American Journal of Emergency Medicine 37 (2019) 1336–1339

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Original Contribution

Video screen viewing and first intubation attempt success with standard geometry video laryngoscope use

Kenneth W. Dodd, M.D. [a,b,*], Matthew E. Prekker, M.D., M.P.H. [a,b,c], Aaron E. Robinson, M.D., M.P.H. [a], Ryan Buckley, M.D., M.P.H. [a,1], Robert F. Reardon, M.D. [a,c], Brian E. Driver, M.D. [a,c]

[a] Department of Emergency Medicine, Hennepin County Medical Center, 701 Park Avenue, Minneapolis, MN 55415, United States of America
[b] Division of Pulmonary and Critical Care Medicine, Hennepin County Medical Center, 701 Park Avenue, Minneapolis, MN 55415, United States of America
[c] Department of Emergency Medicine, University of Minnesota Medical School, 717 Delaware Street SE, Suite 508, Minneapolis, MN 55414, United States of America

ARTICLE INFO

Article history:
Received 24 June 2018
Received in revised form 15 October 2018
Accepted 15 October 2018

Keywords:
Intubation
Laryngoscopy
Video laryngoscopy

ABSTRACT

Study objectives: Direct laryngoscopy (DL) is the traditional approach for emergency intubation but video laryngoscopy (VL) is gaining popularity. Some studies have demonstrated higher first-attempt success with VL, particularly in difficult airways. In real-world settings, physicians choose whether or not to view the video screen when utilizing VL devices for tracheal intubation. Therefore, we sought to determine whether screen viewing is associated with higher intubation first-attempt success in clinical practice.

Methods: In this retrospective, observational investigation, we studied consecutive adult emergency department intubations at an urban, academic medical center during the calendar year 2013. Cases were identified from the electronic medical record and analyzed using standard video review methodology. We compared first-attempt success rates when standard geometry Macintosh VL was used, stratified by whether the screen was viewed or not.

Results: Of the 593 cases with videos available for review, 515 (87%) were performed with a standard geometry Macintosh video laryngoscope. First-attempt success was not significantly different when the screen was viewed (195/207; 94% [95%CI 91–97]) compared to when the screen was not viewed (284/301; 94% [95%CI 92–97]). The median first-attempt duration was longer when the screen was viewed compared to when the screen was not viewed (45 versus 33 s; median difference 12 s [95%CI 10–15 s]).

Conclusion: In this study of orotracheal intubations performed by emergency physicians with Macintosh-style VL, the first-attempt success rate was high. The success rate was similar whether or not the intubating physician chose to view the video screen.

1. Introduction

Video laryngoscopy (VL) has rapidly gained favor in emergency airway management [1]. This practice trend is supported by a growing body of evidence showing higher first-attempt success, better laryngeal views, and fewer complications [2-4]. Many experts recommend VL as the exclusive means of orotracheal intubation in the emergency department (ED) [5]. However, direct laryngoscopy (DL) remains a crucial skill for emergency physicians [6].

Standard geometry Macintosh video laryngoscopes can be used for both DL and VL. Physicians can look directly into the airway, look at the video screen, or perform a hybrid of both [7]. The performance of standard geometry VL systems when used as DL devices in real-world practice settings has not been well-studied. Current evidence suggests that the C-MAC (Karl Storz Endoscopy, El Segundo, CA) has higher first-attempt success rates than traditional Macintosh DL [8]. While randomized controlled trials of VL screen viewing do exist [9], such trials do not reflect real-world use of the C-MAC. In clinical practice, the choice of whether or not to view the video screen is reassessed throughout an intubation attempt. Each decision is based upon physician preference, patient characteristics, and the intubating conditions.

The objective of this investigation was to compare the first-attempt success achieved with a standard geometry Macintosh video laryngoscope when the screen is viewed compared to the when the screen is not viewed in a real-world clinical setting.

* Corresponding author at: Department of Emergency Medicine, Hennepin County Medical Center, 701 Park Avenue, Minneapolis, MN 55415, United States of America.
E-mail addresses: Kenneth.Dodd@gmail.con (K.W. Dodd), Matthew.Prekker@hcmed.org (M.E. Prekker), Aaron.Robinson@hcmed.org (A.E. Robinson), buckl203@umn.edu (R. Buckley), Robert.Reardon@hcmed.org (R.F. Reardon), Brian.Driver@hcmed.org (B.E. Driver).
[1] Present Address: Department of Emergency Medicine, Yale School of Medicine, 464 Congress Ave, New Haven, CT 06519.

https://doi.org/10.1016/j.ajem.2018.10.018
0735-6757/

Abbreviations

ED	emergency department
DL	direct laryngoscopy
PGY	postgraduate year
VL	video laryngoscopy

2. Methods

2.1. Study design

We performed a retrospective, observational study utilizing video review as the primary method of data collection. The study was approved by the institutional review board at Hennepin County Medical Center.

2.2. Study setting

We studied consecutive intubations at an urban, Level I trauma center with approximately 100,000 annual ED visits. All airway management in the ED is performed by emergency physicians; the majority of intubations are performed by senior emergency medicine residents (post-graduate year three or higher) under the supervision of the attending emergency physician. All senior residents have extensive tracheal intubation training with DL and VL through didactic sessions, skills labs, airway manikins, hi-fidelity simulation, animal laboratories, and clinical rotations.

The C-MAC was the only VL system with a standard geometry Macintosh blade in our ED during the study period. In our ED, the C-MAC is often used as a teaching device for DL, allowing the resident to intubate with direct visualization while the faculty uses the video monitor to supervise the procedure. Bougie use during the first-attempt is common because of associations with bougie use and improved first-attempt success [10-12].

2.3. Selection of participants

Using the electronic medical record (Epic, Verona, WI), we identified adult ED patients (≥18 years old) who were tracheally intubated during the calendar year 2013 by searching for intubation procedure notes, professional fees for intubation, or documentation of ventilator settings in the ED chart. We reviewed videos for all patients identified in this search. Patients intubated with a device other than the C-MAC were excluded, as were patients with missing videos, those intubated prior to ED arrival, and patients with videos in which it was not possible to determine if the video screen was viewed.

2.4. Methods of measurement

Our video review methodology has been previously described [11]. In brief, critically ill or injured patients receive care in one of four resuscitation bays. Each bay has three high-quality, ceiling-mounted video cameras. Streams from these cameras are combined with the output from the patient cardiac and vital sign monitor as well as the audio recording of the room. These are stored as a single video file on a secure internal database.

Three trained investigators independently viewed all videos and recorded observations on a structured data collection form using REDCap electronic data capture tools. For this study, variables of interest included the intubation indication, obesity, cervical immobilization (cervical collar in place prior to intubation or manual in-line stabilization during intubation), abnormal airway anatomy (facial trauma, anterior neck trauma, angioedema, airway mass, or other obvious abnormality), body fluids visible in the mouth, intubating device used, whether the video screen was viewed by the intubating physician (coded as yes, no, or unable to determine), first intubation attempt duration (time elapsed between inserting and removing the laryngoscope blade regardless of status or position of the endotracheal tube), bougie use, first-attempt success (defined as successful passage of an endotracheal tube with a single insertion of the laryngoscope blade), hypoxemia (oxygen saturation < 90%), and esophageal intubation.

Missing data or data points unable to be determined by video review were left blank with no assumed value. First-attempt success and key variables that could influence first-attempt success were documented by a second video reviewer for 10% of the videos to evaluate interobserver agreement. The age, gender, medications administered, and primary diagnosis for each patient were extracted from the electronic medical record. Video reviewers were not aware of the study question.

2.5. Outcome measures

The primary outcome was first intubation attempt success. Secondary outcomes included first-attempt success without hypoxemia and duration of the first-attempt. Insertion of a laryngoscope blade was considered an attempt, regardless of whether an attempt to pass an endotracheal tube or bougie was performed. Intubation success was defined as intratracheal placement of an endotracheal tube by the treating physicians, usually confirmed by waveform capnography.

2.6. Primary data analysis

Patient characteristics, intubation characteristics are presented, unadjusted first-attempt success, first-attempt success without hypoxemia, and first-attempt duration by screen viewing status are presented. The difference in first-attempt success is presented as the difference of the proportion between intubations completed when the video screen was viewed compared to when the video screen was not viewed, along with the associated 95% confidence interval (95%CI). The median difference in first-attempt duration and 95%CI of the difference in medians between groups is also presented.

We used multivariable logistic regression to further explore whether screen use was independently associated with first-attempt success. To create this model, variables that could influence first-attempt success were selected a priori for the final model; these included screen viewing status (predictor of interest), bougie use [11], neuromuscular blockade [13,14], abnormal airway anatomy, body fluids in the mouth, obesity, and cervical immobilization. We used Stata (version 12.1; StataCorp, College Station, TX) for all data analyses.

3. Results

Of the total 676 intubations identified in the electronic medical record during the study period, 515 (87%) were completed with a standard geometry Macintosh video laryngoscope. Of these, it was possible to determine whether or not the video screen was viewed in 508 videos. In total, the screen was viewed in 207 (40%) cases. Patient and intubation characteristics are presented in Table 1.

First-attempt success was similar when the video screen was viewed (195/207; 94% [95% CI 91–97]) compared to when the video screen was never viewed (284/301; 94% [95% CI 92–97]). First-attempt success without hypoxemia and attempt duration by screen viewing status are presented in Table 2. Interobserver agreement for first-attempt success was 98% (κ value 0.90) and for screen viewing was 95% (κ value 0.86). In the multivariable logistic regression model, screen viewing was not associated with first-attempt success or failure (adjusted odds ratio 0.86 [95% CI 0.38 to 1.97]) (Table 3).

Table 1
Patient demographics and intubation characteristics.

Characteristic	C-MAC screen viewed (n = 207)	C-MAC screen not viewed (n = 301)	Difference (95% CI)
Age, median (IQR) - y	52 (33–62)	47 (30–61)	3 (−1 to 6)
Male gender	155 (75)	199 (66)	9% (1–17%)
Indication: neurologic	76 (37)	121 (40)	−3% (−12 to 5%)
Indication: medical	65 (31)	79 (26)	5% (−3 to 13%)
Indication: trauma	42 (20)	71 (24)	−3% (−11 to 4%)
Cervical immobilization	37 (18)	69 (23)	−5% (−12 to 2%)
Obesity	117 (57)	155 (52)	5% (−4% to 14%)
Abnormal airway anatomy[a]	18/196 (9)	40/288 (14)	−5% (−10 to 1%)
Body fluids in mouth[a]	27/203 (13)	47/299 (16)	−2% (−9 to 4%)
Bougie used	189 (91)	222 (74)	18% (11 to 24%)
Neuromuscular blockade	190 (92)	272 (90)	1% (−4 to 6%)
Sniffing position or head elevated[a]	98/203 (48)	146/293 (50)	−3% (−12 to 6%)
Senior resident (PGY3 or higher) performed intubation	202 (98)	292 (97)	1% (−2 to 3%)

All values are number (%) unless otherwise stated. The difference column displays the median difference or difference in proportion between groups. IQR: interquartile range; PGY: post-graduate year.

[a] For these variables, in a portion of the cases a value was not able to be determined by video review.

4. Discussion

In this study of real-world standard geometry Macintosh video laryngoscope use by emergency physicians, first intubation attempt success was high whether or not the intubating physician chose to view the video screen. The similarity in first-attempt success is likely explained by increased screen utilization for more difficult airways. In our study, we believe that emergency physicians were less likely to view the screen for easier intubations and more likely to view the screen for anticipated or actually difficult airways. This is evidenced by higher bougie use, increased rates of hypoxemia, and longer attempt durations when the screen was viewed.

Although no single randomized trial has definitively demonstrated superiority of VL in a general population of ED patients, current evidence suggests that VL is associated with improved first-attempt success, improved laryngeal views, and fewer intubation-associated complications; this is particularly true in patients with difficult airways [1,2,4,7,8,15,16]. However, video laryngoscopes vary [17], and the C-MAC was the only VL device that was associated with reduced first-attempt failure according to a recent systematic review and meta-analysis [4]. It is not known if VL confers an advantage because physicians view the video screen for most intubations or if simply having a video screen available for difficult or failed intubation attempts improves the intubation process.

In an underpowered randomized trial of the C-MAC used as a VL device compared to use as a DL device, first-attempt success was similar between groups (86% for C-MAC DL; 92% for C-MAC VL) [9]. However, this does not reflect how standard geometry video laryngoscopes are used in clinical practice. Many physicians choose to use these devices as direct laryngoscopes, but view the video screen if the laryngeal view is inadequate or if the initial endotracheal tube passage is not successful. Therefore, first-attempt success rates in actual clinical practice with hybrid screen use are likely higher than intubating physicians use the C-MAC strictly as a DL device [7].

While the advantages of a standard geometry video laryngoscope compared to traditional DL are obvious, these devices also have potential advantages over hyperangulated VL devices (e.g., GlideScope or C-MAC D blade). Like standard geometry devices, sharply-angulated devices frequently achieve grade-1 and grade-2 laryngeal views. However, hyperangulated devices do not allow the operator to perform DL, and tube delivery can be more difficult [17]. Soiling of the airway with body fluids may obscure the camera lens when using any VL device. In theory, intubating physicians using sharply-angulated devices would be at more of a disadvantage because they cannot perform DL as easily; although recent evidence suggests that airway soiling reduces first-attempt success similarly for all devices [18]. Teaching DL to novices may also be improved by use of a standard geometry video laryngoscope [3,19]. This may be particularly important for training programs because supervising physicians can coach the intubating physicians through the procedure if any difficulty is encountered. Many experts believe that novice intubators learn best by performing exclusively standard geometry video laryngoscopy. Perhaps the most significant potential advantage of Macintosh-style VL devices, as demonstrated in this study, is the ability of the intubating physician to choose whether to use the video screen or not. This results in high first-attempt success because of the ability to view the video screen as needed, even if the initial intention was to use the device as a direct laryngoscope.

4.1. Limitations

This study has several notable limitations. The retrospective study design may be subject to biases, though we attempted to limit these biases by adhering to optimal research technique [20]. Moreover, our video review methodology allows abstractors to review high-quality videos and audio recording multiple times, thereby minimizing recall bias and missing data.

These data are from a single ED with rates of bougie use higher than most EDs in the United States. The bougie in particular may have influenced the high first-attempt success rates [10,11]. Therefore, the results may not be generalizable to physicians utilizing different methods. Supervising physicians, who view the screen on every attempt, may coach the residents during difficult airway intubation attempts. However, the purpose of this study was not to investigate whether screen viewing is superior in a matched group of patients but rather to

Table 2
First attempt success and time to intubation by video screen viewing status.

Outcome	Video screen viewed (n = 207)	Video screen not viewed (n = 301)	Difference (95% CI)
First attempt success, no. (%; 95% CI)	195 (94; 91–97)	284 (94; 92–97)	0% (−4% to 4%)
First attempt success without hypoxemia[a], no. (%; 95% CI)	98/130 (75; 68–83)	178/214 (83; 78–88)	−8% (−16% to 1%)
Median first attempt duration, seconds (IQR)	45 (36–60)	33 (26–43)	12 s (10 s to 15 s)

[a] Hypoxemia could not be obtained from the remaining 169 videos (in 113, the vital sign monitor feed failed to be captured with the video stream; in 53, no valid oximetry waveform or value was present at any point during intubation; in 3, a valid oximetry waveform was present only before intubation but not during the attempt).

Table 3
Multivariable logistic regression model for first attempt success.

Variable	Odds ratio	95% confidence interval
C-MAC screen viewed	0.86	0.38 to 1.97
Bougie used	6.77	3.2 to 14.33
Neuromuscular blockade	4.92	2.73 to 8.86
Obesity	1.31	0.65 to 2.64
Abnormal anatomy	1.41	0.35 to 5.72
Body fluids in mouth	0.37	0.13 to 1.01
Cervical immobilization	1.15	0.38 to 3.51

This model examined the 480 subjects who did not have missing values for abnormal anatomy or body fluids in the mouth. In a model including all subjects (assuming missing values to be zero) the results of the model were not significantly different. The Hosmer-Lemeshow statistic for this model was 10.24.

compare first-attempt success rates in real-world use of standard geometry Macintosh VL in which screen viewing was at the operators' discretion.

4.2. Conclusions

In this study of real-world standard geometry Macintosh video laryngoscopy use by emergency physicians, first-attempt success for tracheal intubation was high whether or not the video screen was viewed during the intubation attempt. This suggests that these devices may be safely used for both DL and VL, which may allow for improved supervision and teaching without compromising patient safety.

Financial support

None.

References

[1] Brown CA, Bair AE, Pallin DJ, Walls RM, NEAR III Investigators. Techniques, success, and adverse events of emergency department adult intubations. Ann Emerg Med 2015;65:363–370.e1.
[2] Pieters BMA, Maas EHA, JTA Knape, van Zundert AJ. Video laryngoscopy vs direct laryngoscopy use by experienced anaesthetists in patients with known difficult airways: a systematic review and meta-analysis. Anaesthesia 2017;72:1532–41.
[3] Kelly FE, Cook TM. Routine video laryngoscopy is likely to improve skills needed to use a video laryngoscope when laryngoscopy is difficult. Br J Anaesth 2017;119:842–3.
[4] Lewis SR, Butler AR, Parker J, Cook TM, Schofield-Robinson OJ, Smith AF. Video laryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation: a Cochrane Systematic Review. Br J Anaesth 2017. https://doi.org/10.1093/bja/aex228.
[5] Brown CA, Pallin DJ, Walls RM. Video laryngoscopy and intubation safety: the view is becoming clear. Crit Care Med 2015;43:717–8.
[6] Levitan RM. Video laryngoscopy, regardless of blade shape, still requires a backup plan. Ann Emerg Med 2013;61:421–2.
[7] Sakles JC, Mosier JM, Patanwala AE, Arcaris B. The utility of the C-MAC as a direct laryngoscope for intubation in the emergency department. J Emerg Med 2016;51:349–57.
[8] Sakles JC, Mosier J, Chiu S, Cosentino M, Kalin L. A comparison of the C-MAC video laryngoscope to the Macintosh direct laryngoscope for intubation in the emergency department. Ann Emerg Med 2012;60:739–48.
[9] Driver BE, Prekker ME, Moore JC, Schick AL, Reardon RF, Miner JR. Direct versus video laryngoscopy using the C-MAC for tracheal intubation in the emergency department, a randomized controlled trial. Acad Emerg Med 2016;23:433–9.
[10] Driver BE, Prekker ME, Klein LR, Reardon RF, Miner JR, Fagerstrom ET, et al. Effect of use of a bougie vs endotracheal tube and stylet on first-attempt intubation success among patients with difficult airways undergoing emergency intubation: a randomized clinical trial. JAMA 2018;319:2179–89. https://doi.org/10.1001/jama.2018.6496.
[11] Driver B, Dodd K, Klein LR, Buckley R, Robinson A, McGill JW, et al. The bougie and first-pass success in the emergency department. Ann Emerg Med 2017;70:473–478.e1.
[12] McGill JW, Vogel EC, Rodgerson JD. Use of the gum elastic bougie as an adjunct for orotracheal intubation in the emergency department. Acad Emerg Med 2000;7:526–7.
[13] Wilcox SR, Bittner EA, Elmer J, Seigel TA, Nguyen NTP, Dhillon A, et al. Neuromuscular blocking agent administration for emergent tracheal intubation is associated with decreased prevalence of procedure-related complications. Crit Care Med 2012;40:1808–13.
[14] Li J, Murphy-Lavoie H, Bugas C, Martinez J, Preston C. Complications of emergency intubation with and without paralysis. Am J Emerg Med 1999;17:141–3.
[15] Aziz MF, Dillman D, Fu R, Brambrink AM. Comparative effectiveness of the C-MAC video laryngoscope versus direct laryngoscopy in the setting of the predicted difficult airway. Anesthesiology 2012;116:629–36.
[16] Hoshijima H, Denawa Y, Tominaga A, Nakamura C, Shiga T, Nagasaka H. Video laryngoscope versus Macintosh laryngoscope for tracheal intubation in adults with obesity: a systematic review and meta-analysis. J Clin Anesth 2017;44:69–75.
[17] Levitan RM, Heitz JW, Sweeney M, Cooper RM. The complexities of tracheal intubation with direct laryngoscopy and alternative intubation devices. Ann Emerg Med 2011;57:240–7.
[18] Sakles JC, Corn GJ, Hollinger P, Arcaris B, Patanwala AE, Mosier JM. The impact of a soiled airway on intubation success in the emergency department when using the GlideScope or the direct laryngoscope. Acad Emerg Med 2017;24:628–36.
[19] Herbstreit F, Fassbender P, Haberl H, Kehren C, Peters J. Learning endotracheal intubation using a novel video laryngoscope improves intubation skills of medical students. Anesth Analg 2011;113:586–90.
[20] Kaji AH, Schriger D, Green S. Looking through the retrospectoscope: reducing bias in emergency medicine chart review studies. Ann Emerg Med 2014;64:292–8.