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Strategies to improve first attempt success at intubation in critically ill patients

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Abstract

Tracheal intubation in critically ill patients is a high-risk procedure. The risk of complications increases with repeated or prolonged attempts, making expedient first attempt success the goal for airway management in these patients. Patient-related factors often make visualization of the airway and placement of the tracheal tube difficult. Physiologic derangements reduce the patient's tolerance for repeated or prolonged attempts at laryngoscopy and, as a result, hypoxaemia and haemodynamic deterioration are common complications. Operator-related factors such as experience, device selection, and pharmacologic choices affect the odds of a successful intubation on the first attempt. This review will discuss the 'difficult airway' in critically ill patients and highlight recent advances in airway management that have been shown to improve first attempt success and decrease adverse events associated with the intubation of critically ill patients.

Key words: airway management; critical care; emergency department; emergency medicine; intensive care; intubation; laryngoscopy; prehospital

Editor's key points

Airway management in critically ill patients is high risk as a result of anatomic and physiologic characteristics that increase the risk of complications. Complications include hypoxaemia, aspiration of gastric contents, haemodynamic deterioration, hypoxic brain injury, cardiopulmonary arrest and death. One or more complications occur in 22–54% of all intubations performed in critically ill patients, making emergent intubation one of the highest risk procedures a patient may require.[1–5]

The 4th National Audit Project (NAP4) report of the Royal College of Anaesthetists and the Difficult Airway Society identified several deficiencies that increased the risk of adverse outcomes related to emergent airway management.[6] Opportunities identified for improvement include pre-intubation assessment, planning for the initial attempt and identification of back-up plans, and availability and use back-up devices and personnel. Publication of the NAP4 report has invigorated focus on improving the safety of emergency airway management. This review will discuss the 'difficult airway' in critically ill patients and present evidence-based strategies for maximizing first attempt success with airway management in the intensive care unit. The evidence was obtained through relevant search terms in PubMed and articles were evaluated for relevance, applicability and further pertinent references.

The difficult airway problem and the importance of first attempt success

Critically ill patients often have full stomachs and compromised physiology such that multiple or prolonged attempts are poorly tolerated and result in an increased risk of complications. Griesdale and colleagues[2] reported an overall complication rate of 39% in the intensive care unit, with 13% of all intubations requiring three or more attempts and 10% requiring 10 or more min.

Mort[7] found that when aspiration or hypoxaemia occurs during emergency intubation, patients are 22 times and four times more likely, respectively, to have a cardiac arrest.[7] Patients that had a cardiac arrest during intubation commonly had an oesophageal intubation, which increases the incidence of hypoxaemia and aspiration and increased the risk of death seven-fold. These complications occur more frequently when repeated attempts are required. When more than two attempts were required during emergency intubation, serious complications increased: aspiration of gastric contents (22% *vs* 2%), hypoxaemia (70% *vs* 12%), and cardiac arrest (11% *vs* 1%).[1] More recent data from Sakles and colleagues[8] in the emergency department shows that the risk of adverse events increases with each successive attempt, increasing from 14 to 47% when a second attempt is required. These data suggest that the goal of emergency intubation in the critically ill should be first attempt success.

First attempt success is affected by both patient-related and operator-related factors. Patient-related factors include anatomic features that make visualization of the glottic inlet or the ability to pass a tracheal tube difficult,[9–12] and physiologic factors that limit the duration of the laryngoscopic attempt such as hypoxaemia or haemodynamic instability.[13] Operator-related factors include the experience of the operator,[14–17] device selection,[18–21] and pharmacologic agents used to facilitate the procedure.[22–24] Consequently, any tool that allows the operator to predict the potential difficulty associated with an intubation could be useful for the operator to plan for obviating those potential difficulties.

Difficult intubations are frequently encountered in the emergency department, intensive care unit, and prehospital settings and have been reported to range between 8-13%.[2 3 16 25 26] Conventionally, the 'difficult airway' has been defined as an intubation that requires >2 attempts or 10 min to secure placement of an tracheal tube.[3 16 27] There are several limitations when applying this definition to critically ill patients. First, methods and rules developed to predict the difficult airway have only modest performance.[28–30] Second, utilizing this definition may predict a potentially difficult airway (i.e. >2 attempts), but does not differentiate patients that are at risk of requiring more than one attempt. Many of the patient and operator-related factors described above, and environmental factors such as limited space, poor lighting, and suboptimal bed characteristics that limit the ability to properly position or access the airway, are not included in these prediction models. Lastly, the patient's physiologic derangements may cause difficulty in maintaining oxygenation during the intubation attempt, creating a 'difficult airway' even in the absence of predicted anatomic difficulty.[13 31]

Several methods of pre-intubation assessment aimed at predicting the difficult airway have been developed, all of which focus on the anatomic features that make visualization of the glottic inlet difficult.[11 28 32] These tests have been shown to be difficult to perform in many patients requiring emergency intubation.[33 34] Recently, the MACOCHA score was developed to identify the potentially difficult airway in the intensive care unit. This score considers both patient-related factors pertaining to anatomic difficulty, physiology, and operator-related factors.[32] The components included are: Mallampati score of III or IV, obstructive sleep apnoea, cervical immobility, limited mouth opening, coma, severe hypoxaemia, and non-anaesthetist operators. This seven-item score differentiates difficult from routine intubations with a sensitivity of 73%.[32] Unfortunately, the MACOCHA score does not adequately predict first attempt success, and has not been validated for video laryngoscopy. De Jong and colleagues found that when considering intubations predicted to be difficult by the MACOCHA score, only 4% of intubations performed with the C-MAC video laryngoscope were difficult.[35] Consequently, given the poor reliability of difficult airway *predictors* and difficulty performing pre-intubation assessments properly, attempts to maximize first attempt success should be based on the *characteristics* that make laryngoscopy or placement of a tracheal tube potentially challenging rather than pre-intubation predictors of a 'difficult intubation' that will require >2 attempts or more than 10 min.[36]

Maximizing first attempt success

Preoxygenation

Patients undergoing elective surgeries typically have adequate cardiopulmonary optimization before intubation and are usually able to tolerate short periods of apnoea. This degree of optimization may not be possible for critically ill patients, who frequently require intubation unexpectedly with little time for assessment and preparation. In addition, critically ill patients usually have significant physiologic derangements adding another layer of difficulty to airway management. The lack of time, high oxygen requirement, shunt physiology, and lack of patient cooperation all complicate adequate preparation.[3] These factors can increase the risk of complications during intubation. Oxygen desaturation is the most common complication, occurring in 19–70% of intubations.[1–3 37–42] Oxygen desaturation is also likely the most common reason for an aborted first attempt at intubation, both of which increase the risk of further complications. Therefore, optimization of preoxygenation is of particular interest to prolong time to desaturation and thus improve the likelihood of first attempt success.[43]

The process of preoxygenation is used to replace the nitrogen rich ambient air in the alveoli with oxygen, which is then available for uptake during periods of induced apnoea. In healthy patients, this may be achieved by 3–5 min of tidal breathing or eight vital capacity breaths from a tight fitting non-rebreather mask delivering 100% oxygen.[44–47] However, recent data from Groombridge and colleagues[48] showed that in healthy volunteers, a non-rebreather face mask is much less effective in achieving an adequate end tidal O2 than both bag-valve mask and a closed anaesthetic circuit. Hayes-Bradley[49] recently demonstrated that the addition of supplemental oxygen via a nasal cannula in the presence of mask leaks may be helpful in improving end tidal O2. In patients who are critically ill, the effectiveness of and optimal strategy for preoxygenation is not clear. Mort[50] reported that providing 100% oxygen for 4 min increased the partial pressure of arterial oxygen by 6.7 kPa in only 19% of patients, and extending the period of preoxygenation had little impact.[51] In addition to shunt physiology and complicating comorbidities such as obesity, preoxygenation in critically ill patients may be less efficient secondary to the rigid mask typically used, which allows mixing of ambient air causing a decrease in the effective fraction of inspired oxygen. This effect likely worsens with high min ventilation requirements as a greater proportion room air is entrained.

In stable patients undergoing general anaesthesia, a 20-degree elevation of the head has been shown to improve pre-oxygenation and extend safe apnoea time.[52] Non-invasive positive pressure ventilation has also been used to improve pre-oxygenation before intubation in patients with obesity and shunt physiology.[53 54] Baillard and colleagues[53] reported that 3 min of preoxygenation with non-invasive positive pressure ventilation improved preintubation saturation and reduced desaturation to <80% with intubation from 46 to 7% compared with using a nonrebreather mask for 3 min. A supraglottic airway