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ORIGINAL RESEARCH

Airway

Video laryngoscopy is associated with improved first-pass intubation success compared with direct laryngoscopy in emergency department trauma patients

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Abstract

Objective: We aimed to assess differences in (1) first-pass intubation success, (2) frequency of a hypoxic event, and (3) time from decision to intubate to successful intubation among direct laryngoscopy (DL) versus video laryngoscopy (VL) intubations in emergency department (ED) patients with traumatic injuries.

Methods: This retrospective cohort study was performed at a Level I trauma center ED where trauma activations are video recorded. All patients requiring a Level I trauma activation and intubation from 2016 through 2019 were included. Multivariable logistic regression was used to assess the association between initial method of intubation and first-pass success. Differences in frequency of a hypoxic event and time to successful intubation were assessed using bivariate tests.

Results: Of 164 patients, 68 (41.5%) were initially intubated via DL and 96 (58.5%) were initially intubated via VL. First-pass success for DL and VL were 63.2% and 79.2%, respectively. In multivariable regression analysis, VL was associated with higher odds of first-pass intubation success compared with DL (odds ratio: 2.28; 95% confidence interval: 1.04, 4.98), independent of mechanism of injury, presence of airway hemorrhage or obstruction, and experience of intubator. Frequency of a hypoxic event during intubation was not significantly different (13.2% for DL and 7.3% VL; $P = 0.1720$). Median time from decision to intubate to successful intubation was 7 minutes for both methods.

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Conclusions: Video laryngoscopy, compared with direct laryngoscopy, was associated with higher odds of first-pass intubation success among a sample of ED trauma patients. Frequency of a hypoxic event during intubation and time to successful intubation was not significantly different between the 2 intubation methods.

KEYWORDS
direct laryngoscopy, intubation, resuscitation, trauma, video laryngoscopy

1 | BACKGROUND

Intubation is a fundamental skill in emergency medicine and a life-saving procedure for critically ill and severely injured patients. Direct laryngoscopy (DL) has historically been the standard method of performing endotracheal intubation.[1] However, over the past 20-years, video laryngoscopy (VL) has been used with increasing frequency in a variety of clinical settings, including the out-of-hospital, emergency department (ED), intensive care unit (ICU), and operating room settings.[1]

Patients with traumatic injuries often require cervical spine immobilization and may have facial injuries or airway obstruction and hemorrhage, making intubation conditions more difficult than patients without traumatic injuries.[2,3] Hyperangulated VL blades offer the benefit of improved glottic visualization without head and neck manipulation; however, the ability to insert an endotracheal tube may be more difficult with VL.[4,5] One prior randomized controlled trial found similar mortality and first-pass intubation success rates for VL and DL,[6] and another found similar success rates for both VL and DL among trauma patients.[7] Further, some studies have found that VL is associated with higher frequency of complications, such as hypoxia, compared with DL.[4,7,8]

1.1 | Importance

Results are mixed regarding the first-pass success of endotracheal intubation using VL in comparison with DL. Several randomized controlled trials demonstrate similar first-pass intubation success for VL and DL.[5–8] Other randomized controlled trials demonstrate higher success for VL when intubation was performed by residents or critical care fellows,[9,10] one ICU study demonstrated lower intubation success with VL,[11] and 2 out-of-hospital studies demonstrate lower success for VL.[12,13] Several meta-analyses have also found similar first-pass success for video and direct laryngoscopy,[14–16] although the success of intubation by novices was improved with VL.[16]

Video recording and review of trauma resuscitations has emerged as a reliable tool for quality improvement and research.[17–19] Video review allows for more accurate observation of events during trauma resuscitations and can supplement medical record and flow sheet documentation. Because of the synchronous nature of many trauma resuscitation events, medical record documentation of events and timing of events is often incomplete and inaccurate.[17–19] Therefore, incorporating data obtained from video review for research may be more accurate than solely relying on reports or data documented in medical records. In this study, we reconciled data from medical records, trauma flow sheets, and video recordings to derive the most accurate dataset possible. Given the paucity and mixed results of studies on first-pass intubation success for VL compared with DL among ED patients with severe traumatic injuries, we sought to determine first-pass intubation success for VL versus DL among this unique population.

1.2 | Goals of this investigation

The objectives of our study were to assess differences in (1) first-pass intubation success, (2) frequency of a hypoxic event during intubation, and (3) time from decision to intubate to successful intubation among DL and VL intubations in ED patients requiring a Level I trauma activation. We hypothesized that first-pass intubation success would be higher for VL compared with DL, frequency of hypoxic events would be higher with DL compared with VL, and time from decision to intubate to successful intubation would not be significantly different among the 2 groups of patients.

2 | METHODS

2.1 | Study design and setting

This was a retrospective cohort study of patients arriving to the ED of North Shore University Hospital between January 1, 2016 and December 31, 2019. The STROBE guidelines were used for reporting this study. Part of the Northwell Health system, North Shore University Hospital, located in Manhasset, New York, is a 756-bed quaternary care facility, American College of Surgeons-verified Level I adult trauma center, with residency programs in emergency medicine and general surgery. The ED cares for approximately 90,000 patients per year. During the study period, the mean number of Level I trauma activations was 242 per year and mean number of Level II trauma activations was 448 per year. This study was approved by Northwell Health's Institutional Review Board with a waiver of informed consent.

2.2 | Selection of participants

Patients ≥18 years of age requiring a Level I trauma activation and intubation were included in this study. As part of our trauma video review program, we have been tracking intubation outcomes since 2016. We excluded patients who were already intubated upon ED arrival. Video laryngoscopy in our ED is performed with a hyperangulated GlideScope and a rigid GlideRite stylet is used for endotracheal tube placement. Intubation decisions are made in conjunction by emergency and trauma attending physicians. In general, patients receive rapid sequence intubation medications unless they are in traumatic cardiac arrest or receiving fiberoptic intubation; however, this was not specifically analyzed in this study. Intubations are typically performed by emergency medicine residents with supervision from emergency attending physicians.

Emergency medicine residents at our institution are trained in intubation on mannequins during their first week of orientation as part of their Advanced Cardiovascular Life Support training. During their first month of residency, they spend 2 days learning and practicing DL and VL intubation methods on fresh frozen cadavers. During their first year of training, residents also complete 6 weeks of training with the Department of Anesthesiology, where they are exposed to both DL and VL intubation methods and are always directly observed by an attending physician for all intubations. On average, our emergency medicine residents complete 64 intubations by the end of their first year and 128 intubations by the end of their third and final year of residency training. All emergency attending physicians have completed an emergency medicine residency program accredited by the Accreditation Council for Graduate Medical Education, where airway management was part of their required curriculum. Intubators are free to use the intubation method of their choice, and our residency programs do not favor one method over the other. Junior emergency medicine residents also respond to Level I trauma activations and occasionally intubate at the discretion of the emergency attending physician. Physician assistants and fellows cover Level I trauma activations when emergency medicine residents are at weekly educational conferences. Regardless of who performs the intubation, they are always supervised by an emergency attending physician. If a patient develops hypoxia, subsequent intubation attempts are performed by the attending physician.

In our ED, Level I trauma activation patients are treated in 1 of 4 resuscitation rooms equipped with video and audio recording capabilities. The charge nurse activates the recording capabilities and the entire patient assessment and treatment process, from preparation to removal of the patient from the room, is recorded. All Level I trauma activation recordings are reviewed for quality improvement purposes. A standardized data collection form is used to collect data gathered from the video recordings and data are entered into our institutional trauma registry (Trauma One, Lancet Technology, Inc., Boston, MA, USA). The trauma registry is maintained by a dedicated trauma program manager and includes information on injured patients consistent with the National Trauma Data Bank (NTDB) standards.
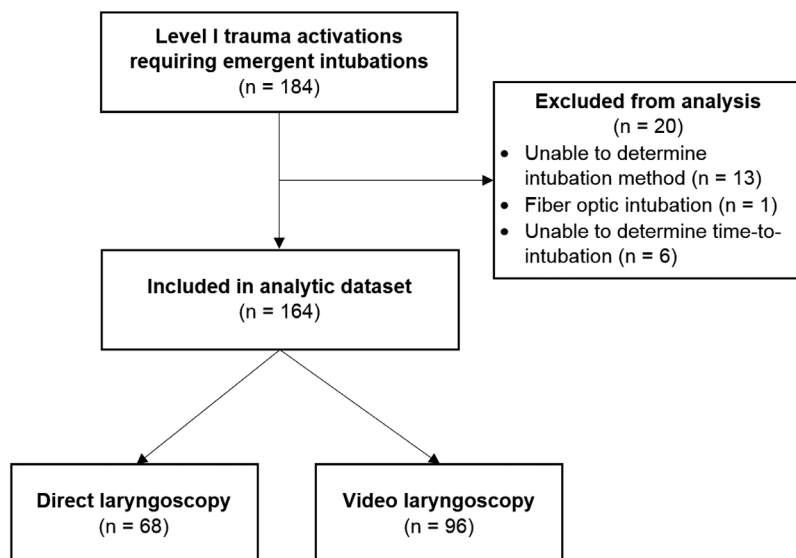

The Bottom Line

Debate still remains as to whether video laryngoscopy should be preferred over direct laryngoscopy to secure the airway in the emergency department. This retrospective cohort study of 164 trauma patients requiring intubation found higher rates of first-pass success with video laryngoscopy (72%) versus direct laryngoscopy (63%) with equal frequency of hypoxic events occurring during the procedure.

Additional patient care data are collected in the trauma registry on patients receiving trauma resuscitation by the acute care surgery team. Intubation activities are also documented in the electronic medical record through procedure notes and manually documented on trauma flow sheets, including number of intubation attempts, whether medications were administered, time of intubation, endotracheal tube size and placement location, and hemodynamic parameters before and after intubation.

2.3 | Study protocol

Level I trauma activation patients requiring intubation were retrospectively identified through the trauma registry. Relevant variables were downloaded from the trauma registry, including patient age, sex, initial vital signs, use of rapid sequence intubation, mechanism of injury, indication for intubation, time decision to intubate was made, time of successful intubation, intubator, and disposition from the ED. Patients' electronic medical records were then accessed by trained abstractors (AV, GH, AD, AN) who were blinded to the outcomes of the study to manually abstract additional data regarding details of the intubation on procedure notes and trauma flow sheets, including number of intubation attempts, method of intubation for each attempt, intubator performing each attempt, and presence of a hypoxic event (peripheral oxygen saturation <90%). All abstractors received standardized training from the principal investigator before starting chart abstractions and a standardized electronic data collection form was used. Data from all 3 sources (trauma registry; physician and procedure notes; and trauma flow sheets) pertaining to our outcome measures were reconciled. When the data sources conflicted, data from the trauma registry were used primarily, as data from the trauma registry are derived from video review and deemed to be the most accurate; trauma flow sheets were secondary, and physician or procedure notes were tertiary. Patients with discrepancies were reviewed by the trained abstractor and principal investigator. Missing data and outliers were verified through reviewing the medical records and checking the trauma registry. If the primary independent variable and outcome measures could not be ascertained for a patient through all 3 data sources, the patient was excluded from the analysis.

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FIGURE 1 Patient inclusion and exclusion

2.4 | Outcome measures

All outcome measures were defined *a priori*. The primary outcome measure of this study was first-pass intubation success, which was operationalized as a dichotomous variable (successful vs not successful). An intubation attempt was deemed not successful if the direct or video laryngoscopy blade was placed in the patient's mouth and then completely withdrawn without a confirmed placement of an endotracheal tube. Secondary outcomes measures were frequency of a hypoxic event during intubation and time to successful intubation. A hypoxic event during intubation was defined as a peripheral oxygen saturation of <90% from the initial time the laryngoscope blade was placed in the patient's mouth until the completion of postintubation assessment after confirmation of the endotracheal tube, which was at the discretion of the video and chart reviewers. Time to successful intubation was defined as the time interval from the time the decision to intubate was made to the time intubation was confirmed with auscultation and either qualitative or quantitative end tidal capnography. The starting time for time to successful intubation was the time that the clinical team made the decision to intubate; this was determined based on video review when the decision to intubate was verbalized by the team on video.

2.5 | Statistical analysis

Descriptive statistics were used to describe the study sample. Because of the non-normal distribution of continuous variables, medians and interquartile ranges (IQRs) are reported. Frequencies and proportions are reported for categorical variables. The study sample was stratified into 2 groups: (1) patients whose first intubation attempt was via direct laryngoscopy, and (2) patients whose first intubation attempt was via video laryngoscopy. Unadjusted absolute differences in our 3 outcomes measures (first-pass intubation success, frequency of a

hypoxic event during intubation, and time to successful intubation) based on initial method of intubation were reported. Chi-square tests and a Wilcoxon rank sum test also were - conducted to assess for differences in our outcomes by initial intubation method. A multivariable logistic regression model was constructed to assess the independent association between initial intubation method and first-pass intubation success. Preintubation patient characteristics between DL and VL patients were not significantly different, with the exception of mechanism of injury. Presence of airway hemorrhage or obstruction and experience of intubator are considered clinically relevant.[9–11,20,21] Therefore, these 3 covariates (mechanism of injury, presence of airway hemorrhage or obstruction, and experience of intubator) were included in our multivariable regression model.

Body mass index (BMI) also may be an important factor that influences intubation success,[15,20,21] but BMI was not available for approximately 12% of our study sample. We controlled for BMI in a sensitivity analysis, and the effect estimate of interest was essentially unchanged; therefore, we chose not to control for BMI in our final regression model. The Hosmer-Lemeshow goodness-of-fit test was used to assess model fit.[22] All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC, USA).

3 | RESULTS

3.1 | Characteristics of study subjects

During the study period, there were a total of 184 Level I trauma activations requiring intubation in our ED. We were unable to determine the intubation method for 13 patients, one patient was intubated fiber optically during the initial attempt, and we were unable to determine time to successful intubation for 6 patients. Therefore, a total of 20 patients were excluded from our analysis; our analytic study sample comprised 164 patients (Figure 1).

Patient characteristics for the study sample, stratified by initial intubation method, are presented in Table 1. The median age of the study sample was 60 years, 68.9% were male, 41.5% had initial intubation attempt with DL, and 58.5% had initial intubation attempt with VL. Initial vital signs, including heart rate, respiratory rate, systolic blood pressure, peripheral oxygen saturation, and Glasgow Coma Scale (GCS) score, were not significantly different between patients intubated via DL compared with VL. Median Injury Severity Score was 10 and did not differ between DL and VL patients. The distribution of mechanism of injury was different between the 2 groups of patients; falls were the most common mechanism of injury, with 48.5% of DL patients and 42.7% of VL patients suffering from a fall. There were also more VL patients injured by a motor vehicle or motorcycle crash compared with DL patients (30.2% vs 14.7%). The majority of patients (57.3%) were intubated owing to a GCS score <9 and risk for deterioration secondary to intracranial hemorrhage (26.8%). The majority (70.7%) of intubations were performed by senior emergency medicine residents (third- and fourth-year residents) and overall mortality was 29.1%.

3.2 | Main results

Our 3 outcome measures by initial intubation method are presented in Table 2. First-pass intubation success was significantly higher for VL compared with DL (79.2% vs 63.2%; absolute difference of 16.0%; $P = 0.0243$). Frequency of a hypoxic event during intubation was not significantly different between VL and DL (7.3% vs 13.2%; absolute difference of 5.9%; $P = 0.1720$). Median time to successful intubation was also not significantly different for VL and DL (7 minutes, IQR: 5, 9 vs 7 minutes, IQR: 5, 8) ($P = 0.1752$).

Results of our multivariable logistic regression model of the association between initial intubation method and first-pass intubation success are presented in Table 3. After adjusting for mechanism of injury, presence of airway hemorrhage or obstruction, and experience of intubator, video laryngoscopy was significantly associated with higher odds of first-pass intubation success (adjusted odds ratio: 2.28; 95% confidence interval: 1.04, 4.98) when compared with direct laryngoscopy. The Hosmer-Lemeshow goodness-of-fit test indicated good model fit ($P = 0.9836$). When we adjusted for patient BMI in a sensitivity analysis, our results were not substantially different (adjusted odds ratio: 2.36).

4 | LIMITATIONS

Our study has several limitations. First, this study included only patients from a single ED and thus, results may not generalize to other EDs that may have varying levels of expertise, resources, and personnel. Further, 58.5% of the 164 patients analyzed had VL as their initial intubation attempt, compared with 41.5% of patients who had DL; this seems to indicate that intubators at our institution attempt intubation with VL more frequently than DL for patients with traumatic injuries. Because our intubators use VL more frequently, they may be more pro-

ficient with VL. This reflects the actual clinical practice at our institution, which may not be the case at other institutions. Second, we were unable to analyze our data on time to successful intubation in seconds, as times in our trauma registry and trauma flow sheets are recorded in the hour:minute format. Third, 19 patients were excluded from our analysis because the trauma registry and medical record documentation did not capture the method of intubation or time to successful intubation for these patients. The videos are automatically deleted every 28 days to protect patient confidentiality; therefore, we were unable to review the videos to ascertain method of intubation. Fourth, the presence or absence of a cervical collar during intubation attempts was not captured by our trauma registry and was not consistently documented in the medical record; therefore, we do not have data on this variable for the 2 groups of patients. Fifth, we were missing information on the presence of a hypoxic event during intubation for 36.6% of our study sample. The majority of these patients arrived to our ED in the year 2016, and hypoxic events were not specifically tracked by our trauma registry until 2017. We included these patients in our analysis by creating a "not documented" category. However, the chi-square test P value was not substantially different in a sensitivity analysis that excluded these patients. Because of the missing data and the low frequency of hypoxic events during intubation, this outcome is likely underpowered to detect a difference between VL and DL. Lastly, the retrospective, non-randomized nature of our study might have biased our results. Other factors not captured in our study might have influenced intubators' selection of initial intubation method.

5 | DISCUSSION

In this study, we found that video laryngoscopy, compared with direct laryngoscopy, was associated with higher first-pass intubation success among a sample of ED patients with traumatic injuries, independent of mechanism of injury, presence of airway hemorrhage or obstruction, and experience of the intubator. We also found that frequency of a hypoxic event from intubation and time to successful intubation were not significantly different between the 2 intubation methods. These findings are clinically significant, as first-pass intubation success is the primary, and most important, outcome of our study, and video laryngoscopy was not associated with adverse, patient-centered outcomes.

Our results contrast with those found in several studies that assessed differences in first-pass intubation success between VL and DL; many of them found that first-pass intubation success was not different between the 2 intubation methods.[4–8,14–16,23] Several studies found first-pass intubation success to be higher among patients intubated via VL compared with DL.[9,10,16] We are aware of only 2 studies that specifically examined VL compared with DL in ED patients with traumatic injuries.[6,7] Both of these studies found no difference in first-pass intubation success between VL and DL for trauma patients and Yeatts et al[6] found that VL was associated with a higher incidence of hypoxia and longer intubation times, compared with DL.

TABLE 1 Patient characteristics stratified by initial intubation method

Variable	Total sample (n = 164)	Direct laryngoscopy (n = 68)	Video laryngoscopy (n = 96)
Median (IQR)	60 (40, 79)	56 (32, 80)	61 (41, 79)
Sex			
Male, n (%)	113 (68.9%)	46 (67.7%)	67 (69.8%)
Female, n (%)	51 (31.1%)	22 (32.4%)	29 (30.2%)
Injury Severity Score (n = 147)			
Median (IQR)	10 (4, 25)	10 (4, 22)	10 (4, 25)
ED heart rate, per minute			
Median (IQR)	92 (75, 112)	95 (76, 111)	91 (75, 113)
ED respiratory rate, per minute (n = 162)			
Median (IQR)	20 (16, 23)	18 (16, 22)	20 (17, 24)
ED systolic blood pressure, mmHG (n = 162)			
Median (IQR)	137 (121, 160)	134 (118, 160)	138 (122, 160)
Oxygen saturation, % (n = 163)			
Median (IQR)	98 (96, 100)	99 (95, 100)	98 (96, 100)
ED Glasgow Coma Scale (n = 163)			
Median (IQR)	10 (6, 14)	9 (4, 14)	11 (7, 14)
Body mass index, kg/m^2 (n = 145)			
Median (IQR)	26 (23, 30)	26 (24, 28)	26 (23, 30)
Rapid sequence intubation medications			
Administered, n (%)	152 (92.7%)	61 (89.7%)	91 (94.8%)
Not administered, n (%)	12 (7.3%)	7 (10.3%)	5 (5.2%)
Mechanism of injury			
Bicyclist or pedestrian struck, n (%)	17 (10.4%)	4 (5.9%)	13 (13.5%)
Fall, n (%)	74 (45.1%)	33 (48.5%)	41 (42.7 %)
Motorcycle or motor vehicle crash, n (%)	39 (23.8%)	10 (14.7%)	29 (30.2%)
Assault, n (%)	17 (10.4%)	15 (22.1%)	2 (2.1%)
Burns, n (%)	1 (0.6%)	0 (0.0%)	1 (1.0%)
Suicide attempt, n (%)	2 (1.2%)	1 (1.5%)	1 (1.0%)
Other, n (%)	14 (8.5%)	5 (7.4%)	9 (9.4%)
Indication for intubation[a]			
GCS <9, n (%)	94 (57.3%)	41 (60.3%)	53 (55.2%)
Airway hemorrhage or obstruction, n (%)	16 (9.8%)	9 (13.2%)	7 (7.3%)
Preprocedure, n (%)	14 (8.5%)	9 (13.2%)	5 (5.2%)
Hypoxia, n (%)	12 (7.3%)	2 (2.9%)	10 (10.4%)
Risk for deterioration secondary to hemorrhagic shock, n (%)	9 (5.5%)	4 (5.9%)	5 (5.2%)
Risk for deterioration secondary to intracranial hemorrhage, n (%)	44 (26.8%)	14 (20.6%)	30 (31.3%)
Other, n (%)	36 (22.0%)	17 (25.0%)	19 (19.8%)
Type of intubator performing initial attempt			
Fellow/Attending/Anesthesia/Surgeon, n (%)	22 (13.4%)	8 (11.8%)	14 (14.6%)
Fellow	7 (4.3%)	1 (1.5%)	6 (6.3%)
Emergency attending physician	10 (6.1%)	5 (7.4%)	5 (5.2%)
Anesthesia	3 (1.8%)	0 (0.0%)	3 (3.1%)
Trauma surgeon	2 (1.2%)	2 (2.9%)	0 (0.0%)

(Continues)

TABLE 1 (Continued)

Variable	Total sample (n = 164)	Direct laryngoscopy (n = 68)	Video laryngoscopy (n = 96)
PGY-1/PGY-2/Physician Assistant, n (%)	26 (15.9%)	12 (17.7%)	14 (14.6%)
PGY-1	3 (1.8%)	1 (1.5%)	2 (2.1%)
PGY-2	18 (11.0%)	11 (16.2%)	7 (7.3%)
Physician assistant	5 (3.1%)	0 (0.0%)	5 (5.2%)
PGY-3/PGY-4, n (%)	116 (70.7%)	48 (70.6%)	68 (70.8%)
PGY-3	115 (70.1%)	47 (69.1%)	68 (70.8%)
PGY-4	1 (0.6%)	1 (1.5%)	0 (0.0%)

ED, emergency department; GCS, Glasgow Coma Scale; IQR, interquartile range; ICU, intensive care unit; PGY, postgraduate year.
[a]Response options are not mutually exclusive.
Note: column percentages may sum to 100% due to rounding.

TABLE 2 Outcome measures by initial intubation method

Outcome measures	Total sample (n = 164)	Direct laryngoscopy (n = 68)	Video laryngoscopy (n = 96)	Unadjusted absolute difference in proportion or median	P value[a]
First-pass intubation success					0.0243
Yes, n (%)	119 (72.6%)	43 (63.2%)	76 (79.2%)	16.0%	
No, n (%)	45 (27.4%)	25 (36.8%)	20 (20.8%)	16.0%	
Hypoxic event during intubation					0.1720
Yes, n (%)	16 (9.8%)	9 (13.2%)	7 (7.3%)	5.9%	
No, n (%)	88 (53.7%)	31 (45.6%)	57 (59.4%)	13.8%	
Not documented, n (%)	60 (36.6%)	28 (41.1%)	32 (33.3%)	7.8%	
Time to successful intubation, minutes					0.1752
Median (IQR)	7 (5, 9)	7 (5, 8)	7 (5, 9)	0	

[a]P values derived from chi-square tests for first-pass intubation success and hypoxic event during intubation and Wilcoxon rank sum test for time-to-successful intubation.
Note: hypoxic event is defined as peripheral oxygen saturation <90%.
IQR, interquartile range.

There are a few potential reasons for the higher first-pass intubation success associated with VL in our study. First, we supplemented our medical record data with data obtained from video recordings of trauma resuscitations, whereas most prior studies relied solely on medical record documentation. Video recording and review represents the

TABLE 3 Multivariable logistic regression model of first-pass intubation success associated with initial intubation method (n = 164)

	Adjusted odds ratio (95% CI)
Initial intubation method	
Direct laryngoscopy	1.00 (Reference)
Video laryngoscopy	2.28 (1.04, 4.98)

Model adjusts for mechanism of injury, presence of airway hemorrhage or obstruction, and experience of intubator; Hosmer and Lemeshow Goodness-of-Fit Test P = 0.9836.
CI, confidence interval.

most accurate source of data, as we are able to replay the videos as many times necessary, from various angles, to ascertain sequence and timing of intubation events. Traditionally, most intubation procedure notes are templated and written after the procedure and thus, may not accurately capture the sequence and timing of events owing to recall bias, to which the video review method is immune. Therefore, we believe our study analyzed data that are more accurate than previous studies. Second, our study sample comprised only Level I trauma activation patients with an overall mortality of 29.1% and thus, represents a more severely ill population than that of other studies.[6,19] Additionally, the patient population in our study is older than the 2 randomized trials comparing DL and VL in trauma patients.[6,7] This may indicate that VL is more beneficial for intubating severely ill and elderly patients than DL. Third, it is possible that with increased preference for use of VL over DL for intubating trauma patients, as seen in our population with 58.5% of trauma patients intubated with VL, the experience and proficiency of the intubators with VL over DL are responsible for the difference in first-pass intubation success.

In the context of ED patients with traumatic injuries, our finding that first-pass intubation success is higher for VL compared with DL has face validity. Successful intubation with DL often requires hyperextension of the patient's head and neck to improve glottic visualization. In patients with major trauma, in-line stabilization and cervical spine immobilization are prioritized during intubation attempts. Therefore, DL may be more challenging in trauma patients when compared with VL, as a hyperangulated VL blade likely allows for improved glottic visualization during spinal immobilization. Further, 27.4% of initial intubation attempts were unsuccessful in our overall study sample. This high proportion of first-pass intubation failure is consistent with previous research on intubation in trauma patients.[6,7,16]

The majority of initial intubation attempts in our study were performed by emergency medicine residents or physician assistants, with 70.7% of these intubations being performed by third- or fourth-year emergency medicine residents. Previous research has demonstrated that trainees and less experienced intubators have higher success rates with video laryngoscopy compared with direct laryngoscopy, which may explain the difference in first-pass success in our study.[9,10,16] It is possible that trainees have lower first-pass success with direct laryngoscopy, because attending physicians are unable to visualize the laryngoscopy attempt, leading to premature removal of the laryngoscopy blade by the trainee. Unfortunately, we did not capture data on the duration of each intubation attempt. Shorter first intubation attempts in the direct laryngoscopy group could have explained this difference. Additionally, these first-pass success rates are consistent with previous research on intubation in trauma.[6,7,16]

Patients in our study intubated by VL versus DL were largely similar with respect to baseline characteristics. Although median Injury Severity Scale scores were similar, a proportion of patients in the VL group may have had more severe injuries than the DL group. More patients in the VL group had higher-energy mechanism of injuries than the DL group, indicated by the greater proportion of patients with motorcycle or motor vehicle crashes (30.2% in VL vs 14.7% in DL), and bicyclist or pedestrian struck (13.5% in VL vs 5.9% in DL), and fewer patients with falls (42.7% in VL vs 48.5% in DL). Further, patients in the VL group also had longer ICU length of stay compared with patients intubated via DL. Therefore, VL may have been used more often than DL for more severely injured patients in our study; however, we would expect this to make first intubation attempt success more difficult in the VL group. Further studies are needed to elucidate the decisionmaking process among physicians regarding how they decide to select one intubation method over the other. There may be unmeasured patient, physician, institutional, or situational factors that influence their decision.

In conclusion, we found that video laryngoscopy was associated with higher odds of first-pass intubation success compared with direct laryngoscopy in ED patients requiring a Level I trauma activation, independent of mechanism of injury, presence of airway hemorrhage or obstruction, and experience of intubator. Further, frequency of a hypoxic event and time to successful intubation were not significantly different between VL and DL. Future studies should focus on severely injured trauma patients, which was the novel focus of our study.

CONFLICTS OF INTEREST

None.

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