

Comparison of Single-use and Reusable Metal Laryngoscope Blades for Orotracheal Intubation during Rapid Sequence Induction of Anesthesia

A Multicenter Cluster Randomized Study

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ABSTRACT

Background: Single-use metal laryngoscope blades are cheaper and carry a lower risk of infection than reusable metal blades. The authors compared single-use and reusable metal blades during rapid sequence induction of anesthesia in a multicenter cluster randomized trial.

Methods: One thousand seventy-two adult patients undergoing general anesthesia under emergency conditions and requiring rapid sequence induction were randomly assigned on a weekly basis to either single-use or reusable metal blades (cluster randomization). After induction, a 60-s period was allowed to complete intubation. In the case of failed intubation, a second attempt was performed using the opposite type of blade. The primary endpoint was the rate of failed intubation, and the secondary endpoints were the incidence of

complications (oxygen desaturation, lung aspiration, and/or oropharynx trauma) and the Cormack and Lehane score.

Results: Both groups were similar in their main characteristics, including the risk factors for difficult intubation. The rate of failed intubation was significantly decreased with single-use metal blades at the first attempt compared with reusable blades (2.8 vs. 5.4%, $P < 0.05$). In addition, the proportion of grades III and IV in Cormack and Lehane score were also significantly decreased with single-use metal blades (6 vs. 10%, $P < 0.05$). The global complication rate did not reach statistical significance, although the same trend was noted (6.8% vs. 11.5%, $P =$ not significant). An investigator survey and a measure of illumination pointed that illumination might have been responsible for this result.

Conclusions: The single-use metal blade was more efficient than a reusable metal blade in rapid sequence induction of anesthesia.

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What We Already Know about This Topic

- ❖ Single-use laryngoscope blades may reduce expense and risk of infection compared with reusable blades
- ❖ Single-use plastic blades are less efficient than reusable blades in emergency intubation

What This Article Tells Us That Is New

- ❖ In a randomized study of more than 1,000 patients for emergency intubation under rapid sequence intubation, single-use metal blades were associated with fewer failed first attempts and fewer poor grade laryngeal views than reusable metal blades

THE single-use laryngoscope blade is widely used in anesthesia because it is less expensive and may remove a potential but not yet defined higher risk for contamination among reusable blades.¹⁻³ However, although appraisal of a new drug takes almost a decade before appearing on the market, airway devices are commonly marketed without previous rigorous clinical investigation. Unfortunately, because of different types of plastic or metal used in construction in

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addition to different physical characteristics such as curvature, rigidity, and illumination, single-use blades may be very variable in performance and may endanger patient safety.⁴ Two recent randomized studies have revealed that single-use plastic blades are less efficient and are at the origin of an increased complication rate in rapid sequence induction of anesthesia in emergency setting.^{4,5}

In emergency situations and with a full stomach, rapid sequence induction of anesthesia is indicated to protect the lung against aspiration of gastric contents. Unfortunately, in the emergency context, failed attempts of tracheal intubation are known to increase⁴⁻⁷ in parallel with the occurrence of complications such as surface wounds of the oropharynx, oxygen desaturation requiring mask ventilation, and increasing risk of lung aspiration, cardiac arrest, and increased mortality.^{4,7-9} In this context, the efficiency of intubation material seem s crucial. Although the single-use plastic blade is not recommended in rapid sequence induction of anesthesia,^{4,5} the efficiency of the single-use metal blade has not been previously assessed. The aim of this multicenter cluster randomized study was to test the hypothesis that the performance of the single-use metal blade was not inferior to the reusable metal laryngoscope blade in rapid sequence induction of anesthesia.

Materials and Methods

The study was approved by our ethics committee (Comité de Protection des Personnes se Prêtant à la Recherche Biomédicale de l'Hôpital Pitié-Salpêtrière, Paris, France). Because of the emergency conditions and the regular use of the two types of laryngoscope blades in clinical practice, waived informed consent was authorized by the ethics committee. Our study followed the CONSORT recommendations concerning the reporting of studies with cluster randomization.¹⁰

Experimental Protocol

Patients older than 18 yr undergoing general anesthesia in emergency conditions and requiring rapid sequence induction were included. Exclusion criteria were contraindication to the medication used for induction, upper respiratory tract abnormalities, and history of a difficult tracheal intubation requiring an alternative to direct laryngoscopy. The following risk factors for difficult tracheal intubation were routinely recorded: modified Mallampati class, mouth opening, thyromental distance, immobilization of the neck with a Minerva or neck rigidity, short neck, macroglossia, buck teeth, retrognathism, pregnancy, and cervical hematoma. We also recorded patients' weight and height and calculated their body mass index, which has been demonstrated to be a weak predictor of difficult intubation.¹¹ Obesity was defined as a body mass index more than 30 kg/m².

This multicenter randomized trial involved four French teaching hospitals. Senior and junior anesthesiologists and nurse anesthetists were recruited to participate in the study to minimize possible observer bias. However, junior anesthesi-

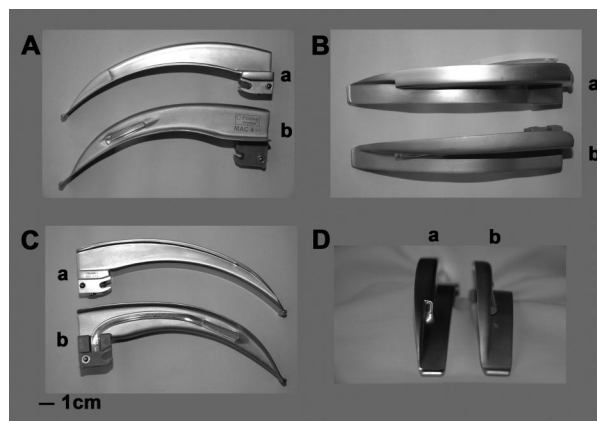


Fig. 1. Comparison of reusable metal (a) with single-use metal (b) blades: right (A), up (B), left (C), and front (D) views, respectively.

ologists and nurses performed intubation under the supervision of a senior anesthesiologist.¹² All these centers used reusable metal blades and single-use metal blades in routine tracheal intubation. The whole emergency anesthetic team was renewed each day. The type of blade for the first attempt, standard Macintosh metal reusable blades (Heine class c+®; Heine, Herrshing, Germany) or Macintosh metal single-use blades (Metal Cristal®; Penlon, Abingdon, United Kingdom), was established using a cluster randomization table. The randomized type of blade was used during seven consecutive days. In this study, we chose the single-use Cristal® metal blade because this device had been selected by an independent anesthesiologist expert panel of Assistance Publique – Hôpitaux de Paris (Paris, France) as one of the best available in the French market in agreement with results from a preliminary study.¹³ Moreover, main characteristics between the reusable and single-use Cristal® metal blade tested in this study seemed comparable (fig. 1).

After preoxygenation with 100% oxygen for 4 min or the time required to obtain an end-tidal expiratory oxygen concentration above 90% by face mask, anesthesia was induced with 5 mg/kg thiopental (Nesdonal®, Abbott, Campoverde di Aprilia, Italia) or 0.4 mg/kg etomidate (Hypnomidate®; Jansen, Beerse, Belgium) followed by neuromuscular blockade using 1 mg/kg succinylcholine (Celocurine®; Pharmacia, Espoo, Finland). Etomidate was the induction agent of choice in elderly patients and in case of any hemodynamic instability. The decision to use etomidate or thiopental was that of the senior anesthesiologist. After muscle fasciculations had been observed to ensure adequate muscle relaxation, tracheal intubation was performed using an endotracheal tube (Portex®; Tijuana, Mexico) systematically associated with an internal stylet and cricoid pressure (Sellick's maneuver). The size of the blade (n° 4) and of the endotracheal tube (7.5 mm of internal diameter) were standardized. The height of the operating table was adjusted, so that the patient's forehead was at the level of the anesthesiologist's xiphoid cartilage. The patient's head was extended in the "sniffing" position in patients without neck collar and spine trauma and using manual stabilization in patients suspected to have spine trauma.¹⁴ The dura-

tion of intubation was defined as the time between the onset of insertion of laryngoscope blade into the mouth until the inflation of the endotracheal tube cuff. A 60-s period was allowed to complete the first tracheal intubation attempt, as previously described.⁴ When a second attempt was required, it was performed systematically using a metal blade of the type other than that used during the first attempt and taking over 60 s. The view of the glottis was assessed on each attempt and was scored according to the four visual grades of the Cormack and Lehane score.¹⁵ If the trachea could not be intubated within 60 s at the second attempt, the protocol was discontinued, and the airway was managed according to the difficult airway algorithm of the American Society of Anesthesiologists and French Society of Anesthesia and Intensive Care.^{16,17} All data were kept totally secret during the whole study until the final analysis.

Endpoints

The primary endpoint was failure to intubate the trachea within the first 60 s. The secondary endpoints were complication rates, duration of intubation, and the Cormack and Lehane score. The following complications were recorded: oxygen desaturation defined as a value less than 90% requiring mask ventilation and thus exposing the patient to lung aspiration, clinical lung aspiration requiring prolonged ventilation and confirmed by chest radiographs, and clinical surface wounds of the oropharynx diagnosed by the anesthesiologist. The outcomes were measured at the individual patient level.

Investigator Survey

Because of the noninferiority hypothesis, no attempt was made to understand the possible mechanisms involved in a difference of failure between the two groups. Thus, after completion of the analysis of the study but before the investigators received information concerning the results, we performed an opinion survey in 80 investigators sharing out the four centers involved in the study. We asked them two questions related to the clinical situation of tracheal intubation during a rapid sequence induction for an emergency case. The first question asked to them was whether single-use metal laryngoscope blades are (1) superior, (2) inferior, or (3) equivalent to reusable metal blade. In case of superiority or inferiority, they were asked for the main reason for that difference: (1) exposition of glottis, (2) light provided, (3) rigidity, (4) unknown reason, and (5) other reason.

Measurement of Illuminance

Afterward, we also measured the illuminance provided by a sample of the single-use and reusable blades. A Lux Meter (Lux Meter 545, Testo AG, Lenzkirch, Germany) was placed at the end of a black tube. The laryngoscope and its blade were placed at the contact of the Lux Meter and in a perpendicular position to maximize the amount of lumen received by the detector. Measurements were performed in a dark room without any light ($n = 10$ measures, 0.3 ± 0.2 Lux). The coefficient of variation of the measurement ($n = 20$) was

3.9%. We performed 70 measurements using single-use blades and 70 measurements using reusable blades. Reusable blades were those available and used a given day and were not selected, thus representing various numbers of sterilization processes. New batteries were installed in the laryngoscope for every 24 measurements. A low illuminance was defined as a value below the tenth percentile of measurements.

Statistical Analysis

Data are expressed as mean \pm SD, median (95% CI) for non-normal distributed variables (normality of distribution was assessed using Shapiro-Wilk W test), or number (percentages). Comparisons of means were performed using the Student t test. Comparisons of proportions were performed using Z test. The outcomes were measured at the patient and not at the cluster level, which could have induced some imbalance between groups. To control this, we conducted a *post hoc* complementary propensity score analysis.¹⁸ The propensity score (that a single-use laryngoscope blade was used) was constructed using a nonparsimonious logistic regression that included all variables cited in table 1 and their second degree interaction terms. To describe the imbalances between groups, the relative risks associated with each variable before and after propensity score adjustment were calculated. A per-protocol analysis was initially planned because of the noninferiority hypothesis, but an intention-to-treat analysis was finally retained because the study was interrupted and a superiority hypothesis was tested.

Assuming a proportion of failure of 4.5%,⁴ a number of clusters of 148 with 15 subjects per cluster, and an 80% power to detect a noninferiority margin difference between the proportion of failure in the two groups proportions of 3.0%, we calculated that 2,200 patients should be included (1,100 in each group). Thus, the proportion of failure in the reusable metal blade group was assumed to be 7.5% under the null hypothesis and 4.5% under the alternative hypothesis. The test statistic used was the one-sided Z test. This power calculation assumed the effect of cluster design, which includes the effect of the inter cluster correlation and the effect of the coefficient of variation of cluster size.¹⁹ These two variables were estimated using our previous study conducted with a comparable design.⁴ In this power calculation, we also took into account two sequential tests (*i.e.*, one interim analysis) using the Pocock spending function to determine the test boundaries with a global significance level of the test being 0.05.²⁰ This interim analysis was planned because the hypothesis about the frequency of primary endpoint was uncertain because it was based on relatively few patients in our previous study (95% CI, 1–7%).⁴ Moreover, although this interim analysis was not expected to permit a conclusion for noninferiority of the new material (underpowered), it could enable terminating the study earlier in the case of superiority of one of the devices, which was thought to be appropriate from an ethical point of view.

All P values were two tailed and a P value of less than 0.05 was considered significant. Statistical analysis was

Table 1. Baseline Characteristics of Patients in the Single-use or Reusable Metal Blade Groups

	Reusable Metal Blade (n = 497)	Single-use Metal Blade (n = 575)	Relative Risk (95% CI)	P Value	Adjusted Relative Risk* (95% CI)	P Value
Age (yr)	48 ± 22	51 ± 22	1.01 (1.01–1.02)	0.03	1.00 (0.99–1.00)	0.99
Men	309 (62%)	357 (62%)	0.99 (0.78–1.28)	0.97	1.00 (0.78–1.28)	0.99
Women	188 (48%)	218 (48%)	—	—	—	—
Body mass index (kg/m ²)	25 ± 5	24 ± 4	1.02 (0.99–1.05)	0.07	1.00 (0.97–1.03)	0.99
Body mass index ≥ 30 kg/m ²	63 (13%)	61 (11%)	1.22 (0.84–1.78)	0.29	0.96 (0.64–1.45)	0.96
Modified Mallampati score						
Class I	252 (51%)	294 (51%)	—	—	—	—
Class II	181 (36%)	227 (39%)	—	—	—	—
Class III	55 (11%)	46 (8%)	1.10 (0.92–1.28)	0.31	1.00 (0.84–1.19)	0.99
Class IV	9 (2%)	8 (1%)	—	—	—	—
Mouth opening (mm)	44 ± 10	44 ± 10	44 ± 10	0.96	1.00 (0.99–1.01)	0.99
Thyromental distance (mm)	71 ± 16	71 ± 16	71 ± 16	0.89	1.00 (0.99–1.01)	0.99
Associated criteria						
Short neck	42	42	—	—	—	—
Retrognathism	17	18	—	—	—	—
Pregnancy	1	1	—	—	—	—
Cervical hematoma	6	1	—	—	—	—
Other	14	20	—	—	—	—
Any criteria	80 (7.6%)	82 (7.5%)	1.15 (0.83–1.61)	0.44	1.07 (0.76–1.51)	0.69
Anesthesia induction						
Thiopental	219 (44%)	264 (46%)	0.92 (0.86–1.08)	0.58	1.00 (0.78–1.28)	0.99
Etomidate	278 (56%)	311 (54%)	—	—	—	—
Intubation provider						
Nurse anesthetist	268 (54%)	312 (54%)	—	—	—	—
Junior anesthesiologist	147 (30%)	175 (30%)	0.92 (0.65–1.30)	0.86	0.99 (0.71–1.42)	0.99
Senior anesthesiologist	84 (17%)	88 (15%)	—	—	—	—

Data are expressed as mean ± SD or n (%); $P < 0.05$ vs. reusable metal blade group.

* Adjustment of relative risk was performed using propensity score.

CI = confidence interval.

performed using SPSS version 17 software (SPSS, Inc., Chicago, IL).

Results

Interim analysis was conducted after 74 clusters. Because the proportion of failure was significantly greater in one group, the study was ended, and the analysis was performed. The single-use metal blades were randomly assigned to 38 clusters (51%) and reusable metal blades to 36 (49%); 575 patients (54%) were managed using single-use metal blades and 497 (46%) with reusable metal blades (fig. 2). The observed coefficient of variation in cluster size was 0.49. The cluster randomization design induced some mild statistical imbalances such as age and body mass index in a univariate analysis (table 1), but no significant imbalance was observed in the patient's characteristics after propensity score adjustment (c -index = 0.55; table 1). According to the protocol guidelines, all successful tracheal intubation procedures lasted less than 60 s with failure lasting longer than this period. There was no error in group assignment at the first attempt. Two patients,

one in each group, were successfully intubated after 120 s and thus were considered as failures.

At the first attempt, the proportion of failure was significantly smaller in single-use metal blade group than in reusable metal blade group (2.8 vs. 5.4%, respectively; 95% CI of the difference, 0.3–5.2%; $P < 0.05$) (fig. 3). In addition, the severity of grade in Cormack and Lehane score was significantly different between the two groups, with a decreased proportion of grades III and IV in single-use metal blades (10 vs. 6%, $P < 0.05$) (table 2). The time of intubation was comparable between groups (table 2). Failure rate was similar for nurse, junior, or senior anesthesiologists with single-use (2.6, 2.9, and 3.4%, respectively; $P =$ not significant) and reusable metal blades (5.2, 4.8, and 7.3% respectively; $P =$ not significant). After propensity score adjustment, similar results were retrieved for the main and secondary endpoints (table 2), suggesting that no large imbalance was induced by the design of the study. No significant difference could be noted between centers (data not shown).

Among the 43 failures, a second attempt was performed in 41 patients, the remaining patients being successfully in-

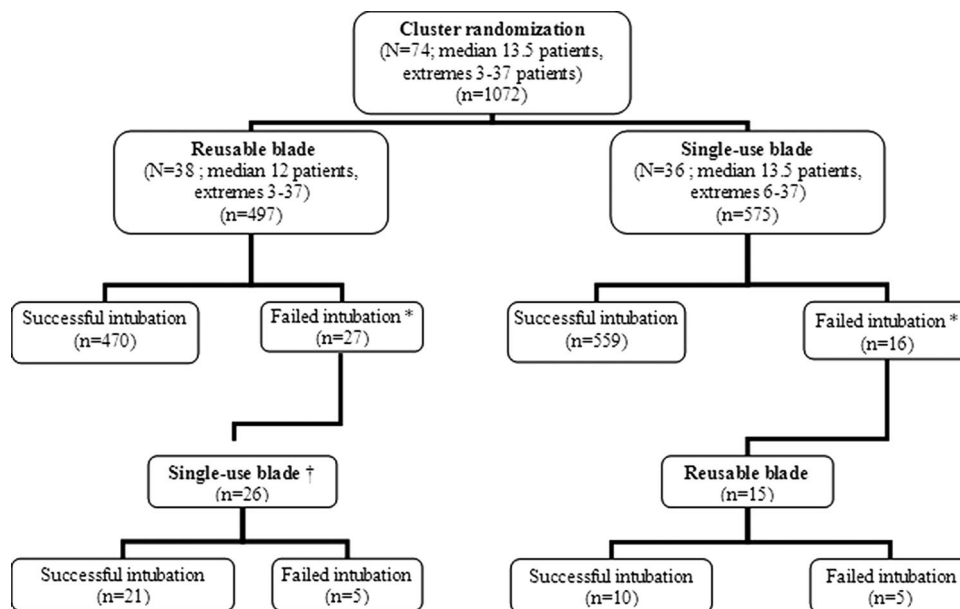


Fig. 2. Flow diagram of the study. N is the number of clusters and n the number of patients. * One patient in each group was successfully intubated after the first attempt but after 120 s, and they were considered as failure (see Methods); thus, these patients did not experience a second attempt. † The second attempt after failed intubation was performed systematically using the opposite type of blade, except in two patients who were assigned to the single-use blade group but were intubated using reusable blades.

tubated at the first attempt but only after 120 s. After an intention-to-treat analysis of the second attempt, failure was observed in 5 of 26 patients (19%) in the single-use metal blade group and in 5 of 15 patients (33%) in the reusable metal blade group. Cormack and Lehane score grades of III and IV were observed, respectively, in 7 of 15 patients (47%) in the single-use metal blade group and 13 of 26 patients (50%) in the reusable metal blade group. However, there were two errors in group assignment at the second attempt, two patients initially in the reusable metal blade group being intubated with a reusable metal blade. After a per-protocol analysis, at the second attempt, failure was observed in 5 of 17 patients (29%) in the single-use metal blade group and in 5 of 17 patients (21%) in the reusable metal blade group.

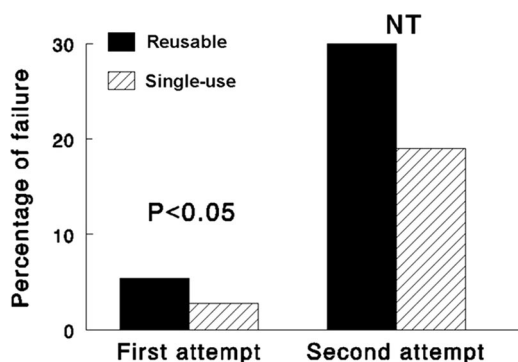


Fig. 3. Comparison of failure at the first (n = 575 and 497, respectively) and second attempts (n = 26 and 15, respectively) between single-use and reusable metal laryngoscope blades. An intention-to-treat analysis was performed (at the second attempt, two patients assigned to the single-use blade group but were intubated using reusable blades). * $P < 0.05$ versus metal reusable blades; NT = not tested because of small sample size.

Cormack and Lehane score grades of III and IV were observed, respectively, in 7 of 17 patients (41%) in the single-use metal blade group and 13 of 24 patients (54%) in the reusable metal blade group. Anyway, these differences were not tested for statistical significance because of the small sample size. In the 10 patients with failure at the second attempt, the trachea was successfully intubated at the third attempt using an Eichmann stylet (n = 5), a Fastrach® (SEBAC, Gennevilliers, France) (n = 3), an endotracheal tube of small diameter (n = 1), or a fiberoptic bronchoscope (n = 1).

The occurrence of complications was comparable after propensity score adjustment (table 2) despite a trend to decrease the global complications with single-use metal blades compared with reusable metal blades (6.8 vs. 11.4%, respectively; $P =$ not significant). One case of lung aspiration was diagnosed in the single-use metal blade group in association with a failed intubation (table 2). In contrast, five cases of lung aspiration were diagnosed in the reusable metal blade group of which two were associated with failed attempts (table 2).

An opinion survey was performed among 80 investigators (58% were senior anesthesiologists, 14% junior anesthesiologists, and 28% anesthetist nurses). Although the majority of investigators thought that single-use and reusable metal blades are equivalent, the proportion of investigators who thought that they were superior was three times more than those who thought they were inferior (table 3). In the investigators who thought that single-use metal blades were superior, the main reason evoked was the light provided (table 3).

The mean illuminance provided by the reusable blades was significantly greater than that provided by the single-use

Table 2. Efficiency of the Reusable and Single-use Metal Laryngoscope Blades at the First Attempt

	Reusable Metal Blade (n = 497)	Single-use Metal Blade (n = 575)	Relative Risk (95% CI)	P Value	Adjusted Relative Risk* (95% CI)	P Value
Cormack and Lehane score						
Class I	376 (76%)	463 (80%)	—	—	—	—
Class II	73 (15%)	79 (14%)	—	—	—	—
Class III	30 (6%)	20 (4%)	1.23 (1.04–1.47)	0.02	1.19 (1.00–1.42)	0.04
Class IV	18 (4%)	13 (2%)	—	—	—	—
Failed intubation	27 (5.4%)	16 (2.8%)	0.49 (0.26–0.94)	0.03	0.53 (0.28–0.98)	0.04
Intubation time (s)	26 ± 14	24 ± 14	1.01 (1.00–1.02)	0.04	1.00 (1.00–1.03)	0.06
Complications						
Oxygen desaturation < 90%	48 (9.6%)	36 (6.2%)	—	—	—	—
Inhalation	5 (1%)	1 (0.1%)	—	—	—	—
Surface wound of oropharynx	4 (0.8%)	2 (0.3%)	—	—	—	—
Any complication	49 (9.9%)	38 (6.6%)	1.55 (0.99–2.40)	0.06	1.39 (0.89–2.17)	0.15

Data are expressed as mean ± SD or n (%); $P < 0.05$ versus reusable metal blade group.

* Adjustment of relative risk was performed using propensity score.

CI = confidence interval.

blades, but the variation (reflected by the SD) was also markedly increased (fig. 4A). In fact, when considering the blades providing a low illuminance (< 40 Lux, corresponding to the tenth percentile), the proportion was significantly greater in the reusable blade group (fig. 4A).

Discussion

This multicenter cluster randomized trial showed that intubation failure was less frequent with single-use metal blades

Table 3. Investigator Opinion Survey (n = 80) Concerning the Performance of Single-use versus Reusable Metal Laryngoscope Blades When Used during Rapid Sequence Induction for an Emergency Case

As compared with reusable blades, single-use blades are	(n = 80 questionnaires)
Better	27 (34%)
Equivalent	44 (55%)
Worse	9 (11%)
If single-use blades are better, what is the main reason?	(n = 27 questionnaires)
Mechanical properties for exposition	5 (19%)
Light provided	22 (81%)
Rigidity	0 (0%)
Unknown reason	0 (0%)
Other reason	0 (0%)
If reusable blades are better, what is the main reason?	(n = 9 questionnaires)
Mechanical properties for exposition	5 (56%)
Light provided	1 (11%)
Rigidity	2 (22%)
Unknown reason	0 (0%)
Other reason	1 (11%)

Data are n (%). Because of rounding addition of percentages may not provide a sum of 100%.

than with reusable metal blades in patients requiring rapid sequence induction of anesthesia in emergency conditions.

In an emergency with a full stomach, rapid sequence induction of anesthesia is indicated to protect the lung against lung aspiration. Unfortunately, in this context, failed attempts of tracheal intubation are known to increase the occurrence of complications such as surface wounds of the oropharynx and oxygen desaturation requiring mask ventilation, thus exposing the patient to lung aspiration, cardiac arrest, and increased mortality.^{4–8} A recent randomized study, performed in the operating room in patients requiring rapid sequence induction of anesthesia, has revealed a failure rate of 17% when a plastic single-use blade was used in contrast with 3% observed with a reusable metal blade.⁴ In addition, 100% of these patients were successfully intubated at the second attempt when a reusable metal blade was used.⁴ In addition, the proportion of grades II–IV of the Cormack and Lehane score was reduced from 96 to 16% when intubation was performed with single-use plastic blades.⁴ Moreover, the duration of intubation was increased by 30% with single-use plastic blades compared with a reusable metal blade, and this delay was associated with a threefold increase in complications.⁴ These results have been recently confirmed in a randomized study performed out of the hospital in an emer-

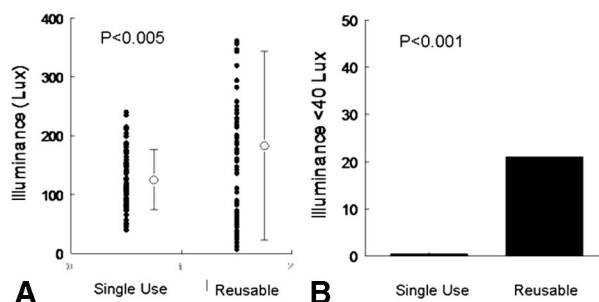


Fig. 4. Measurement of illuminance provided (A) and proportion of low illuminance (< 40 Lux, B) in single-use and reusable metal blades (n = 70 in each group).

gency setting, in which intubation conditions are known to be worse than in the operating room.⁵ The failure rate with plastic single-use blades was 24% compared with 16% with reusable metal blades.⁵ Unfortunately, the occurrence of complications was not investigated in this study, but it is well established that major oxygen desaturation after failed intubation impairs the neurologic prognosis and increases mortality in brain trauma patients.²¹

In this study, the failure rate at the first attempt was 5.4% with a reusable metal blade, and this result is in agreement with previous studies in which failed intubation rates in rapid sequence induction of anesthesia were between 3 and 6% in the operating room.^{4,9,22} In contrast with results obtained with single-use plastic blades,⁴ this study showed that the single-use metal blade was more efficient than the reusable device (fig. 2). This result was confirmed by the difficult intubation severity grading provided by Cormack and Lehane score that was significantly improved with single-use metal blades compared with reusable metal blades (table 2). In addition, we observed a nonsignificant trend to a decrease in the global complications rate.

The difference of success rate for tracheal intubation observed between plastic single-use and metal reusable blades may be explained by the insufficient rigidity of a plastic blade compared with a metal blade.^{4,23} The peak force exerted at laryngoscopy was greater using a single-use plastic blade than with a reusable metal blade (39.6 ± 16.2 vs. 32.8 ± 12.7 N, respectively; $P < 0.05$).²⁴ Moreover, as shown in a randomized study performed in 700 patients, the Sellick maneuver, required in rapid sequence induction, did not significantly increase the rate of failed intubations.²⁴ In the specific case of single-use Cristal® metal blade, the inherent mechanical characteristics seems to be very close to those of the reusable metal blade. The light intensity and the illumination of larynx, which are usually similar or worse with a reusable blade compared with single-use blades, could be a possible explanation of our findings as shown in a previous study performed in manikin³ and as suggested in the opinion survey we performed (table 3). It should be noted that the fiber-optics in reusable blades are known to be quickly altered by repeated steam sterilization.^{3,23,24} This was confirmed by the measurement of illuminance (fig. 4). Although the mean illuminance was greater in the reusable blade, a wider variation in illuminance was also observed, and all blades providing a low illuminance (< 40 Lux) belonged to the reusable group. Moreover, mean illuminance was greater in the single-use plastic blades (Lite-blade®, Rush, Kern, Germany) compared with single-use metal blades used in this study (288 ± 89 vs. 155 ± 89 Lux, $P < 0.001$) (Amour J, personal data), which suggests that rigidity was the main limiting factor of intubation success rate with the single-use plastic blade, as previously reported.^{4,23}

Several points should be mentioned concerning the potential limitations of our study. First, blinding of the investigators was not possible in this study because of the difference of appearance of the devices used in the two groups and

the cluster design of the trial. Nevertheless, the assessors were not informed of the primary hypothesis of the study, data were totally kept secret throughout study, and data analysis was made after closure of the study to limit the risk of observer bias. Second, the choice of the duration of intubation attempt of 60 s has not been well defined in the literature but was defined *a priori* because it seems to represent a reasonable duration for intubation during a rapid sequence.⁴ Third, neuromuscular blockade was not monitored. However, our objective was to test both metal blades in real emergency conditions in which monitoring of neuromuscular blockade is rarely performed in France, and we used succinylcholine in a manner and at a dose that represented four times the ED₉₅. That dose is known to provide satisfactory intubation conditions in 98% of patients.²⁵ Fourth, junior anesthesiologists and nurse anesthetists were also recruited to participate in the study in association with senior anesthesiologists. However, intubation efficiency was found to be similar between these three groups, which represent the classic population of intubation providers in emergency and critical care departments. Moreover, supervision of intubation by a senior anesthesiologist has been recently demonstrated to significantly decrease failure rate.¹¹ Fifth, our results may not apply to pediatric patients. Sixth, because of the early termination of the trial and of the relatively small number of patients with primary endpoint, we have to consider that the magnitude of the effect could have been overestimated.²⁶ Finally, although our survey of investigators and measurement of illumination both supported the hypothesis that a better illumination is responsible for the superiority of single-use metal blades, it should be pointed out that we did not demonstrate a causality link between failures observed in our randomized study and this mechanism.

In conclusion, in contrast with single-use plastic blades, single-use metal blades are associated with a significantly higher success rate of tracheal intubation during rapid sequence induction of anesthesia than reusable metal blades and may decrease the rate of complications in this clinical setting. Potentially resolving the three issues of infection, cost, and efficiency, the single-use metal blade should be recommended, at least in the emergency setting.

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