Implementation of a Revised Montpellier Bundle on the Outcome of Intubation in Critically Ill Patients: A Quality Improvement Project

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Abstract

Introduction: The feasibility of implementing a revised Montpellier intubation bundle incorporating recent evidences was tested in a quality-improvement project. It was hypothesized that this “Care Bundle” implementation would reduce intubation-related complications.

Methods: The project was conducted in an 18-bedded multidisciplinary intensive care unit (ICU). Baseline data for intubations were collected over 3-month “Control Period”. During the 2-month “Interphase”, a revised intubation bundle was developed, and staff members involved in the intubation process were extensively trained on different aspects of intubation with emphasis on bundle components. Various components of the bundle were pre-intubation fluid loading, pre-oxygenation with NIV plus PS, positive-pressure ventilation post-induction, succinylcholine as a first-line induction agent, routine use of stylet, and lung recruitment within 2 minutes of intubation. Intubation data were collected again in the 3-month “Intervention Period”.

Results: Data were collected for 61 and 64 intubations, respectively, during control and intervention periods. There was significant improvement in compliance to five of six-bundle components; improvement in pre-intubation fluid loading during the intervention period did not reach statistical significance. Overall, at least 3 components of the bundle were complied with in over 92% of intubations in the intervention period. However, whole-bundle compliance was limited to 14.3%. Incidences of major complications were reduced significantly in the intervention period (23.8% vs 45.9%, \( p = 0.01 \)). There was significant reduction in profound hypotension (21.77% vs 29.51%, \( p = 0.04 \)) and a nonsignificant 11.89% reduction in profound hypoxemia. There were no differences in minor complications.

Conclusion: Implementation of an evidence-based revised Montpellier intubation bundle is feasible and it reduces major complications related to endotracheal intubation.

Keywords: Endotracheal intubation, Intensive care unit, Intubation bundle, Intubation complications, Quality improvement.

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Highlights

- There is a need for incorporating newer evidences as a “care bundle” during endotracheal intubations in critically ill patients.
- Implementation of a revised bundle is feasible even in ICUs outside the developed world.
- Bundle implementation demonstrates reduction in the rate of major intubation-related complications.

Introduction

Compared with the operating room (OR), endotracheal intubation in the ICU is associated with a higher rate of complications. This is related to the emergent nature of the procedure, poor physiological reserve of critically ill patients, and at least in some places lack of experience of physicians performing the procedure. In the multicenter INTUTURE study, as high as 45.2% of the ICU intubations were complicated by at least one major adverse event. There are wide variations in the incidences of major complications reported in different studies – severe hypoxemia in 9.3–26%, profound hypotension in 9–46.2%, and cardiac arrest in 2–3.1% of patients. Apart from patient-related factors, risk of complications increases with poor pre-oxygenation technique, duration of intubation, number of attempts at intubation, and immediate post-intubation care.

An effective way to reduce complications is to optimize cardiovascular and respiratory status to the best-possible level prior to and during intubation and also by minimizing the number of attempts to shorten the duration of intubation. Efficacy of a “care bundle” was first demonstrated by Jaber and colleagues, who could demonstrate significant reductions in the number of peri-intubation complications, by “employing a group of evidence-based interventions” (now famous “Montpellier Bundle”). Montpellier bundle was based mostly on evidence available in anesthesia literature and experiences in the operating room.

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A curtailed version of Montpellier bundle had also shown to significantly improve first-pass intubation success. However, with newer evidence showing benefits of several other interventions during ICU endotracheal intubation, we felt it necessary to revisit the Montpellier bundle. We hypothesized that incorporating these recent evidence-based interventions in a revised Montpellier bundle would improve the outcome of endotracheal intubation. We, therefore, conducted a quality-improvement project to determine the feasibility of implementing this revised bundle and the efficacy of its implementation on the intubation outcome during the intervention period.

**Materials and Methods**

The project was conducted in the 18-bed multidisciplinary ICU of a tertiary care private hospital from northern India. Round-the-clock coverage in the ICU is provided by a critical care team led by a consultant intensivist. All decisions regarding endotracheal intubation are taken by the ICU consultant. Relevant data for all endotracheal intubations performed on adult patients (≥18 years) during the “Control Period” and “Intervention Period” were collected prospectively. The study was approved by Institutional Ethics Committee (EC/2021/28 dated 08 October 2021), and the need for written consent was waived off. The study was registered in the national clinical trial registry of India (CTRI/2021/11/038089).

**Study Intervention**

**Control Period**

A prospective audit was carried out, starting from 16 June, 2021, for a period of 3 months, looking into different aspects of endotracheal intubation, using a standard proforma. During this period (“Control Period”), no written protocol was in place for endotracheal intubation in the unit. However, a number of interventions suggested by the original Montpellier bundle were loosely followed. At least 2 operators are always available during all ICU intubations.

**Interphase**

During this period, we developed a 6-point “Endotracheal Intubation Bundle” based on the review of airway-management literature for critically ill patients, with an aim to reduce peri-intubation complications. Components of the 6-point bundle are shown in Table 1. In the period between 16 September 2021 and 15 November 2021, the critical care team (consultants, fellows, and nurses) was provided with extensive training on endotracheal intubation processes, including classroom lectures, written material, and training regarding the implementation of different components of the bundle.

**Intervention Period**

In the 3-month “Intervention Period” (16 November 2021–15 February 2022), the intubation procedure was protocolized aiming to implement the 6-point care bundle. However, implementation of an individual component of the bundle was at the discretion of the consultant intensivist, keeping in mind what is best for the patient in the prevailing circumstances.

**Measurements**

Before endotracheal intubation, baseline characteristics were recorded for all intubation procedures: age, gender, presence of obesity, reason for ICU admission, APACHE-II score at intubation, and any need for vasopressor or oxygen support at intubation.

**Statistical Analysis**

Baseline characteristics, intubation processes (including bundle compliance), outcomes of intubation for all intubation procedures, and hospital outcomes for all patients included in control and intervention periods were compared using Student’s t-test for continuous variables and chi-square test for categorical variables.
**Table 2: Definition of terms used**

- **Emergency nature of intubation**: It was defined as real emergency if intubation is required without any delay, a relative emergency if intubation is required within 1 hour, and deferred emergency if the intubation can wait for >1 hour.
- **Time of intubation**: Regular hour was defined as between 9 AM and 5 PM from Monday to Saturday, except on holidays. All other times were considered as out of hour.

- **Operator experience**: Operators were classified as “Experienced” if they were working in the ICU >5 years with experience in endotracheal intubation or with postgraduate training in anaesthesiology plus working in the ICU for at least 1 year with experience in endotracheal intubation. Other operators were classified as “Trainees” and they were allowed to perform intubation only under supervision of an experienced staff. Trainee operators who had undergone 3-year postgraduate training in anaesthesiology were further classified as “Anesthesia Trainee Operator”.
- **Attempt**: Each attempt of advancing the endotracheal tube toward the glottic opening was considered as an attempt.
- **Cormack–Lehane grading**: Airway was classified based on direct laryngoscopic view, as described by Cormack and Lehane in their original paper.14

- **Intubation difficulty scale**: Level of difficulty during intubation was graded as described earlier by Adnet and colleagues based on number of attempts or operators, number of alternative techniques used, Cormack–Lehane grade, lifting forces required during laryngoscopy, any BURP maneuver performed and vocal cord mobility.15

- **Profound hypoxemia**: Profound hypoxemia was defined as any fall in SpO2 below 80% or fall of SpO2 by 10 percentage points for patients in whom SpO2 value was <90% following 3 minutes of pre-oxygenation.

- **Profound hypotension**: Profound hypotension was defined as fall of SBP below 65 mm Hg (for any duration) or below 90 mm Hg that did not improve after 500 mL crystalloid bolus or any hypotension that requires initiation of vasopressor support or need for an increase in vasopressor (for patients already on vasopressor pre intubation).

- **Arrhythmias**: New-onset atrial fibrillation or atrial flutter, ventricular premature complex at a rate >6/min, or new-onset bigeminy/trigeminy or ventricular tachycardia (sustained or nonsustained) will be included in this category.

- **Aspiration**: Visible migration of stomach content into the lung.

intervention periods were compared. All categorical variables were summarized as numbers and percentages (%). On the other hand, quantitative variables with normally distributed data were summarized as mean ± standard deviation (SD) and quantitative data with non-normal distribution were presented as median with 25th and 75th percentiles [interquartile range, (IQR)]. Data normality was checked by using Kolmogorov–Smirnov test.

Qualitative variables were compared using Chi-square test. Non-normally distributed quantitative variables were compared using Mann–Whitney test (for two groups), and independent t test was used for comparison of normally distributed data between two groups. If any cell had a value of less than 5, then Fisher’s exact test was used. Two-tailed p-value of <0.05 was taken as level of statistical significance.

Data entry was done in Microsoft EXCEL spreadsheet. The final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 21.0.

**Results**

Baseline Characteristics

We compared data from 61 intubations completed on 54 patients in the control period with 63 intubations done on 57 patients in the intervention period. Apart from clinically nonsignificant differences in the number of obese patients and reasons for ICU admissions, all baseline variables before intubation were similar (Table 3).

Intubation Procedure

Different aspects of intubation procedures are reported in Table 4. Compared with the control period, there was significant increase in the compliance to all individual components of the bundle during the intervention period with the sole exception of fluid loading prior to intubation. In the intervention period, compliance to all components of the bundle was observed in 14.3% of intubations and complete noncompliance was seen in 3.2% (Fig. 1). In 58 of 63 intubations (92.06%), at least 3 components of the bundle were applied. Physicians’ self-reported reasons for noncompliance to individual components are shown in Table 5.

Outcomes of Intubation

Table 6 shows the outcome of intubation procedures. No significant differences were observed in the first-attempt success, number of operators, rescue equipments used, or level of intubation difficulty between two periods.

In total, 28 of 61 intubations in the control period were complicated by at least one major adverse event, compared with 15 of 63 intubations in the intervention period (45.9% vs 23.8%, p = 0.01). The incidence of profound hypotension was significantly lower in the intervention period (29.51% vs 21.77%, p = 0.04) (Fig. 2). There was 11.89% reduction in profound hypoxemia incidence during the intervention period, however, this difference did not reach statistical significance. Two patients, who died during intubation (both in the control period), had cardiac arrest as the indication for the procedure. Five intubations were complicated by cardiac arrest (2 in control period and 3 in intervention period), return of spontaneous circulation (ROSC) was achieved in all of them. There was no difference in minor complications (Fig. 3). In the intervention period, there were two esophageal intubations, out of which one was associated with profound hypoxemia.

In the overall cohort, rate of first-pass success was 81.82% in 66 patients where stylet was proactively used, compared with 74.14% in 58 patients where it was not used, however, this difference was not statistically significant (p = 0.301). In total, 30 of 97 intubations with first-pass success had some complications, compared with 13 of 27 intubations requiring multiple attempts (30.92% vs 48.14%, p = 0.096). Overall, 14 of 70 patients who received fluid loading developed profound hypotension, compared with 13 of 54 patients who did not receive it (20% vs 24.07%, p = 0.586).
**Table 3: Baseline characteristics before endotracheal intubation**

<table>
<thead>
<tr>
<th></th>
<th>Control period (N = 61)</th>
<th>Intervention period (N = 63)</th>
<th>Total (N = 124)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (in years), mean (SD)</td>
<td>63.41 ± 15.61</td>
<td>61.49 ± 15.28</td>
<td>62.44 ± 15.41</td>
<td>0.491†</td>
</tr>
<tr>
<td>Female gender, No, %</td>
<td>25 (40.98%)</td>
<td>22 (34.92%)</td>
<td>47 (37.90%)</td>
<td>0.487§</td>
</tr>
<tr>
<td>Obesity, No, %</td>
<td>2 (3.28%)</td>
<td>11 (17.46%)</td>
<td>13 (10.48%)</td>
<td>0.016‡</td>
</tr>
<tr>
<td>APACHE II</td>
<td>21.52 ± 7.6</td>
<td>20.56 ± 6.86</td>
<td>21.03 ± 7.22</td>
<td>0.457†</td>
</tr>
</tbody>
</table>

**Reasons for ICU admission, No, %**

- Advanced malignancy: 0 (0%)
- Airway compromise: 0 (0%)
- Circulatory shock: 5 (8.20%)
- Complications of CKD: 2 (3.28%)
- Complications of CLD: 3 (4.92%)
- Quadriplegia: 0 (0%)
- Respiratory failure: 28 (45.90%)
- Seizure: 0 (0%)
- Stroke: 8 (13.11%)
- Trauma: 2 (3.28%)
- Other: 13 (21.31%)

**Heart rate (median, IQR)**

Control period: 112 (100–138.25) vs 110 (98–131.5) days, p = 0.226†

*Independent t test; †Mann Whitney test; §Chi square test; APACHE, acute physiology and chronic health evaluation; CKD, chronic kidney disease; CLD, chronic liver disease; IQR, interquartile range; LMA, laryngeal mask airway; SD, standard deviation*

**Outcome of Patients**

Patients who were intubated in the ICU during the control period had significantly higher mortality at hospital discharge (66.67% vs 42.11%, p = 0.009). In the intervention period, one patient who achieved ROSC following peri-intubation cardiac arrest died on the following day. There was no difference in ICU median, 6 (4–8) vs 6 (5–10) days, p = 0.063 or hospital length of stay [median, 11 (8.25–13.75) vs 10 (8–15) days, p = 0.925].

**Discussion**

Development, training, and implementation of an evidence-based intubation bundle are feasible in ICUs. There was over 90% compliance to at least 3 components of the bundle during the intervention period with a significant increase in the compliance to almost all components (with the exception of fluid loading pre-intubation). With extensive training and implementation of the bundle, the incidence of life-threatening complications during and within 1 hour of endotracheal intubation could be reduced by half. The incidence of profound hypotension was significantly lowered during the intervention period. There was also a nonsignificant reduction in the incidence of profound hypoxemia by 11.89 percentage points.

**Rationale for 6-component “Care Bundle”**

**Fluid Loading Pre-induction**

Profound hypotension is common during ICU intubation, especially in older and more severely ill patients.

In the Montpellier protocol, routine fluid loading pre-induction was included as part of a comprehensive intervention strategy and the strategy showed a reduction in the incidence of profound hypotension. However, a recent study by Janz and colleagues looking into the effect of fluid loading on severe hypotension was stopped early because of futility.

We decided to include fluid loading before endotracheal intubation in our intubation bundle, since it was already part of routine strategy in our ICU. From the crude analysis of data from our overall cohort, the incidence of profound hypotension was not lowered with fluid loading (24.07% without fluid loading versus 20% with fluid loading; nonsignificant). However, we observed a significant decrease in profound hypotension incidence in the intervention period, which may be explained by overall improvement in the intubation process and a numerical increase in the rate of first-pass success during the intervention period.

**Preoxygenation for 3-minutes with Noninvasive Ventilation**

Noninvasive pressure-support ventilation (NIV plus PS) with a face mask using an ICU ventilator is a useful preoxygenation strategy.
Table 4: Comparison of intubation processes between control and intervention periods

<table>
<thead>
<tr>
<th>Indication for intubation</th>
<th>Control period (N = 61)</th>
<th>Intervention period (N = 63)</th>
<th>Total (N = 124)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway compromise</td>
<td>19 (31.15%)</td>
<td>22 (34.92%)</td>
<td>41 (33.06%)</td>
<td>0.152†</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>3 (4.92%)</td>
<td>0 (0%)</td>
<td>3 (2.42%)</td>
<td></td>
</tr>
<tr>
<td>Circulatory shock</td>
<td>3 (4.92%)</td>
<td>8 (12.70%)</td>
<td>11 (8.87%)</td>
<td></td>
</tr>
<tr>
<td>Planned general anesthesia</td>
<td>1 (1.64%)</td>
<td>0 (0%)</td>
<td>1 (0.81%)</td>
<td></td>
</tr>
<tr>
<td>Hypoxemic respiratory failure</td>
<td>24 (39.34%)</td>
<td>18 (28.57%)</td>
<td>42 (33.87%)</td>
<td></td>
</tr>
<tr>
<td>Hypercapnic respiratory failure</td>
<td>11 (18.03%)</td>
<td>15 (23.81%)</td>
<td>26 (20.97%)</td>
<td></td>
</tr>
<tr>
<td>Emergency nature of intubation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real</td>
<td>33 (54.10%)</td>
<td>30 (47.62%)</td>
<td>63 (50.81%)</td>
<td>0.156‡</td>
</tr>
<tr>
<td>Relative</td>
<td>22 (36.07%)</td>
<td>31 (49.21%)</td>
<td>53 (42.74%)</td>
<td></td>
</tr>
<tr>
<td>Deferred</td>
<td>6 (9.84%)</td>
<td>2 (3.17%)</td>
<td>8 (6.45%)</td>
<td></td>
</tr>
<tr>
<td>Time of intubation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>28 (45.90%)</td>
<td>28 (44.44%)</td>
<td>56 (45.16%)</td>
<td>0.871§</td>
</tr>
<tr>
<td>Out of hour</td>
<td>33 (54.10%)</td>
<td>35 (55.56%)</td>
<td>68 (54.84%)</td>
<td></td>
</tr>
<tr>
<td>Experience of operator</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experienced</td>
<td>61 (100%)</td>
<td>57 (90.48%)</td>
<td>118 (95.16%)</td>
<td>0.043‡</td>
</tr>
<tr>
<td>ICU trainee anesthesia</td>
<td>0 (0%)</td>
<td>4 (6.35%)</td>
<td>4 (3.23%)</td>
<td></td>
</tr>
<tr>
<td>ICU trainee nonanesthesia</td>
<td>0 (0%)</td>
<td>2 (3.17%)</td>
<td>2 (1.61%)</td>
<td></td>
</tr>
<tr>
<td>Fluid loading pre-intubation</td>
<td>31 (50.82%)</td>
<td>39 (61.90%)</td>
<td>70 (56.45%)</td>
<td>0.213§</td>
</tr>
<tr>
<td>Pre-oxygenation with NIV</td>
<td>13 (21.31%)</td>
<td>55 (87.30%)</td>
<td>68 (54.84%)</td>
<td>&lt;0.0001§</td>
</tr>
<tr>
<td>Alternative pre-oxygenation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMV - positive pressure</td>
<td>41 (85.42%)</td>
<td>5 (62.50%)</td>
<td>46 (82.14%)</td>
<td>0.007‡</td>
</tr>
<tr>
<td>BMV + positive pressure</td>
<td>3 (6.25%)</td>
<td>0 (0%)</td>
<td>3 (5.36%)</td>
<td></td>
</tr>
<tr>
<td>HFNO</td>
<td>4 (8.33%)</td>
<td>0 (0%)</td>
<td>4 (7.14%)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0 (0%)</td>
<td>3 (37.50%)</td>
<td>3 (5.36%)</td>
<td></td>
</tr>
<tr>
<td>Positive pressure post-induction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>33 (54.10%)</td>
<td>4 (6.35%)</td>
<td>37 (29.84%)</td>
<td>&lt;0.0001§</td>
</tr>
<tr>
<td>BMV + positive pressure</td>
<td>18 (29.51%)</td>
<td>6 (9.52%)</td>
<td>24 (19.35%)</td>
<td></td>
</tr>
<tr>
<td>NIV + VCV</td>
<td>10 (16.39%)</td>
<td>53 (84.13%)</td>
<td>63 (50.81%)</td>
<td></td>
</tr>
<tr>
<td>Sedative agents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Etomide</td>
<td>52 (85.25%)</td>
<td>57 (90.48%)</td>
<td>109 (87.90%)</td>
<td>0.544§</td>
</tr>
<tr>
<td>Propofol</td>
<td>5 (8.20%)</td>
<td>2 (3.17%)</td>
<td>7 (5.65%)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>4 (6.56%)</td>
<td>4 (6.35%)</td>
<td>8 (6.45%)</td>
<td></td>
</tr>
<tr>
<td>Analgesic agents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fentanyl</td>
<td>43 (70.49%)</td>
<td>43 (68.25%)</td>
<td>86 (69.35%)</td>
<td>0.787§</td>
</tr>
<tr>
<td>None</td>
<td>18 (29.51%)</td>
<td>20 (31.75%)</td>
<td>38 (30.65%)</td>
<td></td>
</tr>
<tr>
<td>Succinylcholine for induction</td>
<td>1 (1.64%)</td>
<td>10 (15.87%)</td>
<td>11 (8.87%)</td>
<td>0.009§</td>
</tr>
<tr>
<td>Alternative neuromuscular blocker</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rocuronium</td>
<td>55 (91.67%)</td>
<td>51 (94.44%)</td>
<td>106 (92.98%)</td>
<td>1‡</td>
</tr>
<tr>
<td>Atracurium</td>
<td>1 (1.67%)</td>
<td>0 (0%)</td>
<td>1 (0.88%)</td>
<td></td>
</tr>
<tr>
<td>No neuromuscular blocker</td>
<td>4 (6.67%)</td>
<td>3 (5.56%)</td>
<td>7 (6.14%)</td>
<td></td>
</tr>
<tr>
<td>Sellick’s maneuver</td>
<td>12 (19.67%)</td>
<td>0 (0%)</td>
<td>12 (9.68%)</td>
<td>0.0001‡</td>
</tr>
<tr>
<td>Initial laryngoscopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional</td>
<td>55 (90.16%)</td>
<td>57 (90.48%)</td>
<td>112 (90.32%)</td>
<td>0.953§</td>
</tr>
<tr>
<td>Video</td>
<td>6 (9.84%)</td>
<td>6 (9.52%)</td>
<td>12 (9.68%)</td>
<td></td>
</tr>
<tr>
<td>Pre-emptive use of stylet</td>
<td>11 (18.03%)</td>
<td>55 (87.30%)</td>
<td>66 (53.23%)</td>
<td>&lt;0.0001§</td>
</tr>
<tr>
<td>Post-intubation recruitment maneuver</td>
<td>0 (0%)</td>
<td>46 (73.02%)</td>
<td>46 (37.10%)</td>
<td>&lt;0.0001§</td>
</tr>
</tbody>
</table>

†Mann Whitney test; ‡Chi square test; BMV, bag-mask valve; HFNO, high-flow nasal oxygen; NIV, noninvasive ventilation; VCV, volume control ventilation
Routine use of stylet during intubation has shown to improve first-pass success rate for intubation in recently published STYLETO study. The association between first-attempt success and lower complication rates is now clearly established. In our study, compared with control period pre-emptive use of stylet increased significantly during the intervention period (18.03% vs 87.30%, p = 0.001). In the overall cohort, first-pass was achieved in 54 of 66 intubations (81.81%) when stylet was used compared with 43 of 58 intubations (74.13%) when it was not used. Though this 7.68 percentage-point difference was not statistically significant, it is comparable with the 6.7 percentage point in the first-pass success observed in STYLETO study.

**Succinylcholine for Rapid Sequence Induction (RSI)**

Because of rapid onset of action (40–60 seconds) and short duration of effect (6–10 minutes), succinyl choline is preferred as a muscle relaxant during RSI in the operating room. However, there are several limitations for its widespread use in critically ill patients. Rocuronium has been the preferred relaxant for RSI in our unit. However, in a single-center Swiss study in critically ill patients, succinyl choline use was shown to reduce total duration of intubation compared with rocuronium. Moreover, in a recent Cochrane review, RSI with succinyl choline was found to produce better and more acceptable condition for intubation compared with rocuronium. Based on these evidences, we decided to include succinyl choline as the first-line induction agent in our care bundle. Although, there was a significant increase in succinyl choline use during the intervention period, in 56% of intubations, physicians reported some contraindications to its uses, and in another 23.4%, physicians preferred not to use it without any specific reason.

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Recruitment Maneuver Post-intubation

Large increase in the airway and alveolar pressure for a brief period ["Recruitment Maneuver (RM)"] can potentially recruit lung volume, reduced during induction of general anesthesia. In a single-center Swiss study, routine RM at 40 cm H\textsubscript{2}O for 30 seconds within 2 minutes of intubation had shown to improve oxygenation at 5 minutes post intubation without any increase in incidences of hemodynamic compromise.\textsuperscript{8} In our study, post-intubation RM was not performed in one-fourth of intubation episodes during the intervention period, mostly because of contraindications to RM.

**Strengths and Limitations**

To the best of our knowledge, this is the first-of-its kind study outside any developed country, that looked into quality improvement
during endotracheal intubation processes in critically ill patients. The strength of our study includes incorporation of newer evidence-based interventions in the care bundle and the same group of consultant intensivists participating in both control and intervention period. Also, by including all adult patients undergoing intubation, our study more closely reflects real-life scenarios.

However, the current study is limited by its single-center design. Another major limitation of our study is reliance on physician’s self-reporting of intubation processes and complications, with possibility of reporting bias. However, our rates of major complications are comparable to studies reported earlier.6,7 Finally, as we evaluated the effects of implementing several interventions as a bundle, our study’s ability to draw any conclusion on individual component of the bundle is limited.

**CONCLUSION**

In this quality-improvement project, most components of the revised Montpellier intubation bundle could be implemented in the intervention period. Implementation of the revised bundle could significantly reduce rates of major complications related to intubation compared with an unwritten strategy closely resembling the original Montpellier bundle. There was a significant reduction in the incidence of profound hypotension during the intervention.

**REFERENCES**


