

Tracheal Intubation in the Critically Ill: Beyond Anatomy

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Abstract

Airway management in critically ill patients is considered a high-risk procedure. Recent studies have shown a higher complication rate and 28-day mortality associated with this procedure in critically ill adults as compared with patients in the operating room. Critically ill patients have a physiologically difficult airway, increasing their risk of complications during tracheal intubation and transition to positive pressure ventilation. Other factors contributing to this high complication rate include the complex environment and the varied experience of the airway operator. Therefore, implementing strategies to enhance the safety and efficacy of tracheal intubation in the critically ill is paramount. Proper planning and preparation, including human factor considerations, are required for this procedure. Respiratory and haemodynamic optimisation prior to the procedure can help reduce complications. Performing a modified rapid sequence intubation (RSI) and the use of videolaryngoscopy and a stylet or bougie during the first attempt at intubation can improve first-pass intubation success. Use of induction agents such as ketamine or etomidate and periprocedural oxygenation, including apnoeic oxygenation or gentle mask ventilation, during RSI can also help reduce complications. Immediately after intubation, tracheal tube placement should be confirmed using waveform capnography along with the management of immediate complications.

Key words: tracheal intubation, critical care, airway, physiologically difficult airway, ICU

INTRODUCTION

Tracheal intubation is one of the most common procedures performed in the critically ill.¹ Critically ill patients have a “physiologically difficult airway” wherein the patients’ physiological and pathophysiological alterations predispose them to complications during tracheal intubation and transition to positive pressure ventilation.²⁻⁴ In a global study including 2964 critically ill adult patients from 29 different countries, major adverse events occurred in 45% of critically ill patients within 30 minutes of tracheal intubation. The most common adverse event was cardiovascular instability, seen in 42.6% of patients. The second most common adverse event was severe hypoxemia (defined as peripheral capillary oxygen saturation <80%), which was seen in 9.3% of patients.⁵ Cardiac arrest occurred in 3.1% of patients.⁵ Recent multicentre studies have shown a higher complication rate and 28-day mortality associated with this procedure in critically ill patients as compared with patients in the operating room.⁵⁻⁷

Airway management in critically ill patients is therefore considered a high-risk procedure. Factors contributing to this high complication rate include the complex

environment, the varied experience of the operator, and, most important, the critical illness itself.^{8,9} Airway societies and experts have provided guidance to mitigate the complications that occur during this high-risk procedure.⁸⁻¹⁰ This narrative review outlines various strategies to improve the safety and efficacy of tracheal intubation in critically ill adults.

PREPARATION FOR TRACHEAL INTUBATION

Airway Assessment and Preparation

Considering the high risk involved with this procedure, patient assessment and proper planning are paramount.¹¹ The MACOCHA score is validated for airway assessment in the ICU.¹² This score considers, in addition to anatomical alterations, the physiological alterations and the experience of the operator (Table 1). The experts’ Delphi consensus on physiologically difficult airways suggests that an intubation team should consist of at least three healthcare providers, including two airway operators, at least one of whom should be an experienced airway operator.⁴ Although the use of a preintubation checklist has not been shown to reduce

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Table 1 – MACOCHA Score

	Points
Factors related to patient	
Mallampati score III or IV	5
Obstructive sleep apnoea syndrome	2
Reduced mobility of cervical spine	1
Limited mouth opening <3 cm	1
Factors related to pathology	
Coma	1
Severe hypoxemia (<80%)	1
Factor related to operator	
Nonanaesthesiologist	1
Total	12

M. Mallampati score III or IV
A. Apnoea Syndrome (obstructive)
C. Cervical spine limitation
O. Opening mouth <3cm
C. Coma
H. Hypoxia
A. Anaesthesiologist nontrained
Coded from 0 to 12
0 = easy 12 = very difficult

complications in a randomised study, this may be effective when interventions for physiological optimisation are included and when used by less experienced operators.^{13,14}

Human factors influence safe performance of tracheal intubation, making team preparation paramount to mitigate the risk of complications.⁴ In addition to team composition, emphasis should also be placed on team dynamics, considering the situational challenges associated with the procedure. Establishing clear roles and responsibilities and discussion of the primary and rescue plans in advance are essential elements for success. Similarly, closed-loop communication is essential in such stressful situations to prevent medical errors. In addition, ensuring a shared mental model among team members, gathering and interpreting information, and anticipating problems are important tasks that can improve team performance.

Respiratory Optimisation

The head elevated laryngoscopic position with the head of the bed elevated to 30 degrees has been suggested by experts.⁴ In this position, patients are more comfortable. In the flat position, the posterior portions of the lung become more prone to atelectasis. Patients with a physiologically difficult airway typically have some degree of ventilation-perfusion mismatch and/or shunt physiology wherein the perfused alveolae are not ventilated, which reduces the extent to which the partial pressure of oxygen in arterial blood increases relative to the fraction of inspired oxygen. Positive pressure is therefore required to facilitate alveolar recruitment, especially in patients with more severe shunt physiology, to extend the safe apnoea time.

Several strategies for preoxygenation have been practiced to reduce hypoxaemia during tracheal intubation. There are three potential

approaches to consider alone or in combination with one another: high-flow nasal oxygen delivery (HFNO), noninvasive positive pressure ventilation (NIPPV), and ventilation via bag-valve mask (BVM). A systematic review comparing preoxygenation strategies concluded that NIPPV or HFNO is superior to BVM during tracheal intubation in critically ill adults and that NIPPV decreases the incidence of hypoxaemia during tracheal intubation compared with HFNO.¹⁵ These findings suggest that it may be time to abandon the use of conventional facemask oxygen in this high-risk population.¹⁶

In patients who are uncooperative, the use of a subanaesthetic dose of ketamine to facilitate preoxygenation (i.e., delayed sequence intubation) has been shown to significantly decrease peri-intubation hypoxia.¹⁷ Gentle mask ventilation performed during the apnoeic phase between administration of neuromuscular blockade and tracheal intubation has been shown to reduce periprocedural hypoxemia without increasing the incidence of aspiration.¹⁸

Haemodynamic Optimisation

Several factors contribute to the higher incidence of cardiovascular collapse during tracheal intubation in critically ill patients than in those in the operating room. These include the critical illness itself (e.g., sepsis, hypovolaemia, cardiac dysfunction), drug and dose selection used to facilitate intubation (e.g., propofol, benzodiazepines, opioids), the loss of sympathetic drive, and the transition to positive pressure ventilation following tracheal intubation.¹⁹

The high incidence of cardiovascular collapse associated with tracheal intubation in critically ill patients and its impact on mortality underscore the need to focus on prevention rather than merely treating the complications once they occur. It also highlights the importance of close haemodynamic monitoring in the periprocedural period. The minimum mandatory monitoring during tracheal intubation in these patients has been suggested to include noninvasive blood pressure, continuous electrocardiography, and pulse oximetry.⁴ The use of point-of-care ultrasound (POCUS) can be helpful in these patients. POCUS can be used to identify patients at risk for cardiovascular collapse, identify the type of shock, and provide haemodynamic and respiratory assessment, which can aid physiological optimisation.^{4,20}

Haemodynamic optimisation prior to the procedure is important to reduce the incidence of haemodynamic collapse during the procedure. Administration of fluids and/or vasopressors prior to tracheal intubation has been tried to minimise peri-intubation haemodynamic collapse. The Montpellier intubation protocol includes a fluid bolus prior to tracheal intubation unless contraindicated.²¹ However, in two large, randomised, multicentre trials, using a fluid bolus prior to intubation showed no reduction in the incidence of cardiovascular collapse.^{22,23} The first study (PrePARE study)²² was conducted in an unselected patient population, and the second (PrePARE II study)²³ involved patients receiving positive pressure ventilation. With these findings, it seems that the use of a fluid bolus should be considered on a case-by-case basis, guided by an assessment of fluid responsiveness if feasible. Two ongoing international trials (the FLUVA trial [NCT05318066] and the PREVENTION trial [NCT05014581]) are investigating the effectiveness of preemptively administering vasopressors (norepinephrine) in preventing cardiovascular collapse in critically ill adults undergoing tracheal intubation.

PERFORMING TRACHEAL INTUBATION

The default intubation technique for tracheal intubation in the critically ill should be a modified rapid sequence intubation (RSI) technique (titrated administration of rapid-onset sedative hypnotic and a rapid-acting neuromuscular blocking agent and/or gentle mask ventilation). Cricoid pressure (if applied) should be released in the case of difficulty in glottic visualisation.⁴

Drugs Used for Tracheal Intubation

Although propofol provides superior intubation conditions, the *post hoc* analysis of the INTUBE study showed that the use of propofol for induction was the only modifiable independent predictor of cardiovascular collapse in these high-risk patients.²⁴ Therefore, the use of induction agents with a more stable haemodynamic profile, such as ketamine and etomidate, has been suggested, unless contraindicated.⁴ Trials comparing the two drugs for tracheal intubation in critically ill adults have been inconclusive. A recent randomised trial conducted in 14 emergency departments and intensive care units in the United States compared ketamine with etomidate for tracheal intubation of critically ill adults in 2365 patients.²⁵ Although cardiovascular collapse during intubation occurred in 22.1% of patients in the ketamine group compared with 17.0% in the etomidate group (risk difference, 5.1 percentage points; 95% confidence interval, 1.9 to 8.3), the prespecified safety outcomes were similar in both groups. The study concluded that among critically ill adults, the use of ketamine did not result in a significantly lower incidence of 28-day mortality than etomidate when used to induce anaesthesia for tracheal intubation in critically ill adult patients.²⁵

Use of neuromuscular blockade during RSI is associated with greater first-pass intubation success and lesser complications. There has been no clinically meaningful difference in outcomes when succinylcholine and rocuronium was used for tracheal intubation in critically ill patients.²⁶ However, succinylcholine should be used with caution in specific conditions. Although sugammadex may be used for the reversal of rocuronium in an emergency, there is limited safety data in critically ill patients.⁴

Devices Used for Tracheal Intubation

The use of various tools and intubation strategies can help improve first-pass intubation success, thereby reducing complications. Although previous studies in the critically ill failed to demonstrate a clear benefit of using videolaryngoscopy (VL) over direct laryngoscopy (DL) in these patients, a subanalysis of the INTUBE study data showed that VL was associated with higher first-pass intubation success.²⁷ A recent systematic review and metaanalysis clearly demonstrated the superiority of VL to DL with first-pass intubation success in critically ill adults.²⁸ The STYLETO (Styler for Orotracheal intubation) trial demonstrated that using a styler during tracheal intubation with DL resulted in a significantly higher first-pass intubation success rate.²⁹ A study comparing the use of a tracheal tube with a bougie or a styler during the first attempt at intubation in critically ill adults reported no difference in first-pass intubation success.³⁰ Taken together, these studies highlight the importance of the routine use of a styler or a bougie during the first attempt at intubation to improve first-pass intubation success in high-risk patients.

POST-PROCEDURE CARE

The tracheal placement of the tube should be confirmed using consistent waveform capnography over at least seven breaths.³¹ Chest auscultation, chest X-ray, and/or bronchoscopy may be used to confirm optimal depth of the tube within the trachea. The use of sedative infusions along with a lung-protective ventilation strategies should be employed after intubation in these patients.⁴ Management of immediate complications should be prioritised.

SUMMARY

Complications associated with tracheal intubation in critically ill adults continue to remain high, including cardiovascular collapse and hypoxaemia. Evidence supporting the management of patients with a physiologically difficult airway is evolving. Optimising periprocedural oxygenation, adopting measures for haemodynamic and respiratory optimisation, and using measures to improve first-pass intubation success should be considered. Implementation of these evidence-based techniques may help achieve better outcomes in these high-risk patients.

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