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Original Research

First-Pass Success Intubations Using Video Laryngoscopy Versus Direct Laryngoscopy: A Retrospective Prehospital Ambulance Service Study

Christopher M. Eberlein, MD¹, Isidora S. Luther, RN, NP^{1,*},
 Tom A. Carpenter, NRP, CCEMT-P, FPC², Luis D. Ramirez, MPH³

¹ Department of Emergency Medicine, Gundersen Health System, La Crosse, WI

² Department of Emergency Medical Services, Gundersen Health System, La Crosse, WI

³ Department of Medical Research, Gundersen Health System, La Crosse, WI



A B S T R A C T

Objective: In emergency medicine, endotracheal intubation is the gold standard for airway management. First-pass intubation success is beneficial because it secures the patient airway more quickly and avoids complications associated with repeated attempts, such as bleeding and swelling of soft tissue. The key to first-pass success is the ability to visualize the laryngeal inlet. Visualization can be accomplished using traditional direct laryngoscopy or video laryngoscopy. The purpose of our study was to compare the rate of successful first-pass endotracheal intubations using a video laryngoscope with that using a direct visualization laryngoscope in a prehospital emergency setting.

Methods: We retrospectively reviewed data that had been prospectively collected in our emergency department regarding patients who underwent endotracheal intubation performed by personnel from a single local ambulance service from January 1, 2014, through December 31, 2015.

Results: One hundred eighty-one patients were intubated using video laryngoscopy and 115 using direct visualization laryngoscopy. The first-pass endotracheal intubation success rate using video laryngoscopy was 12.6% higher than with direct laryngoscopy.

Conclusion: This retrospective study shows that video laryngoscopy had a higher first-pass success rate than direct laryngoscopy. This is promising because decreasing failure rates provide better patient outcomes.

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Under emergent prehospital conditions, patient survival may depend on quick assessment and critical thinking regarding airway management.¹ Appropriate airway management can decrease the risks of aspiration, dysrhythmias, hypotension, and cardiac arrest.²

In emergency medicine, endotracheal intubation remains the gold standard for airway management.³ Several variables can render intubation difficult including provider skill level; the presence of facial trauma or cervical spine injury; variations in the patient's body, such as obesity, a small mouth, or small mandible; medications; and equipment used. Multiple intubation attempts can cause bleeding, swelling of soft tissues, aspiration pneumonia, pneumothorax, and oxygenation desaturation.⁴ Sakles et al² found that multiple attempts at intubation increase the risk of adverse events. When intubation is

not possible, the use of an alternative airway adjunct, such as surgical airway management, may be required.

Crucial to first-pass success is the ability to visualize the laryngeal inlet; approaches for this include direct and video laryngoscopy. Howard-Quijano et al⁵ reported first-pass success rates as low as 18% after 80 intubations for anesthesia residents in a controlled setting. Some have reported that video laryngoscopy can increase first-pass intubation success rates for paramedics in the prehospital setting,⁶ thus minimizing complications. In a pilot mannequin study, Kim et al⁷ found that video laryngoscopes provide better laryngeal views and promote success, even with difficult airways during compressions.

The purpose of the current study was to compare the first-pass success rate using video laryngoscopy with that using direct visualization laryngoscopy in the prehospital setting. An ambulance service that runs approximately 14,000 calls annually was used for this study. The crew consists of paramedics with experience ranging from 0 to 30 years.

* Address for correspondence: Isidora S. Luther, RN, NP, Mail Stop LM1-001, 1900 South Avenue, La Crosse, WI 54601

E-mail address: isluther@gundersenhealth.org (I.S. Luther).

Crews include emergency medical technicians-basic, paramedics, and critical care paramedics. The ambulance is staffed with any combination of the aforementioned. In this study, 4.11% were staffed by a crew consisting of two critical care paramedics, 23.97% with one paramedic (performer) and one emergency medical technician-basic (assistant), 0.68% with 1 paramedic nontransporting emergency medical service (EMS) vehicle (fly car), and 71.23% with two paramedics.

In 2014, all EMS personnel were provided education and hands-on training of the McGrath MAC video laryngoscope (Covidien, Minneapolis, MN) by a company representative. Any new personnel were given education during the orientation process. Since implementation of the McGrath videoscope, they were provided annual training, until the last two years when they increased education to quarterly training including lecture and skills.

Materials and Methods

After obtaining institutional review board approval, we retrospectively reviewed a prospectively collected deidentified database maintained in our emergency department regarding patients who underwent prehospital intubation from January 1, 2014, to December 31, 2015, while under the care of personnel of the local ambulance service. Data collected included sex; age; estimated body weight; type of laryngoscope used (video or direct); first-pass success or failure; and response, on-scene, and transport times. Video laryngoscopy was conducted using a McGrath MAC video laryngoscope, and direct laryngoscopy was performed using either a Macintosh or Miller laryngoscope.

The emergency services educator collected all data from standardized Wisconsin Ambulance Run Data System (WARDS) reports. The reports were self-reported by EMS personnel. Chart abstraction was taken from chart review and placed on an Excel (Microsoft, Redmond, WA) spreadsheet. Any missing data from the chart were discussed with the crew directly.

Continuous variables (eg, response time) were analyzed using 2-sample *t* tests. Categorical variables (eg, first-pass success or sex) were analyzed using chi-square tests. Data analyses were completed using SAS software, Version 9.4 (SAS Institute, Cary, NC), and *P* < .05 was considered statistically significant.

Results

Two hundred ninety-six patients were included in the study, 199 men and 97 women. Intubation was completed using direct laryngoscopy in 115 patients and video laryngoscopy in 181 patients.

The overall first-pass success rate was significantly higher for video than for direct laryngoscopy (85.6% vs. 73.0%, respectively; *P* = .0074). The patient population had an average age of 59.9 years and an average estimated weight of 194.5 lb. Most patients (242/296, 81.8%) were admitted for general medical reasons. The emergency medical team had a mean time to tube of 17.9 minutes, a mean response time of 11.7 minutes, and a mean transportation time of 18.5 minutes (Table 1).

We found no significant differences in first-pass success rates by age, weight, patient type, or intubation details. Direct and video first-pass success rates were also similar by response time, time to tube, scene time, and transport time. The video first-pass success rate was significantly higher than that by direct visualization for men (85.1% vs. 68.0, respectively; *P* = .0070). Weight trended toward significance for first-pass success by direct versus video (205.5 lb vs. 187.5 lb, respectively; *P* = .0561). Patients who were in cardiac arrest had a lower number of intubations because of the use of supraglottic airway devices.

Mortality including hospital to discharge survival was not obtained because of patients being taken to multiple facilities. We were able to collect peri-intubation arrests on all patients included in this study. In 2014, there were six peri-intubation arrests during EMS care. This included three direct visualization and three video intubations. Of the three that used a videoscope, two had first-pass success. In 2015, there were two peri-intubation arrests, both with first-pass successes using videoscope.

Discussion

Direct laryngoscopy is a difficult skill to teach because only one individual can visualize the vocal cords at a time. Using video camera technology, video laryngoscopy indirectly visualizes the airway structure to guide intubation, allowing more than one individual to see airway landmarks on the screen.

The McGrath MAC is an easily managed lightweight video laryngoscope. Two benefits of this compact system are that the batteries are easy to change and that minimal room is needed for storage. The McGrath MAC is a hybrid device that can be used for direct or video visualization, making this a versatile tool for staff with a variety of expertise. Video laryngoscopy can require less training and may be a useful tool for intubation, especially in the novice caregiver. Two areas of concern with the McGrath are an occasional flicker of screen and palate perforation because of the anterior angle of the blade.⁸

Table 1
First-Pass Intubation Success by Patient Characteristics, Prehospital Variables, and Scope Used^a

Characteristic	Total Population	Overall First-Pass Success	Direct	Direct First-Pass Success	Video	Video First-Pass Success	<i>P</i> Value
All patients	296	239 (80.7)	115	84 (73.0)	181	155 (85.6)	.0074
Mean age ± SD (y)	59.9 ± 20.6	60.2 ± 20.2	57.6 ± 21.2	57.4 ± 19.2	61.4 ± 21.2	61.7 ± 20.6	.1156
Sex, n (%)							.7054
Men	199 (67.3)	156 (78.4)	78 (39.2)	53 (68.0)	121 (60.8)	103 (85.1)	.0070
Women	97 (32.8)	83 (85.6)	37 (38.1)	31 (83.8)	60 (61.9)	52 (86.7)	.9243
Mean weight ± SD (lb) ^a	194.5 ± 68.2	193.2 ± 65.7	208.3 ± 71.3	205.5 ± 70.6	186.8 ± 65.3	187.5 ± 62.8	.0561
Patient type, n (%)							.3771
Adult medical	242 (81.8)	196 (80.7)	94 (38.7)	68 (72.3)	148 (61.0)	128 (86.5)	
Adult trauma	44 (14.9)	38 (86.4)	19 (43.2)	16 (84.2)	25 (56.8)	22 (88.0)	
Pediatric medical	7 (2.4)	4 (57.1)	0 (0.0)	0 (0.0)	7 (100)	4 (57.1)	
Pediatric trauma	3 (1.0)	1 (33.3)	2 (66.7)	0 (0.0)	1 (33.3)	1 (100)	
Intubation detail, n (%)							.4111
Medication assisted	4 (1.4)	4 (100)	0 (0.0)	0 (0.0)	4 (100)	4 (100)	
No medication	139 (47.1)	99 (71.2)	61 (43.9)	37 (60.1)	78 (56.1)	62 (79.5)	
Rapid sequence	153 (51.5)	136 (88.9)	54 (35.3)	47 (87.0)	99 (64.8)	89 (89.9)	
Mean response time ± SD, min	11.7 ± 12.8	11.4 ± 11.7	10.7 ± 9.1	10.6 ± 9.8	12.3 ± 14.6	11.9 ± 12.6	.4315
Mean time to tube ± SD, min	17.9 ± 11.8	18.3 ± 12.4	15.0 ± 9.8	16.4 ± 10.5	18.4 ± 12.1	18.6 ± 12.66	.4828
Mean scene time ± SD, min	30.9 ± 13.0	30.4 ± 12.4	29.8 ± 13.3	29.5 ± 13.2	31.5 ± 12.8	30.9 ± 12.0	.4804
Mean transport time ± SD, min	18.5 ± 16.6	18.3 ± 14.6	20.9 ± 15.3	21.1 ± 16.0	18.2 ± 16.8	18.0 ± 14.5	.5117

SD = standard deviation.

^a Weights are prehospital estimates provided by ambulance personnel.

Our study has limitations. First, heights were not documented, and weights were estimated; thus, whether patient body mass index affects first-pass success is unknown. In addition, our database was created for quality improvement purposes, so data collection was not extensive, rendering multivariate analysis impossible. Self-reporting is subject to the potential for bias, including selective reporting. Third, we could not control for paramedic experience or expertise because it was not possible to dictate which crew would respond to an emergency call. Natural turnover in personnel further complicates any attempt to control for paramedic characteristics. Furthermore, whether to use direct versus video laryngoscopy is not governed by any set protocols; rather, that decision is left to the paramedic's experience, education, and clinical judgment. Lastly, training for video laryngoscopy was provided from April 2014 through June 4, 2014, with data collected for only 2 years. A study with a longer duration and larger sample size is needed.

Conclusion

In the prehospital setting, video laryngoscopy showed a higher first-pass success rate over direct laryngoscopy (85.6% vs. 73%). Decreasing first-pass intubation failure rates promotes better patient prognosis and a decrease in adverse events. As shown in previous studies, video laryngoscopy has advantages when it comes to more difficult airways or head injuries, is easier to use, and provides a better view of the airway.⁹ Our finding that the first-pass success rate is higher using video rather than direct laryngoscopy is useful, but it does not reduce the need for continuing staff education or policies requiring that staff maintain intubation competencies. Future studies that control for such variables as paramedic training and experience, patient body mass index, and patient condition or type of injury might have an impact on direct and video first-pass success rates. Nevertheless, preliminary results appear promising and are corroborated by other studies.¹⁰⁻¹⁴

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Supplementary materials

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1016/j.amj.2019.06.004>.

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