Emergency Non-OR Airway Management

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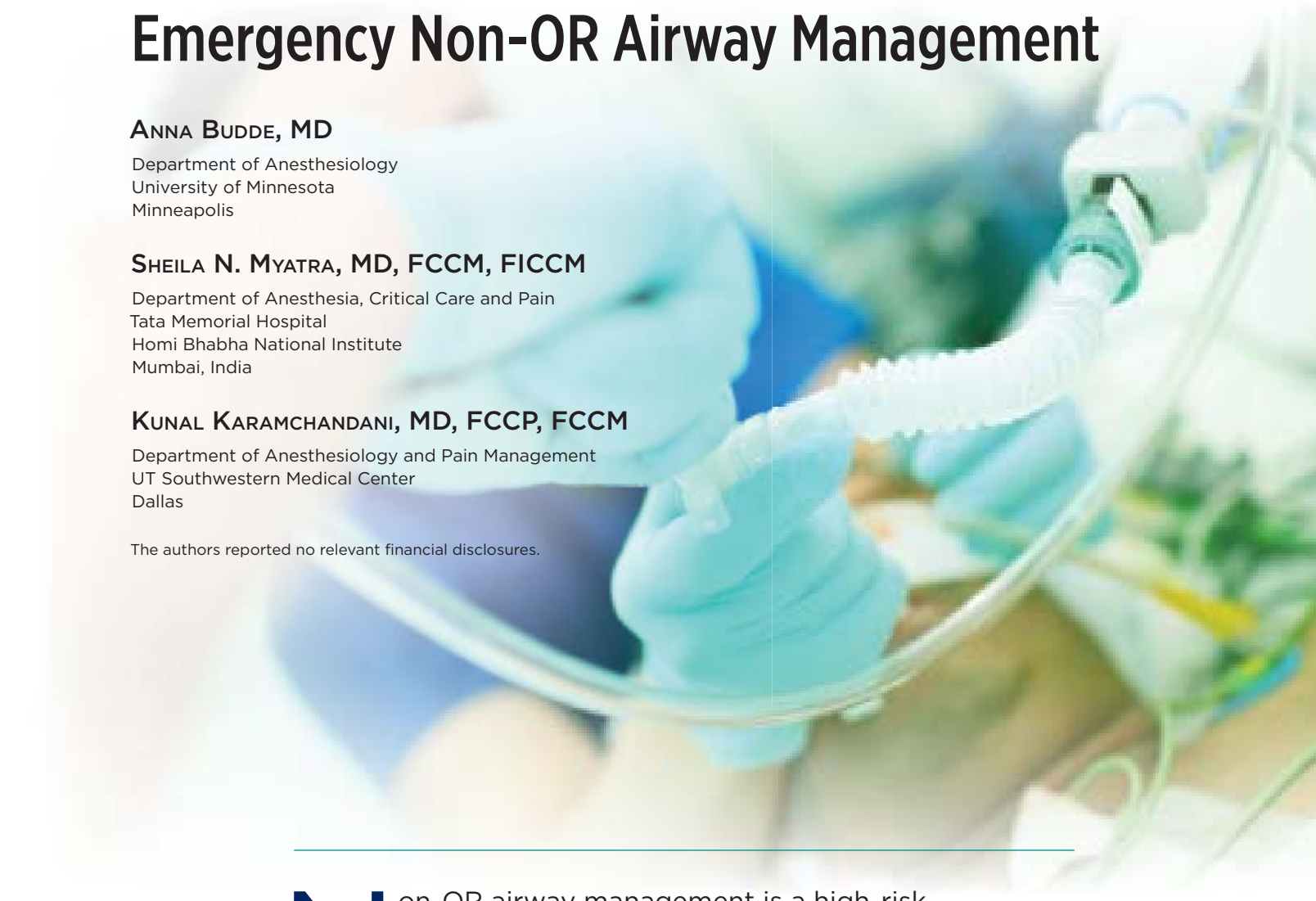

Non-OR airway management is a high-risk procedure with the potential for an anatomically, physiologically and logistically difficult airway.

Introduction

Anesthesia providers are often asked to manage non-OR airway (NORA) emergencies. These procedures are associated with significant complications, and hence are considered extremely high risk. The in-hospital mortality of patients requiring emergent airway management outside the OR has been estimated to be as high as 40% with a 1-in-30 rate of cardiac arrest and a high overall risk of 28-day mortality.[1-3] Peri-intubation hypoxia and hypotension are associated with high morbidity and mortality, and the number of attempts taken to establish the airway is directly proportional to poor outcomes.[2,4] Anesthesia clinicians could be asked to manage emergent airways at various locations outside familiar OR confines, such as the ICU, the emergency department, the regular nursing floor, radiology suites or in the endoscopy suite, especially in hospitals where procedures are performed under conscious sedation by nursing staff. Some of these are remote locations that may be inappropriately staffed with limited access to airway equipment, and such patients are often critically ill with minimal physiologic reserve. A proportion of these patients also may have an anatomically difficult airway, thus increasing the risk for adverse airway-related outcomes. Hence, clinicians managing such airways should prepare for anatomic, physiologic and logistical challenges.

Anatomic Challenges

The incidence of an anatomically difficult emergent NORA setting has been estimated to be around 10%.[4-6] The same patient may have a difficult anatomic airway in a non-OR setting as compared with the OR. Taboada et al evaluated patients who underwent direct laryngoscopy (DL) and intubation in the OR and were subsequently re-intubated in the ICU within a month.[7] They observed that intubation in the ICU was associated with a worse glottic view and lower first-time intubation success rate, and complications were more common.

Furthermore, airway assessment in emergent NORA scenarios can be tricky; there may not be enough time to perform an airway assessment, patients may be delirious or encephalopathic and may not cooperate with an airway exam, and given the increased risk for difficulty outside the OR, previous documentation of airway management in the OR may not be accurate in these circumstances. Bedside screening tests tend to have poor sensitivity and specificity; however, the upper lip bite test may have the highest sensitivity while a combination of the Mallampati score and thyromental distance may be the most accurate.[8,9] The use of an automated facial analysis approach to predict a difficult airway may help overcome some of the limitations related to airway assessment in these situations. Further studies are needed to validate this approach before it becomes part of routine assessment.[10]

Table 1. Conditions Associated With A Physiologically Difficult Airway

Conditions	Physiologic Alterations
Hypoxia	• Poor reserve • Reduced FRC • Ventilation/perfusion mismatch • Shunt physiology
Hypotension	• Vascular and cardiac effects of induction agents • Initiation of positive pressure ventilation • Sudden removal of sympathetic stimulation (hypoxia/hypercarbia)
Severe metabolic acidosis	• Bicarbonate buffering system overwhelmed • Respiratory compensation plateaued
Right ventricular failure	--
Full stomach/ significant GERD	• High risk for aspiration • Supine position not well tolerated
Neurologic injury/raised ICP	• Changes in blood oxygen and CO_2 levels affect ICP • Hypotension decreases CPP • Hypertension increases ICP
Anterior mediastinal mass	• Airway deviation • Airway narrowing • Inability to lie supine • Airway collapse with induction

CO_2, carbon dioxide; **CPP,** cerebral perfusion pressure; **FRC,** functional residual capacity; **GERD,** gastroesophageal reflux disease; **ICP,** intracranial pressure

Physiologic Challenges

An airway is considered physiologically difficult when physiologic derangements place the patient at a higher risk for cardiovascular collapse with intubation and conversion to positive pressure ventilation.[11] In these patients, even when the airway anatomy is favorable and the process of tracheal intubation technically easy, the underlying physiologic perturbations may lead to poor outcomes.

Some common conditions where providers may encounter such physiologically difficult airways are listed in Table 1 along with the physiologic alterations. A thorough review of the patient's medical history and a focused physical exam are vital in tailoring the approach to airway management, including the choice of drugs to avoid associated complications. A bedside point-of-care ultrasound (POCUS) exam may be very helpful in these situations, not only to assess the hemodynamic status of the patient but also to assess for increased aspiration risk. The protocolized use of a handheld POCUS device has been shown to improve the proportion of adequate diagnosis and may improve outcomes in floor patients developing acute respiratory or circulatory failure.[12] Its utility in decreasing complications associated with emergent physiologically difficult NORA management needs further evaluation.

Logistical Challenges

Along with the anatomic and physiologic challenges, it is also important to consider the situational challenges that accompany airway management outside the OR. These situationally difficult airways can arise due to concerns raised by infrastructure, personnel or equipment. Space and lighting limitations, poor access to the patient's head, and limited monitoring capabilities are examples of the infrastructure issues that exist. Lack of availability of appropriate airway and oxygen delivery equipment, such as high-flow nasal oxygen (HFNO) and noninvasive ventilation (NIV), can be a problem. Limitations related to personnel pose significant challenges to clinicians, since the airway team may be working with members who are inexperienced, with expert help not readily available.

The 'COVID Airway'

Emergency airway management in patients with COVID-19 poses a unique set of challenges. Considering that most patients with COVID-19 who require

emergent tracheal intubation are severely hypoxic and have most likely failed HFNO and/or NIV therapy, these patients present with a physiologically difficult airway. Heightened clinician anxieties relating to personal protective equipment (PPE) and health risks from viral exposure also create logistical difficulties. Thus, these scenarios require combining complex time-critical tasks with intensified situational awareness, decision making and team performance during tracheal intubation.

For such intubations, adequate preoxygenation and rapid sequence intubation (RSI) with avoidance of bag-mask ventilation and video laryngoscopy (VL) with appropriate PPE (contact, droplet and airborne)—ideally in a negative pressure environment and with the most experienced personnel performing the laryngoscopy—have been recommended.[13]

Team Communication

Given all the aforementioned challenges associated with an ICU intubation, excellent teamwork and communication are essential to success. Situational awareness is critical in crisis management to allow for optimal resource utilization.

A team also needs to exhibit not only good leadership but also good followership with team members demonstrating the ability to take directions well. Having one clear team leader is important, and all team members should use closed-loop communication techniques. Background noise should be minimized as much as possible, which can be a challenge in the ICU environment compared with the OR.[14]

Cognitive aids and checklists also have been shown to improve team function and help clinicians perform tasks without freezing or panicking.[15] Part of good teamwork during an airway emergency is a team debrief. A debrief is a time when the team can discuss what went well and suggestions for improvement. These discussions should avoid placing blame, and if done well, can provide essential information to guide future airway management in the ICU and prevent complications.[14]

Team Organization

Team organization also should be considered as part of the planning process. A team leader should be designated and ideally relieved of all other duties. The first intubator should be at the head of the bed along with a second intubator to assist, if available. A third person is positioned at the side of the bed to administer medications and watch the monitor. Having an additional person to obtain anything not immediately available is prudent. One person should also act as a timekeeper to ensure the team does not allow too much time to pass without oxygenation and ventilation and be prepared to perform an emergent surgical airway, if necessary.[16] Roles and responsibilities of team members should be assigned in advance, and the airway management and backup plans should be discussed.

Preparation and Planning

When a clinician is called to a NORA emergency, the first question to consider is the urgency of the procedure.[14] If the patient requires emergent or immediate intubation, clinicians should consider whether intubation is appropriate by quickly ensuring that intubation falls within the patient's goals of care. If the patient does not require immediate intervention, another question to consider is whether transfer to an OR would be appropriate. If a patient is stable for transfer and has a known anatomically difficult airway, it may be most appropriate to transfer the patient to the OR for definitive management. Clinicians also should consider whether there are resources only available in the OR, such as rigid bronchoscopes, jet ventilators or more advanced fiberoptic bronchoscopes, which the patient may require. If it is likely the patient will require a surgical airway and they are stable for transfer, an OR may be the best place to secure the airway.

Airway Assessment

Time and patient status permitting, a quick airway exam can yield important information prior to airway management. De Jong et al developed and validated a scoring system called MACOCHA for predicting difficult intubations in ICU patients.[17] Factors involved in scoring included the presence of a Mallampati score of III or IV, sleep apnea, decreased cervical mobility, mouth opening of less than 3 cm, Glascow coma score of less than 8, severe hypoxemia and whether the practitioner is not an anesthetist. The scoring system is shown in Table 2,

Table 2. MACOCHA Scoring

Factor	Points Awarded
Patient-related factors	
Mallampati score of III or IV	5
Obstructive sleep apnea	2
Reduced cervical spine mobility	1
Limited mouth opening <3 cm	1
Disease-related factors	
Coma (Glasgow score <8)	1
Severe hypoxemia	1
Operator-related factor	
Non-anesthesiologist	1

MACOCHA: Mallampati score of III or IV, sleep **A**pnea syndrome, decreased **C**ervical mobility, mouth **O**pening <3 cm, **C**oma defined by a Glasgow score <8, severe **H**ypoxemia, and if the practitioner is not an **A**nesthetist.

Adapted from reference 17.

with the most points given to a patient with a Mallampati III or IV airway.

In the initial validation study of 1,000 intubations in 42 ICUs, the group defined a difficult airway as requiring three or more attempts or the intubation procedure requiring 10 minutes or longer. If the MACOCHA score was less than or equal to 3, the negative predictive value for a difficult airway was 98% and the positive predictive value was 36%, meaning the score being 3 or less was highly effective at ruling out a difficult airway.[17] If the score is greater than 3, it may be prudent to gather additional equipment such as a video laryngoscope.

Positioning

Patient positioning should be optimized as much as possible prior to an intubation attempt to increase the odds of first-pass success. A "ramped" position, reduces the risk for pulmonary aspiration of gastric contents and desaturation by maintaining the patient's functional residual capacity. The debate about whether the "sniffing" or "ramped" position may be more appropriate persists. In the absence of clear-cut evidence favoring one versus the other, positioning should be individually tailored to patient characteristics, as well as the skill set of the intubating clinician.

Awake or Asleep?

Part of planning an intubation and positioning the patient means deciding whether an awake or asleep approach is most appropriate. There are some advantages to consider with either approach. When managing the airway without induction, the patient can continue to ventilate spontaneously, and by avoiding administration of induction drugs, clinicians can avoid the potential for associated hemodynamic instability. In addition, the risk for hypoxia associated with prolonged or failed intubation attempts is minimized because the patient is spontaneously breathing throughout the airway management process. An awake intubation also can be performed in the sitting position, which may be best tolerated in patients who are in severe respiratory distress.

Awake intubations also minimize aspiration risk by avoiding the loss of protective airway reflexes damage to the cervical spine in cases of trauma or cervical spine ligamentous injury.[18] On the other hand, after administering induction drugs and paralytics, airway management is frequently easier, and this asleep method is faster. It is also more comfortable for the patient and may be most appropriate in cases of severe agitation.

Checklists

Checklists have long been regarded by various industries, including medicine, as a method to reduce cognitive load and reduce errors in stressful situations. Instituting a checklist for NORA management may ensure the necessary preparations and precautions have been taken.

Preoxygenation and Apneic Oxygenation

Several strategies can be employed to reduce the risk for complications during an emergent NORA intubation. Preoxygenation and apneic oxygenation increase the time interval after apnea has been induced before desaturation occurs. Oxygen may be delivered using a simple face mask, standard nasal oxygen or HFNO, or NIV. HFNO enhances both oxygenation and carbon dioxide clearance compared with low-flow nasal oxygen and generates a small amount of positive end-expiratory pressure (PEEP).

NIV augments minute ventilation with pressure-supported breaths while providing PEEP, and can decrease right ventricular preload and left ventricular afterload. Thus, HFNO or NIV may be preferred over conventional oxygen for preoxygenation, with NIV being advantageous in severely hypoxic patients.

Rapid Sequence Intubation

Critically ill patients may not be adequately fasting at the time of tracheal intubation and may have gastroparesis associated with critical illness. Therefore, a conventional RSI, which involves administration of rapid-onset agents including an induction agent and muscle relaxant, cricoid pressure, and avoidance of ventilation between induction and tracheal intubation, is usually practiced to avoid pulmonary aspiration.

The use of cricoid pressure during RSI remains controversial. A recent double-blind, randomized study showed noninferiority of sham versus cricoid pressure in preventing aspiration in patients at a high risk for aspiration. In addition, a Cochrane review on the subject of cricoid pressure concluded that more evidence is required.[19,20] Nevertheless, several airway society guidelines still recommend the use of cricoid pressure during RSI.[16,21] Most of these patients are at a risk for hypoxemia due to avoidance of ventilation between neuromuscular blockade and tracheal intubation during RSI.

In a study comparing mask ventilation or no ventilation between induction of anesthesia and tracheal intubation in critically ill patients, a lower incidence of severe hypoxemia and no increase in the rate of pulmonary aspiration were observed in patients receiving ventilation.[22] Although this study was not powered to assess for pulmonary aspiration, it provides some reassurance that gentle mask ventilation to limit hypoxia during RSI may not significantly increase the risk for aspiration.

Choice of Agent for Induction of Anesthesia

Drugs used for induction of anesthesia can increase the risk for hemodynamic and respiratory complications. Propofol provides superior conditions for tracheal intubation. However, it may not be suitable in most critically ill patients who are in shock, are hypovolemic or with cardiac comorbidities, as it can cause a precipitous fall in blood pressure and heart rate. Ketamine and etomidate are the induction agents of choice

unless contraindicated due to their positive hemodynamic profile. A study comparing the two agents in adult trauma patients when used for RSI showed no difference in first-pass success rates, ICU-free days, ventilator-free days or mortality.[23]

Neuromuscular Blockade

Use of neuromuscular blockade during tracheal intubation is associated with greater first-attempt success and fewer complications, and should be considered in all patients.[24,25] A study in critically ill patients comparing succinylcholine with rocuronium found no difference between the two agents with respect to oxygen desaturation or successful first-pass tracheal intubation.[25,26] Sugammadex (Bridion, Merck) may be used for the rapid reversal of rocuronium in an emergency; however, there are limited safety data for its use in critically ill patients.[27] Succinylcholine should be used with caution, as it may precipitate life-threatening hyperkalemia in at-risk patients.

Device Selection for Tracheal Intubation

A recent meta-analysis compared VL with DL and included nine randomized controlled trials with over 2,000 critically ill patients. The use of VL did not improve the first-pass success rate, even when stratifying the studies according to the operator's experience.[28] Some studies included in these meta-analyses have shown a higher incidence of severe life-threatening complications with VL use. An explanation given for these findings is the failure to abort tracheal intubation attempts when there is a clear laryngeal view using VL, leading to prolonged apnea time and complications in this vulnerable group of patients.

Although recent evidence does not support the routine use of VL for tracheal intubation in the ICU, VL improves glottic visualization compared with DL, making it an important tool for difficult airway management in ICU.[29] Therefore, a video laryngoscope should be available during all NORA intubations, and provider familiarity with this device is essential.

Limit Attempts at Intubation

In a recent study, patients who required more than one attempt at intubation had a significantly higher rate of adverse events, including severe hypoxia and cardiac arrest, than those who had a successful first intubation attempt.[30] The study also noted that staff physicians and anesthesiologists were more likely to achieve first-attempt success than residents or clinicians with other backgrounds, which highlights the importance of having experts at airway management available during a NORA emergency.

Hemodynamic Support During Tracheal Intubation

A recent global, multicenter, prospective study of 2,964 patients undergoing emergency NORA tracheal intubation found the incidence of cardiovascular collapse was 42%.[30] Hemodynamic instability during tracheal intubation is an independent predictor of adverse outcomes, including mortality.[3] Fluid loading and vasopressors are often used to prevent and treat hypotension. Fluid loading may or may not be effective, and early use of vasopressors may be an alternative, but needs further evaluation.[31]

Rescue Oxygenation

If the patient desaturates during attempts at tracheal intubation, the first step should be to perform face mask ventilation. If mask ventilation is inadequate, a supraglottic airway device (SAD) should be inserted for rescue oxygenation.[16,22,32] A second-generation SAD, which provides gastric decompression and a good laryngeal seal, is preferred.[16,22] After successful rescue ventilation and oxygenation using an SAD, one of the following options should be considered: tracheal intubation through the SAD under bronchoscopic guidance by an airway expert or a surgical tracheostomy.[3] If tracheal intubation, mask ventilation and SAD insertion all fail to achieve ventilation, an emergency cricothyroidotomy should be performed, even if the oxygen saturation is preserved.[16,22,32]

The optimal method for performing a cricothyroidotomy remains unknown. A surgical or large-bore cannula cricothyroidotomy should be performed, since needle cricothyroidotomy requires the use of transtracheal jet ventilation, which may not be available in a NORA setting. Alternately, a surgical tracheostomy may be considered if a surgeon with the expertise in performing this procedure is immediately available.

Post-Intubation Care

Waveform capnography should be used to confirm tracheal intubation, with five to six consistent waveforms with no decline observed.[16,22] The patient should be treated for any hemodynamic complications associated with the procedure and transported to a location with an appropriate level of care. A handoff should be given to the team managing the patient, and documentation of the procedure as well as any associated difficulties and/or complications should be made in a timely manner.

Conclusion

NORA management is a high-risk procedure with the potential for an anatomically, physiologically and logistically difficult airway, which must therefore be approached with appropriate preparation, personnel and equipment. While the optimal method for securing an emergent NORA has not been defined, evidence-based strategies to avoid complications include providing apneic oxygenation and preoxygenation, considering RSI, use of appropriate medications and devices, and providing hemodynamic support and rescue oxygenation, as required during the procedure.

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