Effect of video laryngoscopy on trauma patient survival: A randomized controlled trial

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BACKGROUND: Many resuscitation scenarios include the use of emergency intubation to support injured patients. New video-guided airway management technology is available, which may minimize the risk to patients from this procedure.

METHODS: This was a controlled clinical trial conducted in the trauma receiving unit in a university-affiliated urban hospital in which 623 consecutive adult patients requiring emergency airway management were prospectively randomized to intubation with either the direct laryngoscope (DL) or the GlideScope video laryngoscope (GVL) device.

RESULTS: The primary outcome was survival to hospital discharge. There was no significant difference in mortality between the GVL group (28 [9%] of 303) and the DL group (24 [8%] of 320) ($p = 0.43$) for all patients. Within a smaller cohort identified retrospectively, there was a higher mortality rate seen in the subgroup of patients with severe head injuries (head Abbreviated Injury Scale [AIS] score > 3) who were randomized to intubation with GVL (22 [30%] of 73) versus DL (16 [14%] of 112) ($p = 0.047$). Among all patients, median intubation duration in seconds was significantly higher for the GVL group (median, 56; interquartile range, 40–81) than for the DL group (median, 40; interquartile range, 24–68) ($p < 0.001$). Among those with severe head injuries, median intubation duration in seconds was also significantly higher for the GVL group (median, 74) than for the DL group (median, 65) ($p < 0.003$). Correspondingly, this group also experienced a greater incidence of low oxygen saturations of 80% or less (27 [50%] of 54 for the GVL group and 15 [24%] of 63 for the DL group; $p = 0.004$). There were no significant differences between the two groups in first-pass success (80% for GVL and 81% for DL, $p = 0.46$).

CONCLUSION: Use of the GlideScope did not influence survival to hospital discharge among all patients and was associated with longer intubation times than direct laryngoscopy. Among the video laryngoscope cohort, a smaller subgroup of severe head injury trauma patients identified retrospectively seemed to be associated with a greater incidence of hypoxia of 80% or less and mortality. (*J Trauma Acute Care Surg*. 2013;75: 212–219. Copyright © 2013 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Therapeutic study, level II.

KEY WORDS: Airway management; laryngoscopes; fiber optic technology; trauma; randomized controlled trial.

All major emergency medical resuscitation guidelines assign the highest priority to early placement of a definitive airway in unstable patients.[1–4] Tracheal intubations under direct visualization have been performed for more than 60 years with a high rate of success. However, emergency airway management is still a high-risk procedure. This reality has influenced frequent attempts to minimize risk through the development of new intubation technology.

With the use of new technology, laryngoscopes are now available, which contain high-resolution video chips that permit fiber-optic technology to be adapted to small, handheld instruments. Among these devices, the GlideScope Video Laryngoscope (Verathon, Bothell, WA) is the most widely used and recently became the only video laryngoscope approved by the US Food and Drug Administration for use in emergency settings.[5] Similar in size and shape to the traditional Macintosh laryngoscope, the GlideScope has been engineered with a greater curvature to the blade, which contains a wide-angle camera lens embedded in the tip. The camera transmits the image to a bedside monitor, thus obviating the need for direct line of sight identification of the vocal cord structures.[6]

The following study is a prospective randomized investigation of the GlideScope Video Laryngoscope. The American Society of Anesthesiologists cites good laryngeal exposure during intubation as one of most important factors associated with success during airway management.[7] Intuitively, devices such as the indirect video laryngoscope should improve intubation performance. As such, this study tested the hypothesis that achieving better visualization during the intubation with the GlideScope Video Laryngoscope would result in a better airway management performance as measured by shorter intubation times. Because the patients in this study who required emergency airway management constituted a critically ill population

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This study was presented as a poster at the 39th Annual Society for Critical Care Medicine, Critical Care Congress, January 2010, in Miami Beach, Florida: "Video laryngoscopy does not improve outcomes in emergency intubation."

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with high rates of mortality, it was postulated that use of the GlideScope might have a measurable positive impact on survival.

PATIENTS AND METHODS

Study Participants

This randomized controlled trial was conducted between July 15, 2008, and May 15, 2010. The study protocol, approved by the study hospital's institutional review board, allowed for delayed consent to be obtained from the patient or legal authorized representative after enrollment owing to the time-sensitive nature of emergency airway management and the inability of individuals who are cognitively impaired as a result of their injury or illness to provide prospective consent. No enrolled patients were excluded from the study from lack of permission. This study was registered with ClinicalTrials.gov (NCT01235065).

Patients were enrolled continually, with the exception of a pause between May and November 2009 while the University of Maryland's Human Protections Research Office upgraded its research evaluation portal and during which time the study's approval had expired under the original format. All patients were cared for at the R Adams Cowley Shock Trauma Center (STC), a large urban trauma center in Baltimore, Maryland. Patients arriving at the STC are assessed in the trauma resuscitation unit (TRU) by a multidisciplinary team consisting of anesthesiologists, emergency medicine physicians, and trauma surgeons.

All patients who required tracheal intubation in the TRU during the study period were assessed for eligibility. Indications for intubation followed the Eastern Association for the Surgery of Trauma guidelines[3] and included airway obstruction, hypoventilation, severe hypoxemia, cognitive impairment (Glasgow Coma Scale [GCS] score ≤ 8), and hemorrhagic shock. Altered mental status, combativeness, and extreme pain were also criteria, which have been clinically validated as reasons for intubation[8] and were used by the staff.

Minors were excluded from the study, as were patients with suspected laryngeal trauma or extensive maxillofacial injury who required an immediate surgical airway and patients with known or strongly suspected spinal cord injury for whom awake flexible fiber-optic intubation was indicated. The study also excluded patients in cardiac arrest on arrival as well as those who died in the TRU.

Treatment Assignment and Interventions

For each intubation, an airway kit was unsealed that contained the intubation equipment and a study form, which randomly assigned the patient to an attempt with either the GVL or the Macintosh direct laryngoscope (DL). The GlideScope had been in routine use at the study institution for 2 years before the initiation of the trial.

All study intubations were performed using rapid sequence induction. For induction, patients with stable blood pressure were sedated with thiopental 4 mg/kg. Neuromuscular blockage was achieved with succinylcholine 1.5 mg/kg. For patients with hemodynamic instability, there was no adjustment to the succinylcholine dose, either the thiopental was adjusted based on provider selection or etomidate was used in the range of 0.2 mg/kg to 0.4 mg/kg. All patients received the same accepted, standard technique applied during the procedure, including administration of 100% inspired oxygen for at least 1 minute before intubation when possible, maneuvers to prevent passive regurgitation, the use of manual in-line stabilization in patients at risk for cervical spine injuries, and continuous monitoring of blood pressure, heart rate, oxygen saturation, and exhaled carbon dioxide. Emergency medicine or anesthesiology residents with a minimum of 1 year of previous intubation experience performed the majority of the procedures under the direct supervision of an attending trauma anesthesiologist. The remaining intubations were performed by the attending anesthesiologist or a nurse anesthetist under attending guidance. With less than 0.5% failed airways, the study institution's intubation success rate compares favorably with previously published series.[9]

Main Outcome Measures

The primary outcome measure was survival to hospital discharge. Secondary outcomes were intubation attempt duration and intubation first-pass success rate. Outcomes measures for each intubation technique were compared for patients with and without predicted difficult airways according to the Mallampati classification system.[9] Of the total number of enrolled patients, the study authors identified severely brain injured patients as an important subgroup for analysis, given the previously described associated between intubation and mortality in this population. The study used an Abbreviated Injury Scale (AIS) head score of greater than 3 to define severe head injuries, consistent with the Association for the Advancement of Automotive Medicine.[10]

Patient mortality rates, mechanism of injury, and AIS scores were abstracted from the STC Trauma Registry, a database which is maintained by highly trained staff with both clinical trauma experience and background in medical informatics, which undergoes periodic internal and external auditing. Mallampati difficulty airway classifications were obtained at the conclusion of the study from anesthesiology assessments documented in the patients' charts.

Data Collection and Outcomes Assessment

Confirmation of intubation attempt duration and success was identified using closed-circuit video. While in the TRU, all patient vital signs, including oxygen saturation, were captured every 6 seconds. For patients with complete and uncorrupted data, oxygen saturation was quantified and graphed as a dependent variable along a time axis (Fig. 1). The study defined the period of intubation attempt as the interval between when the laryngoscope was inserted into the patient's mouth and when it was fully removed. Intubation success was confirmed by the presence of a continuous exhaled carbon dioxide tracing on the patient's monitor coupled with physical signs of appropriate positioning of the tracheal tube. Multiple intubation attempts, including attempts by different individuals, and bag-valve-mask ventilation initiated between intubation attempts were added to the cumulative total intubation length recorded.

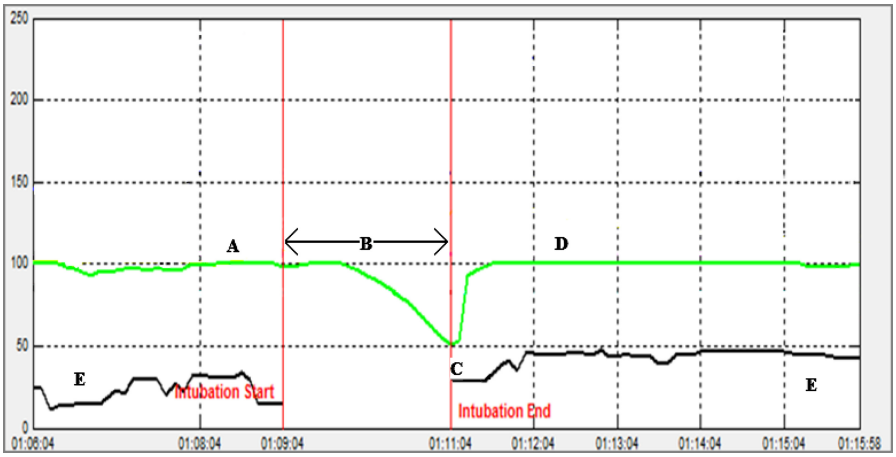

Figure 1. Plot of oxygen saturation level before intubation attempt (*A*), during intubation attempt (*B*), and after intubation attempt (*D*). Also included is oxygen saturation nadir during intubation attempt (*C*) and level of end-tidal carbon dioxide throughout the procedure (*E*).

Sample Size and Power Calculations

Mortality data at the study institution during the 2 years preceding the initiation of this trial has been reported.[11] On average, the mortality rate for individuals who presented with an Injury Severity Score (ISS) between 17 and 25 during this period was approximately 5%. Therefore, power calculations were performed, assuming that the DL group would have a 5% mortality rate. For a two-sided test with Type I error rate of 0.05, power equaled 0.80 to detect as small as a six percentage point higher mortality rate (i.e., 11%) when the video laryngoscope is used or about a 4 percentage point lower mortality rate (i.e., 1%).

Statistical Analysis

Statistical analyses were performed using MedCalc for Windows, version 11 (MedCalc Software, Mariakerke, Belgium). The Student's *t* test and χ^2 test were used to examine the null hypothesis that there was no difference between the groups regarding demographic data. Data that were normally distributed were compared using Student's *t* test, and the results were expressed as mean (SD) and 95% confidence intervals (CIs). Categorical data were compared by χ^2 test, and the results were expressed in percentages. The Wilcoxon rank-sum test was used to evaluate continuous data characterized by a nonnormal distribution. These results were expressed in medians and interquartile ranges (i.e., 25th through 75th percentiles). Among groups with different survival outcomes, multivariable logistic regression analysis was used to calculate adjusted odds ratio (AOR) for patient mortality associated with intubation techniques while controlling for injury severity, mechanism of injury, admission physiology, age, and sex. For all of the statistics regarding study measures, a $p < 0.05$ was chosen as the threshold for determining significance.

RESULTS

Characteristics of Study Subjects

During the study period, 10,318 patients were admitted to the TRU. A total of 898 patients required emergent intubation and were deemed eligible for enrollment in the trial. A total of 623 patients were randomized, while 275 patients were not enrolled owing to attending discretion or unavailability of study equipment at the time of patient arrival or because they failed eligibility criteria. Of the 623 enrolled patients, 320 patients were randomly assigned to intubation with the DL, and 303 patients were randomly assigned to intubation with the video laryngoscope (Fig. 2).

No proportional differences were noted between the patients randomized to each type of intubation with regard to age, sex, race, trauma mechanism, ISS, justification for intubation, and arrival vital signs (Table 1). To account for any potential bias from patients not enrolled owing to attending discretion, comparison analysis was performed between the eligible, enrolled patients and the eligible, nonenrolled patients. The data demonstrates that all groups were proportionally similar in their demographics, injury mechanism, ISS, and arrival vital signs (data not shown). All data were reviewed at the close of the trial, and no selection bias based on skill level of the operator was identified (Table 2).

Of the 623 enrolled patients, 52 patients did not survive to hospital discharge. Those who died were older, experienced penetrating injuries, had greater ISSs, and had lower admission blood pressures (Table 3). No patient in either group required a surgical airway or was observed to experience aspiration or pharyngeal or dental injury as a result of an intubation procedure.

Main Results

There was no difference in hospital mortality between the two groups (Table 1). Approximately 93% of subjects survived to hospital discharge in the DL group, and 91% of subjects survived to hospital discharge in the GVL group ($p = 0.43$). When post hoc analysis was performed on a much smaller cohort of patients, there was an observed higher mortality rate for the subgroup of patients with severe head injuries (head AIS score > 3) who were randomized to intubation with GVL (22 [30%] of 73) versus DL (16 [14%] of 112) ($p = 0.047$). This association between mortality and use of the GlideScope

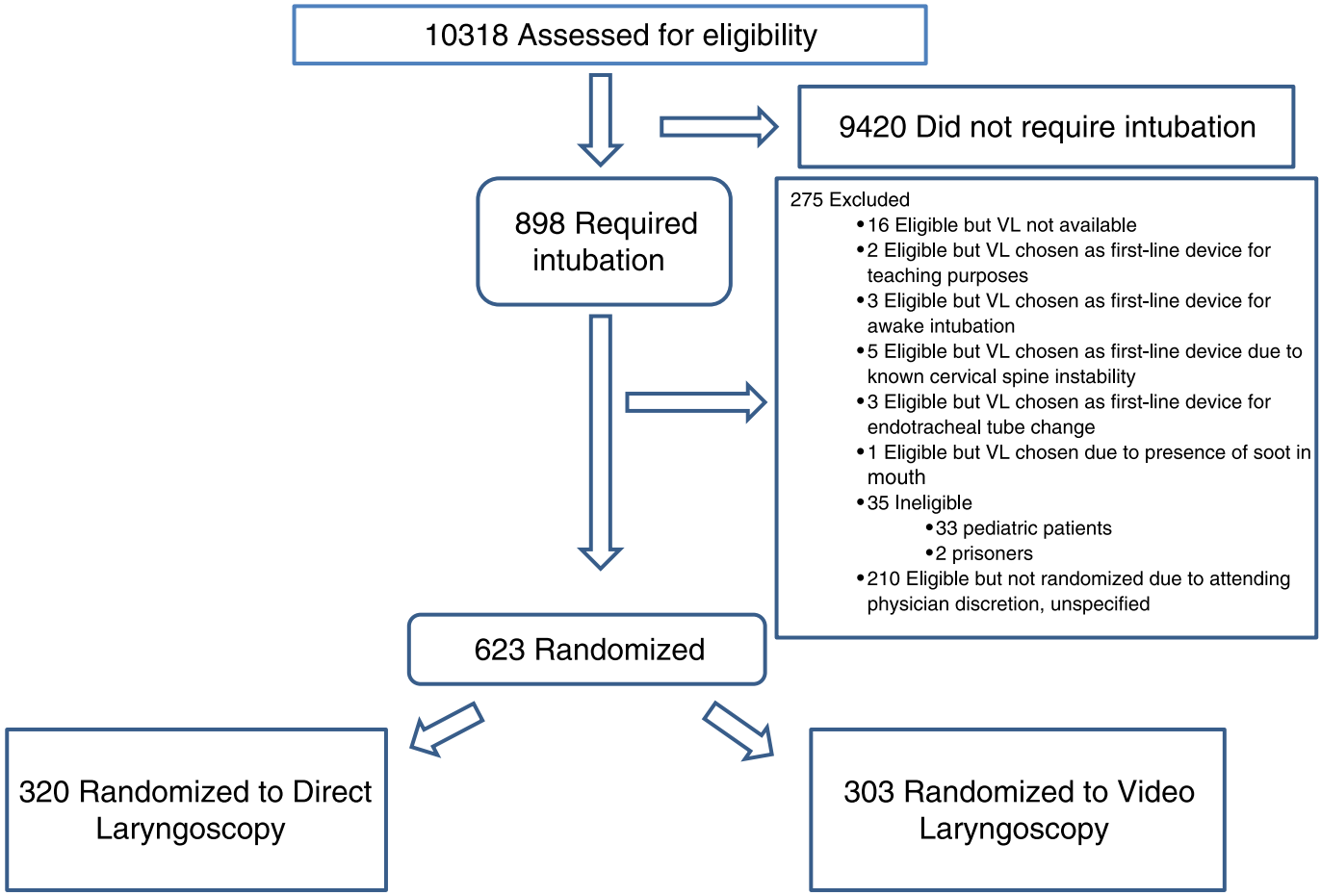

Figure 2. Patient flow diagram.

remained significant even when controlling for patient characteristics such as admission physiology, mechanism of injury, and injury severity (Table 4).

Among all patients, median intubation attempt duration in seconds was significantly higher for the GVL group (median, 56; interquartile range, 40–81) than for the DL group (median, 40; interquartile range, 24–68) ($p < 0.001$). When intubation times between junior residents and senior residents and attending were compared, a statistically longer intubation times across skill levels associated with use of the GlideScope was identified (data not shown). Among those with severe head injuries, median intubation attempt duration in seconds was also significantly higher for the GVL group (median, 74) than for the DL group (median, 65) ($p < 0.003$). Correspondingly, this group also experienced a greater incidence of low oxygen saturations of 80% or less (27 [50%] of 54 for the GVL group and 15 [24%] of 63 for the DL group, $p = 0.004$). No meaningful differences between the two groups were found in the first-pass success rates (81% for DL and 80% for GVL, $p = 0.46$).

Of the 336 patients for whom Mallampati scores were recorded, 178 were randomized to intubation with the DL and 158 were randomized to intubation with the GlideScope. Among patients whose intubation was anticipated to be less difficult, intubation attempts with the GlideScope were of a significantly longer duration than intubation attempts with the DL (median, 55 seconds vs. 40 seconds; $p < 0.001$). Among patients with anticipated "difficult" airways, there was no difference between cohorts regarding number of intubation attempts or intubation attempt duration.

DISCUSSION

To the our knowledge, this is the first randomized study comparing the GlideScope with the DL for emergency tracheal intubation and the first hospital-based randomized study to compare any form of video-assisted intubation with the traditional direct method for emergency airway management. Despite more than a decade of research regarding the GlideScope design, almost all of the Level 1 evidence for its appropriate use is based on healthy participants undergoing elective surgical procedures in the operating room.[12] With the exception of a randomized study performed by a group of helicopter-based physicians in Austria comparing the DL to the Airtraq (Prodol Meditec, Vizcaya, Spain),[13] evidence relating to the emergency use of video laryngoscopes is either from observational studies[14–16] or from research based on quality improvement data derived from retrospective

TABLE 1. Patient Demographics, Mechanism of Injury, ISS, Reason for Intubation, Admission Physiology, and Outcome Measures by Airway Management Device Group

Characteristics	% Missing	Direct Laryngoscopy (n = 320)	Video Laryngoscopy (n = 303)	*p**
Age, mean (range), y	0	43 (18–94)	42 (18–119)	0.72
Males, n (%)	0	244 (76.3)	216 (71.3)	0.13
Race, n (%)	0			
American Indian/Eskimo		3 (0.9)	2 (0.7)	0.93
Black		110 (34.4)	97 (32.0)	
Hispanic		8 (2.5)	9 (3.0)	
White		163 (50.9)	156 (51.5)	
Other		36 (11.3)	39 (12.9)	
Mechanism of Injury, n (%)	10.3			0.06
Blunt		220 (68.8)	225 (74.3)	
Assault		23 (7.2)	19 (6.3)	
Motor vehicle		95 (29.7)	115 (38.0)	
Bicyclist/pedestrian		32 (10.0)	13 (4.3)	
Other		21 (6.6)	28 (9.2)	
Fall		49 (15.3)	50 (16.5)	
Penetrating		42 (13.1)	34 (11.2)	
Gunshot		23 (7.2)	20 (6.6)	
Stabbing		13 (4.1)	10 (3.3)	
Other		6 (1.8)	4 (1.3)	
Other		23 (7.2)	15 (5.0)	
Severity of injury	12.2			
ISS median (25th–75th percentile)		19 (9–29)	17 (9–27)	0.19
Reason for intubation, n (%)	0			0.44
Traumatic cardiac arrest		12 (3.8)	6 (2.0)	
Other		67 (20.9)	49 (16.2)	
Severe cognition impairment		152 (47.5)	155 (51.2)	
Severe case (>2 indications)		4 (1.3)	6 (2.0)	
Severe orthopedic injuries		51 (15.9)	53 (17.5)	
Respiratory distress		14 (4.4)	10 (3.3)	
Severe hemorrhagic shock		20 (6.3)	24 (7.9)	
Arrival vital signs, mean (95% CI)				
Heart rate	7.7	93.4 (90–97)	95.2 (92–99)	0.48
Systolic blood pressure	7.7	115.9 (110–122)	124.1 (118–130)	0.08
Spo_2	14.3	84.8 (82–88)	86.2 (83–89)	0.57
Respiratory rate	6.1	31.4 (28–35)	29.3 (26–32)	0.38
Outcome measures				
Intubation duration, s				
Mean (95% CI)	24.2	56.5 (51.1–62.0)	71.0 (65.3–76.7)	0.002
First-pass success	24.2	81%	80%	0.46
Mortality rate, n (%)	0	24 (7.5)	28 (9.2)	0.43

*p value calculated with appropriate test: Wilcoxon rank-sum test for continuous nonnormal data, Student's t test for continuous normal data, and Pearson's χ^2 test for categorized data.

self-reporting.[17,18] Similar to this study's conclusions, the Austrian retrieval group did not find evidence to support the use of the video laryngoscope for field intubations.[13]

This study did not find an overall difference in mortality between device groups but did demonstrate that use of the GlideScope was associated with an increase in the intubation attempt duration in routine airway management scenarios. The GlideScope did not improve performance among the subgroup of patients anticipated to have "difficult" airways. The study also found that among the subgroup of patients with severe head injuries, a population known to be uniquely vulnerable to certain airway management strategies,[19–24] longer intubation with the GlideScope was associated with a greater exposure to low oxygen levels. This may explain why this subgroup seemed to have a lower survival rate than the cohort with severe head injuries managed with the DL.

Several important limitations must be acknowledged when interpreting the results. First, deferring to each attending anesthesiologist's discretion regarding device use meant accepting a relatively high degree of noncompliance with the study protocol, possibly introducing bias from voluntary exclusion of certain patients. However, the study found that the

TABLE 2. First-Pass Success Rate for Intubation by Experience Level and Specialty

	First-Pass Success, %	n
Specialty		
Anesthesia	68.6	51
Critical care medicine	82.6	86
Emergency medicine	83.6	323
Surgery	66.7	3
Experience level		
PGY 2	83.3	270
PGY 3	77.6	49
PGY 4	84.1	44
PGY 5	100.0	20
PGY 6	74.1	27
Attending	66.7	18
Certified registered nurse anesthetist	85.7	7
Student registered nurse anesthetist	73.9	23

majority of eligible patients who were not randomized were managed by a handful of anesthesiologists who maintained poor participation throughout the trial. Because of these individuals' serial lack of adherence to study protocol, their patients were not randomized preferentially to either group. To further verify this situation, the study compared all of the eligible, enrolled patients with the eligible patients who were not enrolled owing to attending discretion and found them to be proportionally comparable regarding demographics, injury mechanism, injury severity, and arrival vital signs. Importantly, data analysis showed that neither intubation device cohort was biased by containing a greater number of critically ill patients.

TABLE 3. Comparison of Sample Characteristics (Patient Demographics, Mechanism of Injury, ISS, and Admission Physiology) by Survival Groups

Characteristics	% Missing	Did Not Die (n = 571)	Died (n = 52)	*p**
Age, mean (range), y	0	42 (18–119)	54 (20–119)	<0.001
Males, n (%)	0	444 (71)	39 (75)	0.87
Race	0			
Black		189 (33.1)	18 (34.6)	0.96
White		293 (51.3)	26 (50.0)	
Other		89 (15.6)	8 (15.4)	
Intubation duration, s				
Median (25th–75th percentile)	20	48 (32–78)	46 (34–75)	0.76
Trauma mechanism	0			<0.001
Blunt		415 (72.7)	30 (57.7)	
Other		35 (6.1)	3 (5.8)	
Penetrating		61 (10.7)	15 (28.8)	
Median ISS (25th–75th percentile)	12.2	14 (5–26)	34 (25–50)	<0.001
Arrival vital signs, mean (95% CI)				
Heart rate	7.7	98 (95–100)	86 (72–101)	0.45
Systolic blood pressure	7.7	137 (134–140)	111 (92–131)	0.01
Spo_2	14.3	100 (96–103)	98 (96–99)	0.43

*p value calculated with appropriate test: Wilcoxon rank-sum test for continuous nonnormal data, Student's t test for continuous normal data, and Pearson's χ^2 test for categorized data.

TABLE 4. Logistic Regression Analysis of Intubation-Related Variables as Predictors of Mortality in Trauma Patients With Head ISSs >3

Characteristic	AOR*	95% CI
Intubation technique		
Direct laryngoscopy	Ref	
Video laryngoscopy	2.91	1.27–6.67
Age (per year)†	1.04	1.01–1.06
Mechanism of injury		
Blunt	Ref	
Penetrating	5.68	1.87–17.26
Sex		
Male	Ref	
Female	0.61	0.21–1.80
ISS		
16–24	Ref	
>24	11.54	1.47–90.66
Admission vital signs		
Heart rate		
<100	Ref	
≥100	1.35	0.60–3.07
Systolic blood pressure		
<90	Ref	
≥90	0.56	0.22–1.42

*AORs reported while controlling for age, mechanism of injury, sex, ISS, and admission physiology.
†Included in model as continuous variable.

Certain limitations must also be recognized with the study's use of the Mallampati airway classification system. The Mallampati test has not been validated for emergency intubations and as originally described cannot practically be performed in its entirety in incapacitated patients. Nevertheless, the strategy of anticipating intubation difficulties based on visual inspection of the patient's tongue, hard, and soft palate is commonplace in the emergency setting (Mallampati is the "M" in the popular LEMON mnemonic for emergency airway management) and includes most of the maneuvers used to assess awake patients. Of note, a recent meta-analysis concluded that the Mallampati tests, while of low sensitivity, performed well in patients in whom soft tissue distortion increased the pretest probability for difficult airway occurrence, that is, obstetric anesthesia patients with pharyngeal swelling from pregnancy-related fluid retention.[25] This is analogous to the type of patient encountered in the trauma resuscitation unit whose injuries frequently resulted in contusions of the face and neck and/or require the placement of a compressive cervical collar neck immobilizer.

It must also be acknowledged that emergency intubations of less critically ill patients than those in this study would be unlikely to identify a meaningful difference in survival, given that almost 99% of all emergency intubations are ultimately successful with few complications. However, trauma patients who require emergency intubation at the hospital where the

study was conducted have a very high injury severity (median ISS, almost 20), and it is known from historical data that these patients have an institutional mortality rate as high as 5%. While there was no anticipation of finding a difference in mortality due to immediate complications from the different intubation procedures (in fact, enrolled patients who died while in the TRU were subsequently excluded), there was an expectation that for the particular patient population in this study, there was sufficient statistical power to detect whether factors such as longer intubation attempt duration and/or degree of hypoxia exposure might be reflected in longer-term outcome differences.

Finally, the finding of greater mortality among severe head injury patients who were randomized to intubation with the video laryngoscope must be qualified. This statistic was obtained through post hoc analysis, and the primary outcome measure of survival to hospital discharge between intubation device cohorts comparing all enrolled patients did not yield significance. Likewise, the statistical strength to infer associations among head injury, hypoxia, and intubation attempt duration is limited by the small number of patients in these subcohorts and the high degree of complexity of their injuries.

Given these statistical limitations, it is possible that these findings occurred simply by chance. However, there is plausibility in the results. While the difference in intubation attempt duration between each group was in only tens of seconds, oxygen saturation decline in patients undergoing emergency intubation occurs more rapidly than in healthy patients undergoing elective operative cases.[26] Trauma patients are more likely to experience increased catecholamine-related metabolic activity and pulmonary shunt, factors which result in a more rapid decline in oxygen saturation in these patients than in healthy individuals.[27] For ill patients, mathematical models show the oxygen deflection curve steepening significantly when oxygen saturation decreases to 80%.[28] The hypoxia graphs confirm this phenomenon (Fig. 1).

While periods of transient hypoxia may be less important in healthy operative patients with normal physiology, there is evidence that even minor homeostatic perturbations in oxygenation and ventilation are poorly tolerated in patients with severe traumatic brain injuries.[29]

It is possible that relatively small differences in the prolongation of the intubation procedure could have magnified consequences later in the hospital course.

In summary, in a study of a population of trauma patients who were randomized to emergency intubation with either the DL or the GL, the use of the video laryngoscope did not improve survival to hospital discharge and was associated with longer intubation attempt duration. Among patients with severe traumatic brain injuries, this longer attempt seemed to be associated with a greater degree of hypoxia of 80% or less and may have contributed to greater mortality. Despite improved vocal cord visualization with indirect video intubation devices, there was no evidence that "difficult" airways should be preferentially managed with the GlideScope. While the GVL does possess unique characteristics that may support its use as an airway management device, multicenter trials are warranted to further investigate its use for emergency intubation.

AUTHORSHIP

D.J.Y., R.P.D., T.E.G., and T.M.S. are responsible for the study concept and design. D.J.Y., R.P.D., T.E.G., P.F.U., Y.-W.C., J.A.K., H.C. and C.H.B. acquired, analyzed, and interpreted the data. D.J.Y. drafted the manuscript, and D.J.Y., R.P.D., P.F.U., Y.-W.C., T.E.G., J.A.K., C.H.B., and T.M.S. performed critical revision of the manuscript for important intellectual content. H.C., J.A.K., C.H.B. and Y.-W.C. were responsible for statistical supervision and analysis. D.J.Y. had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

DISCLOSURE

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