Comparison of Tracheal Intubation Conditions in Operating Room and Intensive Care Unit

A Prospective, Observational Study

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ABSTRACT

Background: Tracheal intubation is a common intervention in the operating room and in the intensive care unit. The authors hypothesized that tracheal intubation using direct laryngoscopy would be associated with worse intubation conditions and more complications in the intensive care unit compared with the operating room.

Methods: The authors prospectively evaluated during 33 months patients who were tracheally intubated with direct laryngoscopy in the operating room, and subsequently in the intensive care unit (within a 1-month time frame). The primary outcome was to compare the difference in glottic visualization using the modified Cormack-Lehane grade between intubations performed on the same patient in an intensive care unit and previously in an operating room. Secondary outcomes were to compare first-time success rate, technical difficulty (number of attempts, operator-reported difficulty, need for adjuncts), and the incidence of complications.

Results: A total of 208 patients met inclusion criteria. Tracheal intubations in the intensive care unit were associated with worse glottic visualization (Cormack-Lehane grade I/IIa/IIb/III/IV: 116/24/47/19/2) compared with the operating room (Cormack-Lehane grade I/IIa/IIb/III/IV: 159/21/16/12/0; $P < 0.001$). First-time intubation success rate was lower in the intensive care unit (185/208; 89%) compared with the operating room (201/208; 97%; $P = 0.002$). Tracheal intubations in the intensive care unit had an increased incidence of moderate and difficult intubation (33/208 [16%] *vs.* 18/208 [9%]; $P < 0.001$), and need for adjuncts to direct laryngoscopy (40/208 [19%] *vs.* 21/208 [10%]; $P = 0.002$), compared with the operating room. Complications were more common during tracheal intubations in the intensive care unit (76/208; 37%) compared with the operating room (13/208; 6%; $P < 0.001$).

Conclusions: Compared with the operating room, tracheal intubations in the intensive care unit were associated with worse intubation conditions and an increase of complications. (ANESTHESIOLOGY 2018; 129:321-8)

TRACHEAL intubation is a common and critical intervention in the intensive care unit. This procedure is associated with a high incidence of difficult intubation and severe complications.[1–7] In contrast, under elective conditions in the operating room, the complication rate of intubation is low.

The high incidence of difficult intubation in the intensive care unit may be affected by operator-, patient-, and environment-related factors.[8,9] Operator-related factors include the level of experience and training of the operator, and by the use of pharmacologic agents that facilitate the procedure. Patient-related factors include anatomic features that make visualization of the glottic inlet or the ability to pass a tracheal tube difficult, and physiologic factors that limit the duration of the laryngoscopic attempt, such as hypoxemia and hemodynamic instability of the critically ill patient. Environmental factors include limited space, poor lighting, and suboptimal bed characteristics that limit the ability to properly position or access to the patient's head and airway. All of these factors can impair direct visualization of the glottis using a direct laryngoscopy, therefore making tracheal intubation difficult and increasing the rate of complications.

We hypothesized that tracheal intubation in the intensive care unit using direct laryngoscopy would be associated with worse intubation conditions and more complications compared with tracheal intubation in the operating room. The

What We Already Know about This Topic

- Reported incidence rates of difficult trachea intubation are higher outside of the operating room than in the operating room
- The differences may be explained by operator-related, patient-related, and environment-related factors

What This Article Tells Us That Is New

- In this observational study, 208 patients experienced direct laryngoscopy both in the intensive care unit and operating room during the perioperative period
- Tracheal intubation was associated with worse intubation conditions and more complications in the intensive care unit compared with the operating room

This article is featured in "This Month in Anesthesiology," page 1A. This article has a video abstract. This article has an audio podcast. This article has a visual abstract available in the online version.

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main endpoint of the study was to compare the difference in glottic visualization using the modified Cormack–Lehane grade between tracheal intubations performed by anesthesiologists on the same patient in the intensive care unit, and previously in the operating room. Secondary endpoints were to compare first-time success rate, technical difficult of intubation, and the incidence of complications in these two clinical settings.

Materials and Methods

We prospectively evaluated all patients admitted to the intensive care unit at Clinical University Hospital of Santiago, Spain, between March 1, 2015 and November 30, 2017, that were tracheally intubated using a direct laryngoscopy in the intensive care unit and in the previous month in the operating room. Exclusion criteria were pregnancy, aged younger than 18 yr, or tracheal intubations utilizing a bronchoscope or a video laryngoscopy. All intubations were performed by attending anesthesiologists or anesthesia residents supervised by attending anesthesiologists. All anesthesia residents had at least 2 yr of intraoperative anesthesiology experience. The study was approved by the ethics committee of Galicia (Santiago-Lugo, code No. 2015-012). Due to the observational, noninterventional, and noninvasive design of this study, the need for written consent was waived.

The sniffing position was routinely used as standard head positioning for direct laryngoscopy and tracheal intubation,[10] however every anesthesiologist was free to vary patients' head positions, adapting to the clinical situation (*e.g.*, the ramped position for obese patients if necessary). Both arterial blood pressure and oxygen saturation were registered before, during (between the anesthetic induction and the tube insertion), and in the 30-min period after tracheal intubation. Induction of anesthesia and failed attempts were subsequently managed at the discretion of the attending anesthesiologist. If the oxygen saturation decreased less than 90% during intubation attempts, the anesthesiologist withdrew the laryngoscope and initiated mask ventilation.

After each tracheal intubation in the operating room, the operator completed a data collection form, which included the following information: patient demographics, Mallampati classification score (I-IV), identification of the first intubator (attending anesthesiologist *vs.* resident), type of surgery, sedative agent, paralytic agent, the best modified Cormack–Lehane glottic view, number of attempts of tracheal intubation, the need for adjuncts to direct laryngoscopy (gum-elastic bougie), operator-reported difficulty of intubation, and complications during tracheal intubation.

After each tracheal intubation in the intensive care unit, the operator completed a data collection form, which included the following information: patient demographics, reason for admission in intensive care unit, identification of the first intubator (attending anesthesiologist *vs.* resident), indication for intubation, use of noninvasive ventilation prior to intubation, urgency of intubation, sedative agent, paralytic agent, the best modified Cormack–Lehane glottic view, number of attempts of tracheal intubation, the need for adjuncts to direct laryngoscopy (gum-elastic bougie), operator-reported difficulty of intubation, and complications during tracheal intubation.

Visualization of the laryngeal inlet was assessed according to the modified classification of Cormack and Lehane[11,12]: I, full view of the glottis; IIa, partial view of the glottis; IIb, arytenoid or posterior part of the vocal cords just visible; III, only epiglottis visible; IV, neither glottis nor epiglottis visible.

An intubation attempt was defined as insertion of the laryngoscope blade into the oropharynx, regardless of whether an attempt was made to pass the endotracheal tube. A laryngoscopic blade readjustment counted as a single attempt. Successful intubation was defined as correct placement of the endotracheal tube in the trachea. First-attempt success was defined as successful tracheal intubation, as previously defined, on the initial attempt. Operator-reported difficulty of intubation was classified as: easy, mild, moderate, or severe. Urgency of intubation was classified as: emergent, urgent (within 30 min), or semi-elective (more of 30 min). Complications during the intubation included esophageal intubation, hypoxemia (oxygen saturation less than 80%), and hypotension (systolic blood pressure lower than 80 mmHg) during, or 30 min after, intubation. The choice of anesthetic agents was left to the discretion of the anesthesiologist.

The primary outcome was to compare the difference in glottic visualization using the modified Cormack–Lehane grade between intubations performed on the same patient in two different settings such as the operating room and the intensive care unit. Secondary outcomes included first-time success rate intubation, technical difficulty of intubation (number of intubation attempts, operator-reported difficulty of intubation, and the need for adjuncts to direct laryngoscopy), and the incidence of complications during the procedure (hypoxia, hypotension, esophageal intubation).

Statistical Analysis

This is an observational, prospective study of paired measures, in which patients are evaluated both in the operating room and the intensive care unit. Data were collected during a 33-month period. Summary statistics were calculated for categories (frequency, percentage), and for numeric variables (mean, median, SD).

Before data collection, sample size was calculated for the McNemar test as 161 pairs of measurements to detect a 20% minimum increase (from 5 to 25% of Cormack–Lehane IIb, III, and IV) and a 5% maximum decrease (up to 5% of all patients) in Cormack–Lehane grade, with an error alpha of 1%, and a 90% power (two-tailed).

Frequency changes from the operating room to the intensive care unit were assessed using the McNemar chi-square test for paired measurements, and the paired Wilcoxon test. For McNemar tests, variables were recorded in binary categories, as follows:

- Cormack–Lehane grade: Full range was I, IIa, IIb, III, IV; binary range was I+IIa, greater than IIa.
- Number of attempts: Full range was 1, 2, 3, 4, *etc.*; binary range was 1, greater than 1.
- Subjective difficulty: Full range was 1-Easy, 2-Mild, 3-Moderate, 4-Severe; binary range was 1-Easy and Mild difficulty, 2-Moderate and Severe difficulty.

Variables with their full ranges were represented using dodged bar charts.[13] All variables were either discrete or nonparametric.

To evaluate correlation between ordinal factors in a two-way table, we used the nonparametric Goodman–Kruskal gamma test with the corresponding 95% CI. The Fisher test was used to assess statistical significance for single measurements, either in the operating room or in the intensive care unit. Multiple testing was penalized with the Bonferroni procedure. After multiple-testing penalization, only *P* values larger than 0.0024 were considered statistically significant.

The software used was R v.3 for all calculations, and the package Ggplot2 for the graphs (http://cran.r-project.org, accessed 2018).[14] For McNemar sample size calculations, we wrote a custom web app using the Shiny package for R.

Results

During the 33-month study period, a total of 311 patients were tracheally intubated in the intensive care unit. Of these, 208 patients were tracheally intubated previously (less than 1 month before) in the operating room, and met inclusion criteria. A total of 103 (33%) intubations were excluded for the following reasons: 94 intubations were not intubated previously in the operating room, 4 were awake fiberoptic intubations, and 5 were video laryngoscopy intubations. Table 1 shows patient characteristics and their surgical interventions. The reason for intensive care unit admission, reason for intensive care unit intubation, grade of urgency of intensive care unit intubation procedure, and use of noninvasive ventilation before tracheal intubation are shown in table 1. The most frequent indication for intubation in the intensive care unit was acute respiratory failure (83%), and 63% of patients needed noninvasive ventilation before intubation.

There was no statistically significant difference between rank of the intubator in the operating room and in the intensive care unit (table 2, *P* = 0.35). The type of hypnotic and neuromuscular blockade used in the operating room, and intensive care unit tracheal intubations are shown in table 2.

Tracheal intubation in the intensive care unit was associated with worsened glottic visualization (Cormack–Lehane grade I/IIa/IIb/III/IV: 116/24/47/19/2), compared with the operating room (Cormack–Lehane grade I/IIa/IIb/III/IV: 159/21/16/12/0, (*P* < 0.001; fig. 1A). Tracheal intubation in the intensive care unit worsened the visualization of the glottis in 69 patients (33%), and improved visualization of the glottis in 14 patients (7%). The proportion of first-success rate intubation was 97% (201/208) in the operating room, higher than in the intensive care unit (185/208, 89%; *P* = 0.002). The number of attempts of tracheal intubation was higher in intensive care unit patients, compared with operating room patients (*P* < 0.001; fig. 1B).

The difficulty of tracheal intubation was greater in intensive care unit patients than in operating room patients (*P* < 0.001; fig. 1C). Tracheal intubations in the intensive care unit had an increased incidence of moderate and difficult intubation (33/208 [16%]), compared with the operating room (18/208 [9%]; *P* < 0.001). The use of a gum-elastic

Table 1. Specific Variables Recorded in Intubated Patients

	Patients (N = 208)
Demographics	
Age, mean ± SD, yr	70 ± 12
Male sex, n (%)	61 (29)
Weight, mean ± SD, kg	75 ± 13
Height, mean ± SD, cm	165 ± 9
BMI, mean ± SD, kg/m^2	28 ± 5
BMI > 30 kg/m^2, n (%)	62 (30)
Mallampati score, n (%)	
1	41 (20)
2	98 (47)
3	46 (22)
4	4 (2)
Not recorded	18 (9)
Reason for OR surgery, n (%)	
Cardiac surgery	92 (44)
Abdominal surgery	39 (19)
Neurosurgery	27 (13)
Vascular surgery	18 (9)
Trauma surgery	12 (6)
Thorax surgery	10 (5)
Urology surgery	7 (3)
Others	3 (1)
Urgent surgery, n (%)	70 (34)
Reason for ICU admission, n (%)	
Postoperative surgery	138 (66)
Acute respiratory failure	51 (25)
Shock	10 (5)
Neurologic	6 (3)
Others	3 (1)
Reason for ICU intubation, n (%)	
Acute respiratory failure	172 (83)
Shock	33 (16)
Neurologic	37 (18)
Unplanned extubation	7 (3)
Failed trial of extubation	16 (8)
Elective (procedure)	7 (3)
Urgency of ICU intubation procedure, n (%)	
Emergent	15 (7)
Urgent	117 (56)
Semi-elective	76 (37)
Noninvasive ventilation before intubation, n (%)	130 (63)

Data presented as number (%) or mean ± SD.

BMI = body mass index; ICU = intensive care unit; OR = operating room.

Table 2. Comparison of Intubation Characteristics and Procedural Complication Rate between Tracheal Intubation in the OR and the ICU

	OR (N = 208)	ICU (N = 208)	*P* Value
Rank of intubator			
Combined resident and attending anesthesiologist	104 (50)	114 (55)	0.35
Attending anesthesiologist	104 (50)	94 (45)	
Medications used for intubation			
Hypnotic drugs	208 (100)	200 (96)	0.013
Propofol	143 (69)	54 (26)	< 0.001
Etomidate	65 (31)	139 (67)	< 0.001
Midazolam	0	7 (3)	NA
Neuromuscular blocking drugs	208 (100)	201 (97)	0.023
Succinylcholine	32 (15)	187 (90)	< 0.001
Rocuronium	61 (29)	10 (5)	< 0.001
Cisatracurium	115 (55)	4 (2)	< 0.001
Adjunct to direct laryngoscopy used (gum-elastic bougie)	21 (10)	40 (19.2)	0.0023
Procedural complications	13 (6)	76 (37)	< 0.001
Hypotension < 80 mmHg	9 (4)	58 (28)	< 0.001
Hypoxia < 80%	4 (2)	19 (14)	< 0.001
Esophageal intubation	0	4 (2)	1

Data presented as number (%).

ICU = intensive care unit; NA = not applicable; OR = operating room.

bougie was required less often in the operating room compared with the intensive care unit (*P* = 0.002; table 2).

Complications were more common during tracheal intubations in the intensive care unit compared with the operating room (76/208, 37% *vs.* 13/208, 6%; *P* < 0.001; table 2).

There was a relationship between number of intubation attempts, difficulty of intubation, and adjuncts to direct laryngoscopy used, and a difficult laryngoscopy view during tracheal intubation in the intensive care unit. Tracheal intubation was more difficult, required more frequently adjuncts to direct laryngoscopy, and needed more intubation attempts from Cormack–Lehane grade I to IV (*P* < 0.001; table 3).

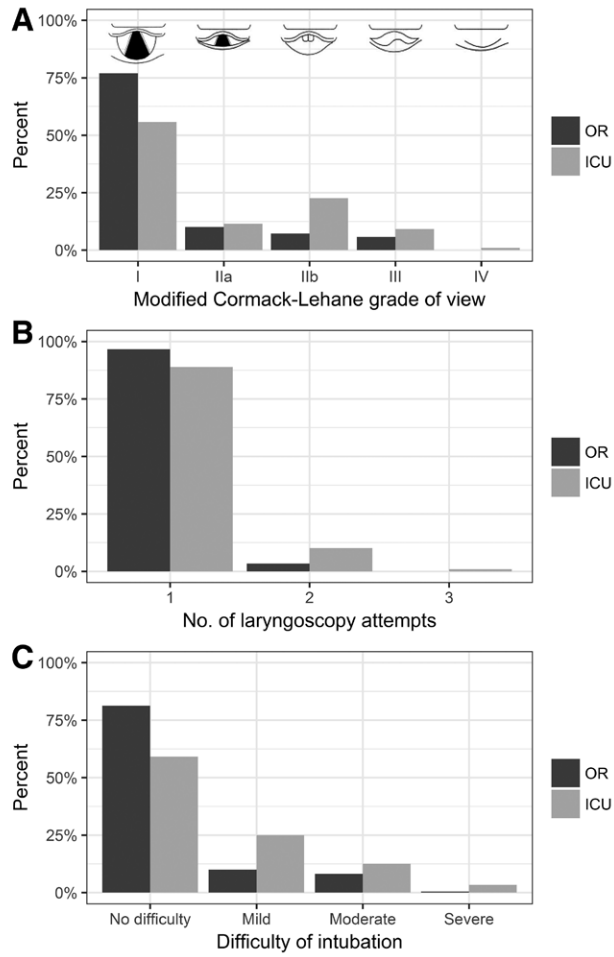

Fig. 1. (*A*) Percentage of patients according to the modified classification of Cormack-Lehane in the intensive care unit (ICU) and in the operating room (OR). Tracheal intubation in the ICU was associated with worsened glottic visualization compared to intubation in the OR (*P* < 0.001). (*B*) Percentage of patients according to the number of laryngoscopy attempts required for successful intubation in the ICU and in the OR. Tracheal intubation in the ICU was associated with more attempts to successfully intubate compared with the OR (*P* = 0.002). (*C*) Percentage of patients according to the operator-reported difficulty of intubation in the ICU and in the OR. Tracheal intubation in the ICU was associated with worse reported difficulty of intubation compared to intubation in the OR (*P* < 0.001).

Discussion

In this study, we have compared tracheal intubation conditions in the same patient in two different clinical settings: the intensive care unit and the operating room. We observed that tracheal intubations with direct laryngoscopy in the intensive care unit were associated with worsened intubation conditions and an increase of complications compared with the operating room. In the operating room, most tracheal intubations are performed under elective, controlled conditions, in optimized patients, and by anesthesiologists who are experts in airway management. The rate of difficult intubation and complications is relatively low.[15] However, the risk of intubation difficulty in the intensive care unit is high,[1–7] and the intensive care unit setting is considered by many authors[3,8] as an independent risk factor of difficult intubation and complications during intubation.

The primary outcome in this investigation was to compare the difference in glottic visualization between the operating room and the intensive care unit because we hypothesized that poor glottic exposure during direct laryngoscopy may be responsible for increased incidence of difficult intubation in the intensive care unit.

To describe glottic visualization during direct laryngoscopy, we used the modified Cormack–Lehane classification. This is a scale used frequently in airway-related research to describe intubation conditions and compare visibility of

Table 3. Relationship between Number of Intubation Attempts, Difficulty of Intubation, Adjuncts to Direct Laryngoscopy Used, and Procedural Complications with Laryngoscopic Grades Obtained during Tracheal Intubations in ICU (N = 208)

	CL-I 116 (56)	CL-IIa 24 (12)	CL-IIb 47 (23)	CL-III 19 (9)	CL-IV 2 (1)	*P* Value
Number of intubation attempts						
1 attempt	114 (98)	22 (92)	39 (83)	10 (53)	0	< 0.001
2 attempts	2 (2)	2 (8)	8 (17)	8 (42)	1 (50)	
3 attempts	0	0	0	1 (5)	1 (50)	
Difficulty of intubation						
No difficulty	101 (87)	18 (75)	3 (6)	1 (5)	0	< 0.001
Mild	13 (11)	5 (21)	29 (62)	5 (26)	0	
Moderate	1 (1)	1 (4)	14 (30)	10 (52)	0	
Severe	1 (1)	0	1 (2)	3 (16)	2 (100)	
Adjunct to DL used (gum-elastic bougie)	6 (5)	1 (4)	18 (38)	13 (68)	2 (100)	< 0.001

Data presented as number (%).
CL = Cormack–Lehane classification; DL = direct laryngoscopy; ICU = intensive care unit.

laryngeal structures.[6,9,16–19] Though different authors have questioned the validity of this scale,[20] several studies have addressed its reliability.[14,21–23] In our institution, all anesthesiologists know and routinely use the Cormack–Lehane classification associated with documenting relevant information, such as number of intubation attempts, need of adjuncts to intubate, and operator-reported difficulty. All data were studied in the current investigation.

In the intensive care unit, poor glottic exposure during direct laryngoscopy may be affected by operator-, patient-, and/or environment-related factors.[8] Because the same patient was intubated in the two different clinical settings by anesthesiologists with similar levels of experience, the worsened glottic visualization observed in the intensive care unit in the current investigation was probably due to physiologic factors of the critically ill patient, as well as environmental factors. Physiologic factors included hypoxemia, hemodynamic instability, laryngeal edema, presence of full stomach, and decreased physiologic reserve that limit the duration of the laryngoscopic attempt. Environmental factors included the limited space, poor lighting, and suboptimal bed characteristics in the intensive care unit that limit the ability to properly position or access the patient's head and airway. These factors can impair direct glottic visualization using a direct laryngoscopy, therefore increasing the technical difficulty of intubation. We observed that patients with previously good glottic visualization and easy tracheal intubation in the operating room had worse glottic visualization with increased number of intubation attempts, and greater difficulty of intubation when these same patients were intubated in the intensive care unit. We think that difficulty in viewing the glottis (Cormack–Lehane IIb, III, or IV) is related to difficult intubation. In the current investigation, we observed a greater number of attempts and difficulty of tracheal intubation in the intensive care unit, from Cormack–Lehane grade I to IV. Similar to our study, other authors[6,10,19] have observed a strong relationship between difficult laryngoscopy view and difficult intubation. Soyunco *et al.*[19] evaluated 366 patients in a prospective observational study and observed that tracheal intubation was more difficult from Cormack–Lehane grade I to IV (11 *vs.* 25 *vs.* 34 *vs.* 81%). Martin *et al.*[6] also showed that Cormack–Lehane grades III and IV were independent predictors of the complications during emergent intubations. Semler *et al.*[10] observed that a ramped position increased the incidence of Cormack–Lehane grades III or IV view, compared with the sniffing position in intensive care unit patients (12 *vs.* 5%). The worsened laryngeal view in the ramped position increased the incidence of difficult intubations and the number of attempts required for intubation.

Although we observed less first-time intubation success rates in the intensive care unit compared with the operating room, we had good results with nearly 90% of patients intubated at the first attempt in the intensive care unit. However, other studies have found first-time success rates between 63 and 75%.[1–3,24] Many authors have suggested that the goal of intubation in the intensive care unit should be first-attempt success.[8,24,25] A recent study from Sakles *et al.*[25] shows that the risk of adverse events increase with each successive attempt, increasing from 14 to 47% when a second attempt is required. Similarly, Simpson *et al.*,[7] in a multicenter study, observed that the frequency of severe hypoxemia increased 14-fold in patients who required more than two attempts at tracheal intubation. They had, similar to the current investigation, a 91% first-time intubation success rate with direct laryngoscopy.

The high first-time intubation success rate in intensive care unit observed in our study and in Simpson's study[7] may be because of the anesthetic experience of the intubators and the high level of supervision of residents. Previous investigations found that tracheal intubation performed by an expert operator was more likely to be successful, took fewer attempts, and was associated with fewer complications and lower mortality than intubations performed by nonexperts.[2,6] Similarly, Schmidt *et al.*[9] found that emergent intubation with supervision by attending anesthesiologists was associated with a statistically significant decrease in complications (6 *vs.* 22%). Jaber *et al.*[1] also described having two operators as a protective factor in reducing complications related to tracheal intubation.

Another factor that may explain the high rate of first-time intubation success in intensive care unit patients in the current study was the high use of neuromuscular blockade for intubation. Overall, 96% of our patients in the intensive care unit received neuromuscular blockade, compared with other studies that document rates from 5 to 72%.[1–3,6,9] The use of neuromuscular blockade in the intensive care unit has been shown to optimize intubation conditions,[26] improving glottic view and reducing intubation attempts,[27,28] and may contribute to decreased complication rates. In the intensive care unit, we used succinylcholine with more frequency, similar to other investigations,[6,7,9,28,29] because the duration of the intubation sequence is significantly shorter, compared with rocuronium in similar intubation conditions.[29] Our intensive care unit patients were seriously ill before intubation. For 83% of patients, the reason for intubation was acute respiratory failure, and nearly 63% needed noninvasive ventilation before tracheal intubation.

In the current study, we observed an increase in the rate of the use of airway adjunct in the intensive care unit compared with the operating room. This probably has also contributed to the high first-time intubation success rate observed in our intensive care unit patients. Data suggest that tracheal intubation, particularly when direct laryngoscopy results in a poor glottic view, is facilitated with the use of a bougie introductor.[30] A retrograde light–guided laryngoscopy was proposed recently to facilitate tracheal intubation in the intensive care unit.[18]

In recent years, several studies have assessed whether the use of video laryngoscopy could increase first-attempt intubation success in the intensive care unit.[15,17,31–38] Conflicting results were obtained. Two meta-analyses[34,35] showed that video laryngoscopy improves first-attempt success, the visualization of the glottis, and reduces mucosal trauma. However, Huang *et al.*,[39] in another meta-analysis, reported that video laryngoscopy did not improve first-attempt success, therefore, do not support routine use of video laryngoscopy during tracheal intubation in the intensive care unit.

Finally, we found that the rates of complications, such as hypoxemia, hypotension, or esophageal intubation, occurred more frequently in the intensive care unit compared with the operating room. Complications may occur in up to 40% of critically ill patients.[1–7,40] Hypoxemia may occur in around 25%, and hypotension in 15 to 35%.[1,2] De Jong *et al.*[3] observed that in obese patients, difficult intubation incidence and complications related to intubation occurred more frequently in the intensive care unit than in the operating room. Although they compared different patients in these two clinical settings, their results agree with ours.

Study Limitations

Our study has limitations. First, this was a study in the intensive care unit and the operating room at Clinical University Hospital of Santiago, Spain. Results are from a single center, and this must be considered when extrapolating the results to other clinical settings. Incorporating a multicenter study in the future could further validate these findings.

Second, in our study all intubations in the operating room and the intensive care unit were performed by attending anesthesiologists or anesthesia residents with more than two years of intraoperative anesthesiology experience. It is not known whether similar results would have been achieved with operators with different skill levels, or without the supervision of an attending physician. Although having similar levels of training, intubators in the operating room were not exactly the same as in the intensive care unit, so it limits the conclusions from this study.

Third, the study was observational. Procedural complications and details of the intubation procedure were collected by the anesthesiologists and the possibility of imperfect documentation and underreporting of complications must be considered.

Four, we concentrated on the complications of hypoxemia, hypotension, and esophageal intubation. Other complications were not documented, and their inclusion may have improved the study.

Last, the neuromuscular blockade and hypnotic drugs used for induction of anesthesia were different in the operating room and in the intensive care unit. The short duration of action of succinylcholine could hamper tracheal intubation in the intensive care unit if difficulty prolongs the attempt. We do not think that this affects the results obtained in the current investigation because in 99% of our intensive care unit patients, tracheal intubation was obtained at first or second attempt.

Despite these limitations, our study offers insight into airway management in intensive care unit and operating room settings.

Conclusions

Compared with the operating room, intubation of the same patient in the intensive care unit using a direct laryngoscopy was associated with worsened glottic view, decreased first-time success rate, and an increase in the technical difficulty of intubation and incidence of complications.

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Competing Interests

The authors declare no competing interests.

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Planocaine: Procaine by May & Baker Ltd. of Dagenham

With John May (1809 to 1893) directing wholesale operations and William Garrad Baker (1815 to 1902) supervising manufacturing and delivery, the pharmaceutical firm of May & Baker (M&B) was founded in 1839 in London. Three years after M&B's surviving founder had passed away, Germany's Alfred Einhorn synthesized the local anesthetic procaine in 1905. Eventually, M&B became one of several non-German companies whose brands of procaine competed against Novocaine, Germany's leading procaine. The 5 ml ampoule (*above*) of 2% procaine solution was branded "Planocaine" by May & Baker Ltd. and manufactured at Dagenham, East London. Planocaine was investigated in 1938 by F. R. Ferguson and K. H. Watkins after cauda equina syndromes complicated 14 spinal anesthetics with "heavy duracaine," a mixture of planocaine and glycerine with either gliadin or gum acacia. (Copyright © the American Society of Anesthesiologists' Wood Library-Museum of Anesthesiology.)

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