Intubation in the ICU

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Tracheal intubation should not be looked down by emergency care practitioners as it has been shown to be associated with a high incidence of complications and morbidity-mortality [1,2]. Indeed, 28%–38% of patients could face life-threatening complications such as hypoxaemia, circulatory instability, cardiac arrest, oesophageal intubation and aspiration pneumoniae [3,4]. Cardiac arrest could occur in one out of 25–40 procedures and is unsurprisingly associated with high mortality [5,6]. These frequent complications can potentially be explained as in-ICU intubation is often performed in an urgent or critical context in patients with acute respiratory, haemodynamic or neurological failure. As all practitioners could deal with this critical situation, they must improve their expertise through training and education. Therefore, it is paramount to identify which parameters are linked to complications and mortality to improve our practice.

In order to complete existing results on an international scale, a large multicentre international study, the "INTUBE study", was conducted by Russotto et al. [7] in a similar design to the LUNG SAFE study, which provided all ICU practitioners around the globe information on acute respiratory distress syndrome (ARDS) care in the ICU [8]. In a multicentre study performed in 29 countries, Russotto et al. aimed at assessing incidence and types of major peri-intubation adverse events in critically ill patients and determining the association between these events and outcomes. This design was like that used by Jaber et al. [3] in a French multicentre study in 2006: each site was invited to prospectively collect data during an 8-week period (anytime in between October 2018 and July 2019) on all tracheal intubation procedures required in adult patients because of neurological, respiratory or cardiovascular failure. Only "in-hospital" but "out of the operating theatre" intubation procedures were included (ICU, emergency department or ward). Major peri-intubation adverse events were clearly defined: severe hypoxaemia, cardiac arrest and cardiovascular instability occurring within 30-min period after the onset of the intubation procedure. In the final analysis, 2964 patients were included with 1340 of them (45.2%) experiencing at least one major peri-intubation adverse event, which is close to the 50.6% rate reported by Jaber et al. [2]. The main indication for intubation was respiratory failure (50.3%). Neurological failure (30.5% of intubations) was the group with the lower occurrence of adverse events (absolute difference with respect to respiratory failure, −17.6%; 95% CI, −21.6% to −13.5%). Among the adverse events, cardiovascular instability was the most reported one (42.6%), followed by severe hypoxaemia (9.3%) and cardiac arrest (3.1%). Experiencing a major adverse event was associated with a higher mortality rate: 40.7% *vs.* 26.3% (absolute risk difference, 14.4%; 95% CI, 10.9%–17.9%; $P < 0.001$). These results confirm the severity of peri-intubation complications.

The number of severe adverse events (close to that reported by Jaber et al. and Cook et al. [3,9]) might appear particularly important. Three questions should be asked to better construe these numbers: who, where and when?

- 51.9% of the first attempts of the procedures were performed by a resident,
- 56.6% of the successful attempts were performed by a physician or consultant,
- 67.2% of the procedures were performed in the ICU (as opposed to the emergency department or the medical or surgical ward),
- 36.2% of the procedures were performed during night shift hours.

Post hoc analysis showed that being an attending physician or consultant rather than a trainee (OR, 0.52; 95% CI, 0.40–0.69) and having anaesthesia as primary specialty (OR, 0.53; 95% CI, 0.41–0.69) was significantly associated with a reduced likelihood of first-pass intubation failure.

What may be the most important inquiry reading these results is the number of adverse events that could have been avoided. In such critical situations, preparation is primordial as bundle protocols have been shown to improve safety related to tracheal intubation [1]. In the Table 1, we reported an update of the Montpellier-Intubation Protocol [1]. A recent study failed to show superiority of a verbal checklist prior to intubation in reducing lower arterial pressure or saturation during the intubation procedure [10]. This checklist lacked intervention aimed at improving physiological parameters (adequate preoxygenation, fluid load, vasopressors, etc.). This study was performed in centres specialised in intubation and less experienced teams could probably benefit from the use of a checklist especially if it includes

Table 1
Updated of the Montpellier-Intubation Protocol adapted from Jaber ICM 2010 [1].

Pre-intubation
1 Two operators (*i.e.*, 4 hands)
2 Fluid loading if no cardiogenic oedema
3 Systematic early introduction of vasopressors
4 Preparation of long-term sedation
5 For preoxygenation, consider upright position (20–30° bed)
6 Preoxygenation during at least 3 min with non-invasive ventilation in case of hypoxaemic acute respiratory failure (FiO_2 100 %, pressure support between 5 and 10 cmH_2O to obtain an expired tidal volume between 6 and 8 mL/kg and a PEEP of 5 cmH_2O), associated with apnoeic oxygenation when available and high-risk of hypoxaemia (OPTINIV method [14])

Per-intubation
7 Consider first videolaryngoscope for intubation procedure, if no videolaryngoscope available, consider direct Macintosh laryngoscopy with Stylet [22]
8 Rapid sequence induction:
- Etomidate 0,2–0,3 mg/kg or ketamine 1,5–3 mg/kg or propofol 1,5–3 mg/kg
- Succinylcholine 1 mg/kg (without contra-indications)
- Rocuronium: 1,2 mg/kg IVD in case of contra-indications to succinylcholine

9 Sellick manoeuvre
10 Ventilation in case of desaturation < 90% or if elevated risk of desaturation higher than the risk of aspiration

Post-intubation
11 Mandatory capnography to check correct tube placement in trachea
12 Increase vasopressors especially if diastolic arterial pressure < 35 mmHg or systolic arterial pressure < 90 mmHg
13 Start early long-term sedation
14 Low airway pressure ventilation at the beginning: tidal volume 6–8 mL/kg, PEEP < 5 cmH_2O and respiratory rate between 10 and 20/min, FiO_2 100%, for a plateau pressure < 30 cmH_2O (protective ventilation will be started after haemodynamic stabilisation)
15 Recruitment manoeuvre: PEEP of 30–40 cmH_2O during 20–30 s, FiO_2 100% (if no cardiovascular collapse and in euvolaemic patient)
16 Cuff pressure between 25–30 cmH_2O

interventions to improve patient parameters. In the study reported by Russotto et al., only half of the procedures were performed following an airway management protocol and only half followed a checklist. As part of preparation and anticipation, the MACOCHA score, a simplified score for identifying patients with difficult intubation has been validated and could help practitioners identify at the bedside patients with difficult intubation and therefore adjust patient management [4].

Even if non-invasive ventilation (NIV) used for preoxygenation has been shown to be associated with less hypoxaemia episodes during intubation than bag-valve preoxygenation [11], INTUBE study reported pre-oxygenation by a bag-valve mask and by NIV in 62.4% and only 11.6% of patients, respectively. Recently, high-flow nasal cannula (HFNC), with the advantage to allow apnoeic oxygenation during tracheal intubation, has been proposed [12,13]. HFNC preoxygenation seems to be non-inferior to NIV preoxygenation except for hypoxaemic patients who could still benefit from NIV. A new strategy of preoxygenation called the OPTINIV method has also been described in hypoxaemic patients with the combination of HFNC for apnoeic oxygenation to NIV that may be more effective in reducing hypoxemia during intubation compared to NIV alone in critically ill patients [14].

When intubation was performed under anaesthesia, propofol was the drug the most frequently used (41.5%) despite its known hypotensive effect. That could probably explain why cardiovascular instability was the most frequent adverse event in the INTUBE study. Ketamine and etomidate were seldom used although being recommended for induction [15,16]. In a recent randomised study, a 500-mL bolus of crystalloids infused before intubation (*versus* no bolus) did not show to reduce cardiovascular collapse following intubation [17]. However, the use of a bundle protocol including early use of norepinephrine as well as administration of 500 mL of crystalloids prior to induction has shown to reduce cardiovascular instability during intubation [1].

Regarding intubation devices, direct laryngoscopy was used in most intubations, whereas videolaryngoscope as the primary device was used in 17.1 intubations. One patient out of 5 required > 1 attempt and the rate of adverse events grew stronger with the number of attempts. The use of a video laryngoscope (OR, 0.60; 95% CI, 0.42–0.85) was significantly associated with a reduced likelihood of first-pass intubation failure.

Different studies and one meta-analysis reported the clinical interest of videolaryngoscopy in the ICU [18–20], leading its use in ICU airway management algorithms in British and French recommendations [9,16]. In contrast, a recent meta-analysis comparing videolaryngoscopy with direct laryngoscopy for intubation in critically ill patients reported similar success rates for intubation but more arterial hypotension with videolaryngoscopy [21]. However, in the subgroup of intubation performed in the ICU, videolaryngoscopy was associated with a higher first-pass success rates, even amongst less experienced practitioners.

All these findings should be taken with caution. Indeed, if videolaryngoscopy allows a better visualisation of the glottis, it does not ensure an easy tube insertion into the trachea. In this context, the systematic use of a stylet should be assessed in a randomised controlled trial [22].

Waveform capnography use was low, only 34.5% of all patients, with a higher use in ICU than in emergency department or ward. Among procedures with accidental oesophageal intubation, 68.9% were performed without a capnograph, leading to difficulties in recognising misplacement of the tube. Waveform capnography should be standard monitoring as vital as blood pressure or SpO_2 [9,16].

Some limitations of this study should be mentioned, especially the self-reporting nature of data, which could influence overestimation or underestimation of patients' severity or intubation-related adverse events. Comprehensiveness of inclusion could always be questioned in this type of study, which could lead to selection bias.

In conclusion, in this large international study, cardiovascular instability was the most frequent adverse event following intubation. The rate of adverse events grew larger with the number of intubation attempts, thus emphasising the major role of expertise and preparation in ICU intubation. This multicentre international study did not report any new findings [7] in comparison with the landmark French multicentre study published 15 years ago. In this period of sustained activity in the ICU, we should maintain high expectations for ourselves and our practice. This study shows us where to start improving our practice.

Conflicts of interest

Pr. Samir Jaber reports receiving consulting fees from Drager, Medtronic, Baxter, Fresenius-Xenios, and Fisher & Paykel.

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