prove useful in difficult airways only

Sakles et al 2011	To compare GVL and DL with regard to: 1. first attempt success rate 2. Glottic view	Retrospective observational study	943 patients in one emergency department	All patients requiring intubation in the ED, performed by trainees	1. Higher success rate of first attempt intubation with GVL, higher success rate with more than one attempt required with DL, lower incidence of oesophageal intubation with VL 2. Improved glottic view with GVL	Overall success rates remain the same, however first attempt success rates favour GVL, this impacts on patient care by offering a potential to improve emergency/difficult airway management
Sakles and Mosier 2014	To compare GVL and DL with regard to: 1. first attempt success rate. 2. Glottic view	Analysis of prospectively collected data	668 over a 7 year period in one trauma centre	All patients requiring intubation in a trauma centre, intubations performed by trainees	1. First attempt success rate increased from 75.6% to 92.1% with GVL over the 7 year period 2. Glottic view remained consistent during the time period	Indications that the reason for failed intubation with GVL was the inability to direct the ET tube correctly. Users would benefit for training in technique

