Impact of Videolaryngoscopy Expertise on First-Attempt Intubation Success in Critically Ill Patients

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Objectives: The use of a videolaryngoscope in the ICU on the first endotracheal intubation attempt and intubation-related complications is controversial. The objective of this study was to evaluate the first intubation attempt success rate in the ICU with the McGrath MAC videolaryngoscope (Medtronic, Minneapolis, MN) according to the operators' videolaryngoscope expertise and to describe its association with the occurrence of intubation-related complications.

Design: Observational study.

Setting: Medical ICU.

Subjects: Consecutive endotracheal intubations in critically ill patients.

Interventions: Systematic use of the videolaryngoscope.

Measurements and Main Outcomes: We enrolled 202 consecutive endotracheal intubations. Overall first-attempt success rate was 126 of 202 (62%). Comorbidities, junior operator, cardiac arrest upon admission, and coma were associated with a lower first-attempt success rate. The first-attempt success rate was less than 50% in novice operators (1–5 previous experiences with videolaryngoscope, independently of airway expertise with direct laryngoscopies) and 87% in expert operators (> 15 previous experiences with videolaryngoscope). Multivariate analysis confirmed the association between specific skill training with videolaryngoscope and the first-attempt success rate. Severe hypoxemia and overall immediate intubation-related complications occurred more frequently in first-attempt failure intubations (24/76, 32%) than in first-attempt success intubations (14/126, 11%) ($p < 0.001$).

Conclusions: We report for the first time in the critically ill that specific videolaryngoscopy skill training, assessed by the number of previous videolaryngoscopies performed, is an independent factor of first-attempt intubation success. Furthermore, we observed that specific skill training with the McGrath MAC videolaryngoscope was fast. Therefore, future trials evaluating videolaryngoscopy in ICUs should consider the specific skill training of operators in videolaryngoscopy.

Key Words: airway management; difficult intubation; endotracheal intubation; McGrath MAC; videolaryngoscopy

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Endotracheal intubation is a high-risk invasive procedure commonly performed in the ICU. Organ dysfunctions, small physiologic reserve, and higher risk of difficult intubation lead to a high frequency of intubation-related complications such as severe desaturation and hemodynamic deterioration (1–5). Because previous research reported a significant increase in hypoxemia as the number of laryngoscopy attempts increased (6–8), the number of intubation attempts should be minimized. Videolaryngoscopes are devices that embed a miniaturized camera on the tip of the blade to indirectly visualize the glottis. Although videolaryngoscopy has been associated with a significant increase in first-attempt success rate when compared with direct laryngoscopy in some studies (10–14), others have reported nonsignificant differences between videolaryngoscopy and direct laryngoscopy (15–18). In a landmark multicenter randomized clinical trial using the McGrath MAC videolaryngoscope (Medtronic, Minneapolis, MN), Lascarrou et al (15) reported that videolaryngoscopy, mostly performed by novice operators, did not improve first-attempt successful intubation rates and was associated with higher rates of severe life-threatening complications compared with direct laryngoscopy.

As part of a quality improvement initiative, we implemented the McGrath MAC videolaryngoscope in our difficult airway toolbox according to French (19, 20) and British guidelines (21).

Because the level of expertise in airway management among attending physicians and among residents was heterogenous, we positioned the videolaryngoscope as the first-line laryngoscope for every intubation in critically ill patients to reinforce skill training.

The aim of the present study was to evaluate the first endotracheal intubation attempt success rate according to operators' previous videolaryngoscope expertise and to describe the relations between the first-attempt success rate and occurrence of intubation procedure complications.

MATERIALS AND METHODS

Study Setting and Design

We performed a study using prospectively collected data from a continuous quality improvement database about airway management in a 20-bed medical ICU at the University Hospital of Montpellier, France. The study protocol was reviewed and approved by the Montpellier Teaching Hospital Institutional Review Board (2019 IRB-MTP-09-01). Given the observational design of the present study, exemption of consent was granted. We followed the Strengthening the Reporting of Observational Studies in Epidemiology statement recommendations (22). The McGrath MAC videolaryngoscope manufacturer was not involved in any step of the present study and the videolaryngoscope and blades were funded on our ICU's budget.

Population and Intubation Procedure

All consecutive intubation procedures with the McGrath MAC videolaryngoscope from September 2018 to June 2019 in our ICU were included. The McGrath MAC is a combo videolaryngoscope which allows both direct and indirect laryngoscopy with a blade that is similar to a traditional Mackintosh blade angulation-wise. The screen is attached to the videolaryngoscope and there is a dedicated X-blade for difficult intubation (**Fig. E2**, Supplemental Digital Content 3, http://links.lww.com/CCM/F646). The McGrath MAC was implemented in our institution's ICUs prior to the constitution of our database as a tool to facilitate intubation in the critically ill. As part of a quality improvement program and to ensure the medical team would be comfortable with the device, the McGrath MAC was positioned as the primary laryngoscope for every single intubation. At the beginning of each resident rotation, ICU residents, fellows, and attending physicians followed a 1-hour e-learning course showing airway management with the videolaryngoscope as well as a 2-hour airway hands-on training course including the use of the McGrath MAC device on a manikin. Both residents and attending physicians in our medical ICU come from different backgrounds (anesthesiology, emergency medicine, critical care, medicine). Most of the residents are airway-novices at the beginning of the rotation. Beside the systematic use of the videolaryngoscope, the intubation procedure was left at the discretion of the supervising physician who complied with the recent guidelines (19, 20, 23). Since residents were first operators of endotracheal intubation, each procedure was supervised by an ICU attending physician. After each endotracheal intubation, intubation-related information was recorded on a data collection sheet by the first operator and supervised by the attending physician in charge.

Data Collection and Definitions

Clinical parameters and outcomes were collected prior to, during, and following the intubation procedure. Prior to the intubation procedure were assessed: demographics, Charlson Comorbidity Index (24, 25), cause of admission and reason for intubation, Simplified Acute Physiologic Score II upon ICU admission and the Sequential Organ Failure Assessment score before the procedure, preoxygenation modality, and criteria for difficult intubation (5, 23, 26). The specific expertise of the operator in videolaryngoscopy was assessed according to the number of previous videolaryngoscopies performed (categorized arbitrarily as from 1 to 5; 6 to 10; 11 to 15, and over 15 procedures) combining both successful and failed attempts. During the intubation procedure, the following were assessed: drugs used for induction, Cormack-Lehane score, blade type, use of a stylet, number of attempts, need for another operator, Sellick maneuver, backward, upward, and rightward pressure (BURP) maneuver, Intubation Difficulty Scale (27), and use of capnography. Each introduction of the videolaryngoscope into the oral cavity as well as any technical assistance to perform the laryngoscopy were considered separate attempts (15). Endotracheal tube positioned in the trachea during first insertion of the videolaryngoscope into the oropharynx without removing the videolaryngoscope from the mouth or using any supplemental airway tool defined a first-attempt success (18). Per procedure and immediate complications were collected (1, 2, 15, 17). We collected data including death, cardiac arrest, severe cardiovascular collapse defined as systolic blood pressure equal or less than 65 mm Hg recorded at least one time or equal or less than 90 mm Hg that lasted 30 minutes despite 500–1,000 mL of fluid loading or requiring introduction of vasoactive support, severe hypoxemia (defined as a decrease in oxygen saturation as measured by pulse oximetry equal or less than 80% during attempts), arrhythmia (defined as supraventricular and/or ventricular arrhythmia without pulseless rhythm requiring therapy), aspiration, esophageal intubation, pneumothorax, and dental injury. Duration of invasive mechanical ventilation, ICU length of stay, and ICU mortality were recorded.

Endpoints

The primary endpoint of the present study was the percentage of first-attempt intubation success rate according to the level of operators' expertise, defined as the number of videolaryngoscopies already performed by the operators. We then divided the cohort of patients into a "first-attempt success" group and a "first-attempt failure" group. The secondary endpoints were analysis of the factors associated with first-pass intubation failure and intubation-related complications.

Statistical Analysis

Quantitative variables were expressed as medians with interquartile range (25–75%) and compared using the Wilcoxon

TABLE 1. Patients Characteristics Upon ICU Admission and Conditions at Intubation

Characteristics	Total ($n = 202$)	First-Attempt Failure ($n = 76$)	First-Attempt Success ($n = 126$)	p
Median age, yr	67 (56–72)	66 (55–71)	67 (58–72)	0.419
Sex, male	126 (62)	46 (61)	80 (63)	0.673
Body mass index, kg/m^2	26 (23–30)	26 (23–29)	25 (23–30)	0.636
Simplified Acute Physiologic Score II	53 (40–66)	53 (41–67)	51 (39–66)	0.636
Charlson Comorbidity Index	5 (2–7)	4 (2–6)	5 (3–7)	0.038
Reasons for ICU admission				
Acute respiratory failure	126 (62)	47 (62)	79 (63)	0.903
Shock	44 (22)	18 (24)	26 (21)	0.611
Neurologic	40 (20)	19 (25)	21 (17)	0.150
Cardiac arrest	10 (5)	7 (9)	3 (2)	0.043
Acute renal failure	16 (8)	6 (8)	10 (8)	0.991
Burn	8 (4)	2 (3)	6 (5)	0.712
Others	12 (6)	4 (5)	8 (6)	1.000
Reason for intubation				
Respiratory failure	122/201 (61)	45/75 (60)	77 (61)	0.876
Hemodynamic instability	24/201 (12)	8/75 (11)	16 (13)	0.667
Coma	39/201 (19)	22/75 (29)	17 (13)	0.006
Cardiac arrest	4/201 (2)	2/75 (3)	2 (2)	0.630
Need for urgent surgery	13/201 (6)	5/75 (7)	8 (6)	0.929
Replace the endotracheal tube	24/201 (12)	8/75 (11)	16 (13)	0.667
Others	7/201 (3)	2/75 (3)	5 (4)	1.000
Clinical features at intubation				
Sequential Organ Failure Assessment score	6 (4–9)	6 (4–9)	6 (4–9)	0.713
Vasopressor use	65/200 (32)	23/74 (31)	42 (33)	0.743
Coma	50 (25)	27 (36)	23 (18)	0.006
Oxygen saturation as measured by pulse oximetry	92 (86–96)	93 (89–96)	92 (84–96)	0.200
High flow oxygen	62/201 (30)	18/75 (24)	44 (34)	0.105
Noninvasive ventilation	59/201 (29)	19/75 (25)	40 (32)	0.334
ICU discharge characteristics				
ICU length of stay, d	10 (6–19)	12 (6–19)	10 (6–19)	0.666
Mechanical ventilation duration, d	6 (3–15)	7 (4–15)	5 (3–15)	0.364
ICU mortality	49/199 (25)	15/74 (20)	34/125 (27)	0.273

Data are summarized as n (%) for the patients with available data or median (interquartile range). One patient can have more than one reason for ICU admission or for intubation.

signed-rank test or the Kruskal-Wallis test as appropriate. Qualitative variables were expressed as n (%) and compared using the chi-square test or the Fisher exact test as appropriate. We performed a multivariate logistic regression to identify first-attempt intubation failure factors. For multivariate analysis, we selected variables according to their clinical relevance and statistical significance in univariate analysis with a p value of less than 0.20. Variables were kept in the final model if the p value was less than 0.05. Results of multivariate analysis are presented as adjusted odds ratios with 95% CIs. A p value of less than 0.05 was considered statistically significant. R Version 3.6.1 statistical software (Free Software Foundation, Boston, MA) was used.

RESULTS

During the study period, 202 intubation procedures were performed on 185 patients. Overall first-attempt intubation success rate was 126 of 202 (62%) (**Table 1**). Among the 202 procedures, 42 (21%) required a second operator to achieve intubation but none required more than two operators. Intratracheal tube position was confirmed by analyzing the capnography curve in 192 procedures (95%). Higher comorbidity score, cardiac arrest as the reason for ICU admission, and presence of coma as the indication to intubate were more frequently encountered in the first-attempt failure group than in the first-attempt success group in univariate analysis, coma being the sole patient-related risk factor associated with first-attempt failure in multivariate analysis (Table 1 and **Fig. 1**). Risk factors for difficult intubation were balanced between groups except for the Mallampati score of 4 which was frequently observed in the first-attempt failure group (**Table 2**). The success and failure groups were similar regarding intubation drugs, blade type, stylet use, use of the BURP, and the Sellick maneuvers on the larynx but high flow oxygen was more frequently used in the first-attempt success group (Table 2; and **Table E1**, Supplemental Digital Content 1, http://links.lww.com/CCM/F644). There were more patients with Cormack-Lehane grade 1 in the first-attempt success group than in the first-attempt failure group (89% vs 75%; $p = 0.01$). Intubation difficulty scale was lower and intubation procedure duration was significantly shorter in the first-attempt success group than in the first-attempt failure group (Table 2 and **Fig. 2**; and Fig. E2, Supplemental Digital Content 3, http://links.lww.com/CCM/F646).

Table 3 and **Table E2** (Supplemental Digital Content 4, http://links.lww.com/CCM/F647), **Table E3** (Supplemental Digital Content 5, http://links.lww.com/CCM/F648), and **Table E4** (Supplemental Digital Content 6, http://links.lww.com/CCM/F649) show demographics and intubation procedure parameters according to the level of expertise in videolaryngoscopy. Expert operators were mostly anesthesiology-trained (Table E4, Supplemental Digital Content 6, http://links.lww.com/CCM/F649). In univariate analysis, first-attempt success was significantly associated with anesthesiology- or critical care medicine-trained operators with previous experience in videolaryngoscopy (Table 3). The multivariable regression model confirmed that senior status and previous expertise in videolaryngoscopy were independently and statistically associated with the first-attempt failure rate (Fig. 1; and **Fig. E1**, Supplemental Digital Content 2, http://links.lww.com/CCM/F645). Figure 2 shows the increase of the first-attempt procedure success rate according to the operators' level of expertise. Having performed more than 15 videolaryngoscopies was associated with a first-pass success rate of 87%. The first-pass success rate did not plateau according to the level of skill training experience (Fig. 2).

A total of 38 patients (19%) presented with at least one complication during the intubation procedure (**Table E5**, Supplemental Digital Content 7, http://links.lww.com/CCM/F650). A significantly higher complication rate was recorded in the first-attempt failure group (24 [32%]) than in the first-attempt success group (14 [11%]; $p < 0.001$) (Table E5, Supplemental Digital Content 7, http://links.lww.com/CCM/F650).

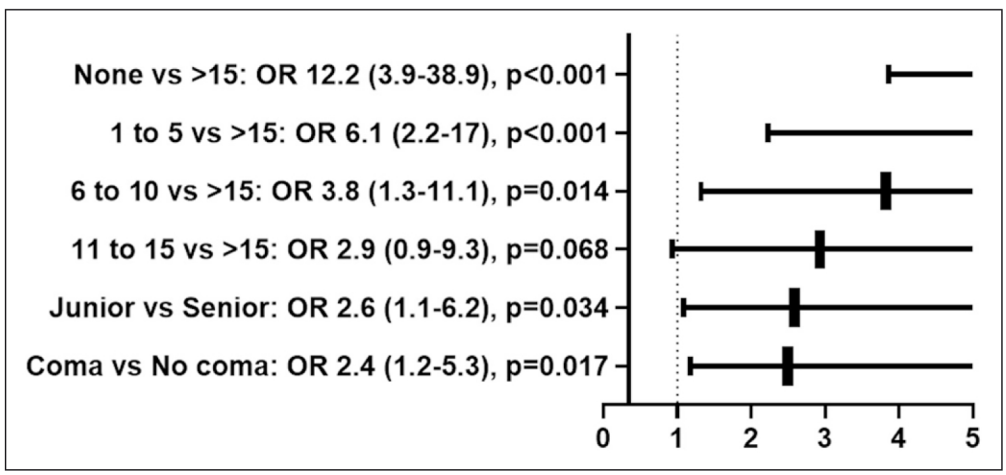

Figure 1. Adjusted odds ratios (ORs) for first-attempt failure. Multivariate analysis model: Predictive factors of first-attempt failure identified were expertise in videolaryngoscopy (VL), junior status, and presence of coma. Expertise in VL was categorized into five groups: none; 1–5; 6–10; 11–15; and over 15 previous VLs performed. Junior operators include residents and medical students.

DISCUSSION

In the present study, we report for the first time in the critically ill population the impact of specific McGrath Mac videolaryngoscopy skill training on the first-attempt intubation success rate, duration of the intubation procedure, and the occurrence of severe immediate postintubation complications.

The first-attempt intubation success rate, an objective parameter ensuring a low risk of bias and high external validity, is strongly associated with immediate life-threatening complications in the critically ill population (6–8) and was the primary outcome of the present study. In the multivariate analysis, the absence of dedicated videolaryngoscopy expertise, junior status, and the presence of coma were independent risk factors of first-attempt failure (Fig. 1). Coma has been associated with difficult intubation in the ICU, possibly because of the presence of secretions and the impossibility to evaluate the Mallampati score, a major component of the MACOCHA score (5). MACOCHA is a multivariable intubation score that takes into account the Mallampatti Score, the presence of Apnea syndrome (obstructive), a cervical spine limitation, opening mouth < 3 cm, coma, hypoxia and non-anesthesiologist trained operator performing the intubation (5). In the present study, we report a mean first-attempt intubation success

TABLE 2. Main Variables Obtained Before Intubation and Description of the Intubation Process

Characteristics	Total ($n = 202$)	First-Attempt Failure ($n = 76$)	First-Attempt Success ($n = 126$)	p
Criteria for difficult intubation				
Previous documented difficult intubation	6 (3)	2 (3)	4 (3)	1.000
Head and neck disease	10/201 (5)	4/75 (5)	6 (5)	1.000
Mallampati score				
I	59/139 (42)	22/51 (43)	37/88 (42)	0.900
II	44/139 (32)	13/51 (25)	31/88 (35)	0.234
III	19/139 (14)	6/51 (12)	13/88 (15)	0.619
IV	17/139 (12)	10/51 (20)	7/88 (8)	0.043
Obstructive apnea syndrome	32 (16)	12 (16)	20 (16)	0.987
Mouth opening < 35 mm	23 (11)	9 (12)	14 (11)	0.874
Limited cervical mobility	12 (6)	7 (9)	5 (4)	0.127
MACOCHA score (5)[a]				
From 0 to 2	91/139 (65)	31/51 (61)	60/88 (68)	0.377
From 3 to 5	13/139 (9)	5/51 (10)	8/88 (9)	1
From 6 to 8	29/139 (21)	11/51 (22)	18/88 (20)	0.876
From 9 to 10	6/139 (4)	4/51 (8)	2/88 (2)	0.192
Cormack-Lehane grade				
1	166/199 (83)	57 (75)	109/123 (89)	0.012
2	24/199 (12)	10 (13)	14/123 (11)	0.709
3	7/199 (3)	7 (9)	0 (0)	< 0.001
4	2/199 (1)	2 (3)	0 (0)	0.145
Intubation Difficulty Scale	1 (0–2)	3 (2–4)	0 (0–1)	< 0.001
Stylet use	175/201 (87)	67/75 (89)	108 (86)	0.460
Intubation procedure duration (min)	1 (1–2)	2 (1–3)	1 (0.5–1)	< 0.001
Maneuvers during laryngoscopy				
Backward, upward, and rightward pressure maneuver	14/201 (7)	7 (9)	7/125 (6)	0.329
Sellick maneuver	13/200 (6)	4/75 (5)	9/125 (7)	0.604

[a]MACOCHA is a multivariable score taking into account the Mallampatti Score, the presence of Apnea syndrome (obstructive), a cervical spine limitation, opening mouth < 3 cm, coma, hypoxia and non anesthesiologist trained operator performing the intubation.

Preoxygenation modalities: more than one modality could be performed on a single patient (e.g., noninvasive ventilation and apneic oxygenation using high-flow nasal cannula oxygen therapy).

Data are summarized as *n* (%) for the patients with available data or median (interquartile range).

rate of 62% (ranging from 30% for novice operators to 87% for the most experimented operators) (Fig. 2). The first-attempt intubation success rate with videolaryngoscope performed in various locations outside the operating rooms has been previously reviewed (28, 29). In the specific context of the ICU, it ranges from 40% (16) to 91% (12) with a median rate of 78% (28). Although nonanesthesia trainees may need up to 47 procedures to reach 90% first-attempt success with a McIntosh direct laryngoscope, 20 (30) to 75 procedures may be needed with the Glidescope (Verathon, Bothell, WA) (31). We herein report an 87% first-attempt success rate after 15 procedures in the ICU using the McGrath MAC. It has been suggested that the videolaryngoscope learning curve might be faster than for direct laryngoscopy (28), but most studies have been performed in noncritically ill patients in the operating room and did not specifically evaluate a learning curve (32).

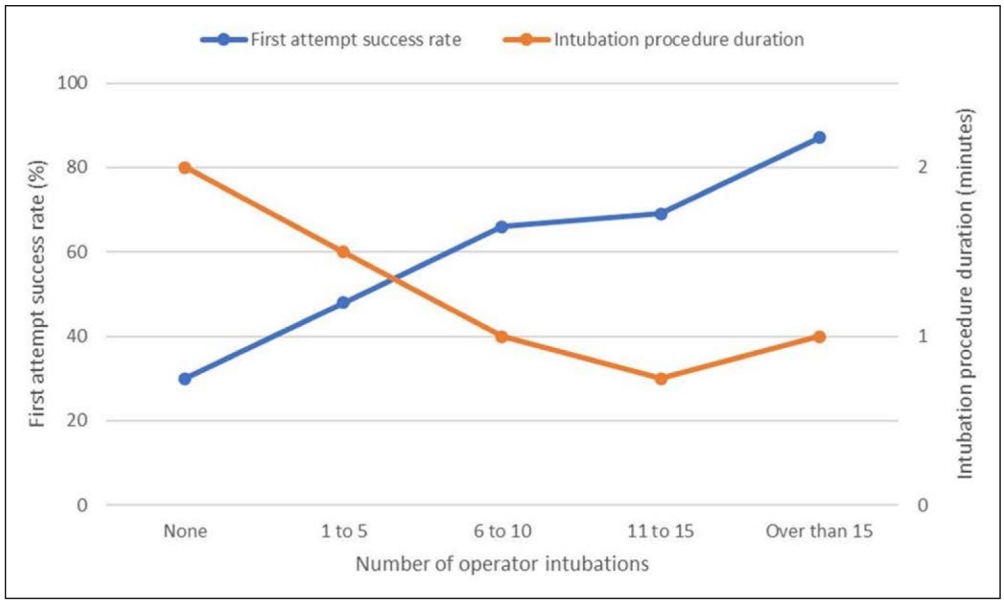

Figure 2. First-attempt success rate and intubation procedure duration according to previous experience in videolaryngoscopy. First-attempt success rate according to previous experience in videolaryngoscopy was as follows: none (30%), 1–5 procedures (48%), 6–10 procedures (66%), 11–15 procedures (69%), and greater than 15 procedures (87%). Number of procedures performed in each group: none, $n = 30$; 1–5 procedures, $n = 48$; 6–10 procedures, $n = 41$; 11–15 procedures, $n = 29$; and greater than 15 procedures, $n = 54$. For intubation procedure duration, median values were reported. Number of procedures performed in each category was as follows: none, $n = 18$; 1–5 procedures, $n = 27$; 6–10 procedures, $n = 23$; 11–15 procedures, $n = 20$; and more than 15 procedures, $n = 45$.

TABLE 3. First-Attempt Success Rate According to the Operator Status

Operators	First-Attempt Success Rate/Overall Attempts ($n = 202$)	p
Operator specialty		
Anesthesia ($n = 13$)	33/42 (79)	
Critical care medicine ($n = 8$)	51/68 (75)	< 0.001
Emergency medicine[a] ($n = 6$)	17/30 (57)	
Internal medicine[a] ($n = 15$)	25/62 (40)	
Previous experience in videolaryngoscopy (procedures)		
None	9/30 (30)	
1–5	23/48 (48)	
6–10	27/41 (66)	< 0.001
11–15	20/29 (69)	
More than 15	47/54 (87)	
Juniors ($n = 30$)	84/152 (55)	< 0.001
Seniors ($n = 12$)	42/50 (84)	

Data are summarized as n (%) for patients with available data.

[a]Only junior operators.

Twelve senior (4/12 anesthesiology-trained) and 30 junior operators (9/30 anesthesiology-trained) did participate in the patient enrollment. All seniors were experts in direct laryngoscopy but a few of them (2/12) had an expertise in videolaryngoscopy. Among the juniors, most of them (21/30) were not skilled in airway management, the nine of 30 skilled in airway being residents in anesthesiology. Procedures were distributed among the different operators during the study period depending on the patients' needs and the random distribution of junior/senior operators across the ICU.

Interestingly, an expert in videolaryngoscopy has usually been defined as being an airway expert in direct laryngoscopy or having been extensively trained in anesthesiology or critical care medicine, regardless of specific videolaryngoscopy skill training (15, 17, 33, 34). For instance, in the study by Lascarrou et al (15), expertise was defined as "a physician who had either worked at ICUs for at least 5 years or worked at ICUs for at least 1 year after receiving at least 2 years of anesthesiology training." However, as for any new tool or technique (35), the use of videolaryngoscope needs specific skill training. In the present study, most of the airway experts were novices with the use of videolaryngoscope while some of the anesthesiology residents rotating in the ICU had previous experience in operating rooms from different institutions with a variety of videolaryngoscopes. First-attempt intubation success rate did not plateau after 15 previous experiences (Fig. 2), suggesting that it might increase with further expertise. The rapid acquisition of videolaryngoscopy skill training in the present study might be attributed to the design of the videolaryngoscope itself which allows for better glottis visualization than direct laryngoscopy (36), to the attached camera which enables the attending physician to provide effective procedure supervision, and perhaps to the use of the stylet in 87% of the procedures. Although the McGrath MAC manufacturer does not recommend routine use of a stylet, it might have facilitated tube insertion when the glottis was visualized yet tracheal tube insertion remained difficult ("can see but cannot intubate" situations), a situation frequently observed in the study by Lascarrou et al (15). The use of a stylet has indeed been associated with less difficult intubations using videolaryngoscope (37, 38) and may accelerate tracheal tube insertion when glottis visualization is imperfect.

The use of videolaryngoscope to improve intubation-related complications remains controverted. Meta-analysis failed to show a decrease in complications using videolaryngoscope, except for esophageal intubation (28, 36), and the study by Lascarrou et al (15) reported an increased risk of immediate complications with the use of videolaryngoscope in comparison with the use of direct laryngoscope. We report an overall complication rate of 19% with significantly fewer complications in the first-attempt success group (11%) than in the first-attempt failure group (32%; $p < 0.001$) (Table E5, Supplemental Digital Content 7, http://links.lww.com/CCM/F650).

A 19% rate of immediate complications is lower than previously reported (1, 3–5). Although we cannot rule out under-reported complications, we implemented the bundle procedures associated with limited complications (19–21, 39) and chose to focus on immediate rather than long-term complications following the procedure. To reduce the complication rate related to intubation, the number of intubation attempts and intubation duration must be limited (6–8). Novice operators spent more time than experts attempting to insert the tracheal tube, which is in line with studies performed with various videolaryngoscopes and direct laryngoscopes using manikins (40) or in the operating room (41). Critically ill patients are especially vulnerable to hypoxemia. It has been shown that positive pressure preoxygenation modalities in hypoxemic patients can avoid episodes of severe hypoxemia during the intubation procedure (19–21, 42, 43). Optimized preoxygenation (using noninvasive ventilation in 82/201 procedures or high flow oxygen in 39/201 procedures) limited the occurrence of severe desaturation during airway management and possibly decreased the level of operators' stress, thereby improving the likelihood of first-attempt success.

This study has several limitations which may weaken our conclusions. First, the present study was a single-center observational study. There was no external supervision of the declaration of intubation procedure conditions and complications. However, even in the few multicenter studies, most of the collected parameters regarding the intubation procedure itself are self-declared, hence, balancing out over- and under-reporting of events. Second, we focused on only one brand of videolaryngoscope that was part of an institutional quality improvement initiative, and we cannot extrapolate our results to other videolaryngoscopes. Third, we did not find an association between first-attempt success, the expertise in videolaryngoscopy and the complications rate, but the present study was not powered to detect such an association. Fourth, we did not find a plateau effect of first-attempt success according to the level of training, and thus, we could not define the number of procedures needed to reach a safe rate of first-attempt success to guide organizations. However, 15 procedures were associated with a very high success rate (87%).

CONCLUSIONS

We report for the first time in the critically ill that specific videolaryngoscopy skill training, assessed by the number of previous videolaryngoscopies performed, is an independent factor of first-attempt intubation success. Future trials evaluating videolaryngoscopy in ICUs should consider the specific skill training of operators in videolaryngoscopy.

Dr. Amalric participated in the study design, collected data, analyzed results, and participated in article editing. Drs. Larcher and Brunot participated in resident training in airway management and in data collection. Dr. Garnier participated in data collection and in article editing. Dr. De Jong participated in the study design and performed the statistical analysis. Dr. Moulaire Rigollet and Corne participated in data collection and in article editing. Dr. Klouche participated in the study design, results analysis, and article editing. Dr. Jung designed the study, supervised data collection, results analysis, and article editing.

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