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A Comparison of the GlideScope Video Laryngoscope to the C-MAC Video Laryngoscope for Intubation in the Emergency Department

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Abstract

Study objective—There is growing use of video laryngoscopy in US emergency departments (EDs). This study seeks to compare intubation success between the GlideScope video laryngoscope and the C-MAC video laryngoscope (C-MAC) in ED intubations.

Methods—This was an analysis of quality improvement data collected during a 3-year period in an academic ED. After each intubation, the operator completed a standardized data form reporting patient demographics, indication for intubation, device(s) used, reason for device selection, difficult airway characteristics, number of attempts, and outcome of each attempt. An attempt was defined as insertion of the device into the mouth regardless of attempt at tube placement. The primary outcomes were first pass and overall intubation success. The study compared success rates between the GlideScope video laryngoscope and the C-MAC groups, using multivariable logistic regression and adjusting for potential confounders.

Results—During the 3-year study period, there were 463 intubations, including 230 with the GlideScope video laryngoscope as the initial device and 233 with the C-MAC as the initial device. The GlideScope video laryngoscope resulted in first-pass success in 189 of 230 intubations (82.2%; 95% confidence interval [CI] 76.6% to 86.9%) and overall success in 221 of 230 intubations (96.1%; 95% CI 92.7% to 98.2%). The C-MAC resulted in first-pass success in 196 of 233 intubations (84.1%; 95% CI 78.8% to 88.6%) and overall success in 225 of 233 intubations (96.6%; 95% CI 93.4% to 98.5%). In a multivariate logistic regression analysis, the type of video laryngoscopic device was not associated with first-pass (odds ratio 1.1; 95% CI 0.6 to 2.1) or overall success (odds ratio 1.2; 95% CI 0.5 to 3.1).

Conclusion—In this study of video laryngoscopy in the ED, the GlideScope video laryngoscope and the C-MAC were associated with similar rates of intubation success.

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Author contributions: JCS conceived the study, designed the data collection instrument, and managed the database. All authors performed statistical analysis and contributed to drafting the article. JCS takes responsibility for the paper as a whole.

Introduction

Background

Direct laryngoscopy is the traditional technique for tracheal intubation in the emergency department (ED). However, it requires alignment of the pharyngeal, laryngeal, and tracheal axes, which can often be difficult or impossible in select patients. In the last decade, video laryngoscopes have been introduced into clinical practice and have been used with increasing frequency for ED intubations.¹⁻⁶ Unlike direct laryngoscopy, video laryngoscopes incorporate a video camera on the undersurface of the blade and transmit the image to a video monitor. This design allows the operator to indirectly view and intubate the glottis, without a direct view of laryngeal structures. Although several different video laryngoscopes are commercially available, the GlideScope (Verathon Medical, Bothell, WA) and the C-MAC (Karl Storz, Tuttlingen, Germany) are the most widely used in US EDs.

Importance

The GlideScope video laryngoscope and the C-MAC have key design differences, and thus slightly different technique may be needed to achieve glottic exposure. The C-MAC has a blade shaped much like a standard Macintosh curve, allowing for a conventional approach similar to direct laryngoscopy. In contrast, the GlideScope video laryngoscope blade has a 60-degree curvature. Although the hyperangulated curvature affords improved glottic exposure in difficult airways, it also requires use of a specially designed curved rigid stylet (GlideRite stylet) to facilitate direction of the tracheal tube to the laryngeal inlet. Given these design differences, it is unclear whether either device would result in higher tracheal intubation success in ED patients. Several studies have compared the GlideScope video laryngoscope and C-MAC to direct laryngoscopy⁷⁻³² but no study has directly compared the GlideScope video laryngoscope with C-MAC in the ED, to our knowledge.

Goals of This Investigation

The goal of this investigation was to compare intubation success between GlideScope video laryngoscope and C-MAC laryngoscopy in ED patients at an urban academic university hospital.

Materials and Methods

Study Design

We analyzed quality improvement data prospectively collected during a 3-year period from February 1, 2009, to January 31, 2012. This project was granted exemption by the University of Arizona Institutional Review Board.

Setting

This study was conducted at the University of Arizona Medical Center, which has a 61-bed tertiary care academic ED with an annual census of approximately 70,000 visits. This ED, also a Level I trauma center, has an ACGME-accredited 3-year emergency medicine residency program, as well as a 5-year combined pediatric/emergency medicine residency

program. The majority of intubations in our ED are performed by emergency medicine residents under emergency medicine attending physician supervision.

Selection of Participants

The GlideScope video laryngoscope and the C-MAC were introduced to our ED in 2001 and 2009, respectively. Only patients who were intubated according to the GlideScope video laryngoscope or the C-MAC as the initial device from February 2009 until January 2012, when both devices were available in the ED, were included in this study. To allow a fair comparison of devices in this study, only intubations performed with the standard reusable GlideScope video laryngoscope were included in this analysis. Also, only intubations using the manufacturer-recommended stylet (GlideRite Rigid Stylet for the GlideScope video laryngoscope and standard malleable stylet for the C-MAC) were included in the study. Device selection and blade size were based on provider preference. Before starting their emergency medicine residency, residents reported variable experience with the GlideScope video laryngoscope, and no resident had experience with the C-MAC.

Data Collection and Processing

After each intubation, the operator completed a standard data collection form describing patient demographics, operator specialty, operator level (postgraduate year), indication for intubation, method of intubation, paralytic agent, sedative agent, device(s) used, reason for device selection, presence of certain difficult airway characteristics, number of attempts at intubation, and the outcome of each attempt. Methods of intubation included rapid sequence intubation, oral intubation with a sedative agent only, and oral intubation without medications.

Reasons for selection of video laryngoscope intubation were defined as “standard,” “difficult,” and “education.” “Standard” indicated routine airway management with no anticipated difficulty. “Difficult” included airways with identified difficult anatomic features. “Education” included instances in which the operator used the device to gain educational experience.

Standard preoperative difficult airway predictors such as the Mallampati score, thyromental distance, and neck mobility have been shown to be challenging to apply in the emergency setting because of lack of patient cooperation and the urgency to complete the intubation rapidly.^{33,34} Thus, we developed a list of difficult airway characteristics that were feasible for determination before intubation, including cervical immobility (intrinsic or caused by a cervical collar), obesity, large tongue, short neck, small mandible, facial or neck trauma, airway edema, blood in the airway, and vomit in the airway.

The senior author reviewed the data forms. If the form had any missing data, it was returned to the operator for completion. If information on the form contained inconsistencies, the operator was interviewed by the senior author for clarification. The data forms were cross-referenced to professional billing and pharmacy records to identify any intubations performed without a corresponding data form. If an intubation was identified without a data form, the operator was given a data form to complete as soon as possible to ensure a maximal capture rate.

Outcome Measures

The primary outcomes were first-pass success and overall intubation success. First-pass success was defined as successful intubation on the initial attempt. Overall intubation success was defined as successful intubation with the initial device regardless of number of attempts required. An attempt was defined as insertion of the laryngoscope blade into the oropharynx regardless of whether an attempt was made to pass the endotracheal tube. Successful intubation was defined as correct placement of the endotracheal tube in the trachea, as confirmed by end-tidal CO₂ capnometry, pulse oximetry, chest auscultation, observation of chest excursion, absence of epigastric sounds, and misting of the endotracheal tube. If there was uncertainty about endotracheal tube placement by the operator and the tube was removed and replaced, the attempt was classified as an esophageal intubation.

According to a previous study using a similar design,³⁵ confounders included in the multivariable analysis were age, sex, trauma status, indication for intubation, method of intubation, paralytic agent, induction agent, presence of at least 1 difficult airway characteristic, operator specialty, Emergency Medicine Resident (EMR) level, and operator-specified reason for device selection.

Primary Data Analysis

Summary statistics were generated for patient, intubation, and operator characteristics. Continuous normally distributed variables were compared between the C-MAC and GlideScope video laryngoscope groups with a Student's *t* test. Categorical variables were compared between groups with the Fisher's exact test. Multivariate logistic regression analyses were performed for each of the outcome variables: first-pass success and overall success. The predictor variable of interest was intubation device (GlideScope video laryngoscope or C-MAC). Other predictor variables added to each model to adjust for confounding included age, sex, trauma status, indication for intubation, method of intubation, paralytic agent, induction agent, presence of at least 1 difficult airway characteristic, operator specialty, EMR level, and operator-specified reason for device selection.

The data were entered into the electronic database program HanDBase 4.0 for the iPad (DDH Software, Wellington, FL; <http://www.ddhsoftware.com>) and subsequently transferred to Excel for Windows 2010 (Microsoft, Redmond, WA; <http://www.microsoftstore.com>). Summary statistics were calculated with InStat 3.10 for Windows (GraphPad Software, San Diego, CA; <http://www.graphpad.com>). All other statistical analyses were performed with Stata for Windows (version 12; StataCorp, College Station, TX; <http://www.stata.com>).

Results

During the 3-year study period, a total of 1,475 consecutive intubations were performed in the ED. We excluded 782 performed with direct laryngoscopy or devices other than GlideScope video laryngoscope or C-MAC, 182 GlideScope video laryngoscope procedures

using a standard stylet, 26 procedures performed by nonemergency physicians, and 22 patients younger than 18 years. We included the remaining 463 GlideScope video laryngoscope or C-MAC intubations in the analysis. Baseline patient, intubation, and operator characteristics are listed in Table 1. A total of 91 providers performed 413 of the intubations. The providers for the remaining 50 intubations were not known. The median number of intubations performed per provider was 4 (interquartile range 2 to 5).

Of the study population, 230 intubations were performed with the GlideScope video laryngoscope as the initial device and 233 with the C-MAC as the initial device. There were no baseline differences between groups, with the exception of trauma status, reason for device selection, and presence of 1 or more difficult airway characteristics (Table 1). There were 108 intubations in which the C-MAC was used exclusively as a video laryngoscope device, 77 intubations in which the C-MAC was used as a direct laryngoscopy, 44 intubations in which the C-MAC was initially used as direct laryngoscopy and switched to video laryngoscope in any attempt, and 4 intubations in which the C-MAC was initially used as video laryngoscope and switched to direct laryngoscopy. These were included in the analysis as C-MAC intubations.

There was no difference in unadjusted first-pass intubation success rates between the GlideScope video laryngoscope (82%) and C-MAC (84%) groups (odds ratio [OR] 0.87; 95% confidence interval [CI] 0.54 to 1.42). First-pass success was similar between the GlideScope video laryngoscope and the C-MAC when stratified by subgroups (Table 2) and was also similar between the GlideScope video laryngoscope and the C-MAC after adjustment for important confounders (OR 1.14; 95% CI 0.65 to 2.03).

Overall intubation success was similar between the GlideScope video laryngoscope (96%) and the C-MAC (97%) (unadjusted OR 0.87; 95% CI 0.33 to 2.30). Overall success was similar between the GlideScope video laryngoscope and the C-MAC when stratified by subgroups (Table 2). Overall success was also similar between GlideScope video laryngoscope and C-MAC after adjustment for important confounders (OR 1.19; 95% CI 0.39 to 3.63). See Appendix E1 (available online at <http://www.annemergmed.com>) for multivariate logistic regression.

The median number of attempts was 1 (interquartile range 1 to 1; range 1 to 5). Among 8 C-MACs not achieving overall success, rescue intubation was accomplished by direct laryngoscopy (n = 6), GlideScope video laryngoscope (n=1), and cricothyrotomy (n= 1). Among 9 GlideScope video laryngoscope patients not achieving overall success, rescue intubation was accomplished by direct laryngoscopy (n = 6), cricothyrotomy (n=2), and C-MAC (n=1).

Limitations

This was a single-center study in an academic tertiary care center. Residents performed nearly all intubations. It is unclear whether the findings can be generalized to other clinical settings. Although we had information about the year of training of the emergency medicine residents, experience could vary between residents according to previous number of intubations and experience with each of the devices. The data were subject to self-report and

recall bias. To account for possible confounders, we used a logistic regression model that incorporated a priori selected clinically relevant observed confounders. However, there are possible unknown or unmeasurable confounders that could account for observed differences. Future research should consider randomization of device use, as well as independent observer scoring of the airway difficulty.

Discussion

In this series of intubations performed at a large urban academic ED, we observed no difference in either first-pass or overall success between the C-MAC and the GlideScope video laryngoscope. The similar success rates persisted among important subgroups (including operator training level) and after multivariable adjustment. These data suggest that it may not be the specific device design, but rather the fundamental incorporation of video technology that provides the improved success observed in studies comparing video laryngoscopy to direct laryngoscopy.^{25,32,35,36} According to these findings, clinicians may opt for either GlideScope video laryngoscope or C-MAC, based on individual and institutional preference.

Previous studies suggest that multiple intubation attempts are associated with adverse events such as aspiration, hypoxemia, hypotension, and cardiac arrest.³⁷⁻³⁹ Collectively, these studies point to the prudence of first-pass success in ED intubation efforts. In clinical settings with difficult anatomy, previous studies suggest that video laryngoscopy may result in higher first-attempt success than conventional laryngoscopy.³² Piepho et al²⁵ found that in patients with a Cormack-Lehane grade 3 or 4 view with direct laryngoscopy, the use of video laryngoscope improved glottis visualization in 94% of patients and intubation was successful in all but 1 case. A recent meta-analysis of studies comparing the GlideScope video laryngoscope with direct laryngoscopy found an improved grade of view and first-attempt success rate in intubations performed by “nonexperts;” however, most of the studies analyzed excluded known or predicted difficult intubations.²² For ED intubations, both the GlideScope video laryngoscope and the C-MAC have been shown to increase grade of view and first-attempt success.^{27,32,35}

Despite the similar success rates observed in our series, clinicians should be aware of the fundamental design differences between the GlideScope video laryngoscope and the C-MAC devices. These distinct features require slightly different laryngoscopic techniques. The GlideScope video laryngoscope is designed with a hyperangulated blade. Although allowing indirect visualization of the glottis, this design often requires the use of a specially shaped stylet.⁴⁰ Direct laryngoscopy is not feasible with the GlideScope video laryngoscope, given the hyperacute blade curvature. However, the GlideScope video laryngoscope may be useful in situations in which it is impossible to align the oral, pharyngeal, and laryngeal axes, such as situations involving tongue swelling, pharyngeal obstruction, or cervical spine immobilization.^{2,11,15,41,42} In contrast, the C-MAC design resembles a traditional Macintosh blade, allowing laryngoscopy to be accomplished by either direct laryngoscopy or indirect video visualization. However, in extraordinarily difficult situations in which the visual axes of the airway cannot be aligned, the hyperacute bend of the GlideScope video laryngoscope

may offer an advantage. Practitioners should be aware of these distinctions when choosing a particular video laryngoscope device.

In conclusion in this study of video laryngoscopy in the ED, the C-MAC and the GlideScope video laryngoscope result in similar rates of first-pass and overall intubation success. The GlideScope video laryngoscope and the C-MAC are both excellent options for a video laryngoscopy system in the ED.

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Appendix E1

Logistic regression models for successful intubation.*

	First-Pass Success		Overall Success	
	OR	95% CI	OR	95% CI
Device=GVL (vs C-MAC) [†]	1.1	0.6–2.1	1.2	0.5–3.1
Patient characteristics				
Age	1.0	1.0–1.0	1.0	1.0–1.0
Male [‡]	0.5	0.3–1.0	1.2	0.3–4.1
Trauma [§]	1.6	0.9–3.0	1.0	0.3–3.7
Number of DACs				
0	[Reference]		[Reference]	
1	0.7	0.3–2.0	1.2	0.1–9.4
2	0.3	0.1–0.8	0.4	0.04–3.5
3 or more	0.3	0.1–0.9	0.5	0.05–4.9
Intubation characteristics				
Reason for intubation				
Airway protection	[Reference]		[Reference]	
Respiratory failure	1.3	0.5–3.1	1.6	0.3–8.7
Cardiac arrest	0.2	0.1–0.7	0.6	0.1–5.2
Patient control	1.2	0.4–3.5	N/A//	N/A//
Hypoxia	1.3	0.1–13.6	0.1	0–1.5
Reason for device				
Standard	[Reference]		[Reference]	
Difficult	0.5	0.3–1.2	0.5	0.1–3.1
Education	1.1	0.4–2.6	1.0	0.1–7.2
Paralytic used	[Reference]		[Reference]	
None	1.6	0.4–6.1	1.1	
Rocuronium	1.6	0.4–5.8	0.8	0.1–11.5
Succinylcholine				0.1–5.2
Sedative used				

	First-Pass Success		Overall Success	
	OR	95% CI	OR	95% CI
None	[Reference]		[Reference]	
Etomidate	0.7	0.2–2.6	2.9	0.5–16.0
Ketamine	0.7	0.2–3.0	N/A ^{//}	N/A ^{//}
Propofol	1.9	0.2–20.6	N/A ^{//}	N/A ^{//}
Other	0.2	0.01–4.0	N/A ^{//}	N/A ^{//}

Operator characteristics

Operator PGY

EMR 1	[Reference]		[Reference]	
EMR 2	2.5	1.3–4.7	2.0	0.5–8.5
EMR 3 or attending	2.5	1.4–4.5	0.6	0.2–1.7

* Clustered by provider.

[†] Reference: Female sex.

[‡] Reference: Device=C-MAC.

[§] Reference: Medical.

^{//} Dropped because it predicted success perfectly.

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Table 1

Patient, intubation, and operator characteristics.

Characteristics	N (%; 95% CI)	
	GVL (n=230)	C-MAC (n=233)
Patient characteristics		
Mean age, y*	47.7; 45.2 to 50.2	49.6; 47.1 to 52.1
Sex		
Male	155 (67.4; 61.3 to 73.5)	152 (65.2; 59.1 to 71.4)
Medical/trauma		
Trauma patients	137 (59.6; 53.2 to 66.0)	98 (42.1; 35.7 to 48.5)
DACs		
1 or more	179 (77.8; 72.4 to 83.2)	146 (62.7; 56.4 to 68.9)
Intubation characteristics		
Primary reason for intubation		
Airway protection	150 (65.2; 59.0 to 71.4)	131 (56.2; 49.8 to 62.6)
Respiratory failure	27 (11.7; 7.5 to 15.9)	43 (18.5; 13.4 to 23.5)
Cardiac arrest	30 (13.0; 8.7 to 17.4)	32 (13.7; 9.3 to 18.2)
Patient control	19 (8.3; 4.7 to 11.9)	22 (9.4; 5.7 to 13.2)
Hypoxia	4 (1.7; 0.0 to 3.4)	5 (2.2; 0.3 to 4.0)
Reason for device		
Standard	48 (20.7; 15.6 to 26.2)	63 (27.0; 21.3 to 32.8)
Difficult	153 (66.5; 60.4 to 72.7)	86 (36.9; 30.7 to 43.2)
Education	29 (12.6; 8.3 to 16.9)	84 (36.1; 29.8 to 42.3)
Method of intubation		
Rapid sequence intubation	190 (82.6; 77.7 to 87.5)	194 (83.3; 78.4 to 88.1)
No meds	32 (13.9; 9.4 to 18.4)	34 (14.6; 10.0 to 19.2)
Sedation only	8 (3.5; 1.1 to 5.9)	5 (2.1; 0.3 to 4.0)
Paralytic used		
None	40 (17.4; 12.5 to 22.3)	39 (16.7; 11.9 to 21.6)
Rocuronium	83 (36.1; 29.8 to 42.3)	96 (41.2; 34.8 to 47.6)
Succinylcholine	107 (46.5; 40.0 to 53.0)	98 (42.1; 35.7 to 48.5)
Sedative used		
None	35 (15.2; 10.5 to 19.9)	37 (15.9; 11.2 to 20.6)
Etomidate	175 (76.1; 70.5 to 81.6)	159 (68.2; 62.2 to 74.3)
Ketamine	12 (5.2; 2.3 to 8.1)	27 (11.6; 7.4 to 15.7)
Propofol	7 (3.0; 0.8 to 5.3)	9 (3.9; 1.4 to 6.4)
Other	1 (0.4; -0.4 to 1.3)	1 (0.4; -0.4 to 1.3)
Operator characteristics		
Operator PGY		
EMR 1	53 (23.0; 17.6 to 28.5)	61 (26.2; 20.5 to 31.9)
EMR 2	98 (42.6; 36.2 to 49.1)	90 (38.6; 32.3 to 44.9)
EMR 3 or attending	79 (34.4; 28.2 to 40.5)	82 (35.2; 29.0 to 41.4)

DACs, Difficulty awareness characteristics; *GVL*, GlideScope video laryngoscope; *PGY*, postgraduate year.

* Continuous variable.

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Table 2

Intubation success stratified by patient, intubation, and operator characteristics.

Characteristics	First-Pass Success				Overall Success		
	GVL, %	C-MAC, %	OR (95% CI)*		GVL, %	C-MAC, %	OR (95% CI)*
Sex							
Male	80	81	0.5 (0.3–1.0)		96	96	0.8 (0.3–2.4)
Female	87	90	[Reference]		96	98	[Reference]
Trauma status							
Trauma	81	81	0.7 (0.4–1.2)		95	96	0.6 (0.2–1.5)
Nontrauma	84	87	[Reference]		98	97	[Reference]
Number of DACs							
0	90	94	[Reference]		98	99	[Reference]
1	91	85	0.6 (0.2–1.3)		100	96	0.6 (0.1–3.8)
2	74	80	0.3 (0.1–0.6)		91	98	0.2 (0–1.2)
3 or more	74	64	0.2 (0.1–0.4)		95	92	0.2 (0.1–1.1)
Reason for intubation							
Airway protection	84	89	[Reference]		96	99	[Reference]
Respiratory failure	93	88	1.5 (0.6–3.4)		96	100	2.0 (0.3–16.4)
Cardiac arrest	57	59	0.2 (0.1–0.4)		93	84	0.2 (0.1–0.7)
Patient control	90	86	1.2 (0.4–3.1)		100	100	N/A [†]
Hypoxia	100	80	1.3 (0.2–10.6)		100	80	0.2 (0–2.1)
Reason for device							
Standard	90	92	[Reference]		98	98	[Reference]
Difficult	78	74	0.3 (0.2–0.7)		95	94	0.3 (0.1–1.4)
Education	93	88	0.8 (0.3–2.0)		100	98	1.0 (0.1–7.4)
Operator PGY							
EMR 1	74	75	[Reference]		96	975	[Reference]
EMR 2	84	90	2.2 (1.2–4.0)		98	98	1.7 (0.4–6.8)
EMR 3 or attending	86	84	2.0 (1.1–3.6)		94	95	0.6 (0.2–2.0)
Paralytic used							
None	65	64	[Reference]		93	87	[Reference]

Characteristics	First-Pass Success			Overall Success		
	GVL, %	C-MAC, %	OR (95% CI) *	GVL, %	C-MAC, %	OR (95% CI) *
Rocuronium	89	88	4.1 (2.2–7.9)	98	99	6.6 (1.7–25.6)
Succinylcholine	83	89	3.3 (1.8–6.1)	96	98	3.7 (1.3–11.1)
Sedative used						
None	66	65	[Reference]	91	87	[Reference]
Etomidate	85	88	3.4 (1.9–6.1)	97	98	4.5 (1.7–12.1)
Ketamine	83	85	2.9 (1.1–7.9)	100	100	N/A [†]
Propofol	100	89	8.0 (1.0–64.0)	100	100	N/A [†]
Other	N/A	100	0.5 (0–8.9)	100	100	N/A [†]

* Univariate analysis.

[†] Dropped because it predicted success perfectly.