Airway management of adults in the acute care setting

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Cite this as: *BMJ* 2026;393:e086612
http://dx.doi.org/10.1136/bmj-2025-086612

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ABSTRACT

Airway management is an important skill for clinicians who care for adults who are acutely ill. Tracheal intubation can be life saving, but also carries a high rate of complications. Numerous tools are available to assess the difficulty of bag-valve-mask ventilation, intubation, and cricothyroidotomy; however, these tools currently have limited predictive value. Preparation, preoxygenation with non-invasive positive pressure ventilation, and physiological optimization are therefore essential steps to all airways. Drugs for induction and paralysis should be tailored to the patient. If rapid sequence intubation is performed, video laryngoscopy is preferred over direct laryngoscopy because it increases the likelihood of first pass success. Confirmation should include capnography or point-of-care ultrasound. Clinicians should ensure adequate analgesia and sedation to avoid patients experiencing awareness with paralysis, but this must be balanced with avoiding oversedation. This review summarizes the current data and provides an evidence based approach to airway management in the acute care setting.

Introduction

Airway management is a critical skill in the acute care setting (eg, emergency department, intensive care unit (ICU)). Although tracheal intubation may be life saving, as many as 40% of patients experience life threatening hypoxemia, hypotension, or cardiac arrest during the procedure.[1] In contrast to the operating theatre, airway management in the acute care setting presents unique challenges, including lack of preoperative assessment, non-fasting state, and unstable critical illness.[2] Multiple recent studies have been published, informing the optimal approach to assessment before intubation, management during intubation, and care after intubation. Therefore, this review of airway management of adults in the acute care setting appraises and discusses the assessment, preparation, pharmacological considerations, intubation techniques, rescue options, confirmatory testing, and post-sedation and ventilator management, with a focus on the most recent literature on the topic. This review is intended for clinicians involved in airway management of adults in the acute care setting and provides an update on the current evidence to optimize the care of these patients. The tools and techniques used during emergency tracheal intubation differ for pediatric patients and the guidance provided here is not intended for that population.

Sources and selection criteria

We searched PubMed and the Cochrane Database of Systematic Reviews for articles published from inception to 1 August 2025 to identify studies reporting on the evaluation and management of tracheal intubation of adults in acute care settings. Initial search terms included “intubation” and “airway management,” followed by focused searches of each component of the tracheal intubation process. This approach was supplemented by forward and reverse citation searches of included articles. We included retrospective and prospective studies, randomized controlled trials (RCTs), systematic reviews and meta-analyses, and guidelines. When available, systematic reviews and meta-analyses were preferentially given the highest weight in informing our review, followed sequentially by RCTs, prospective studies, and retrospective studies. When no acute care setting data were available or data were limited, data from non-critically ill patients in the operating theatre were extrapolated to this setting.

Epidemiology

Tracheal intubation is a common procedure in acute care settings. In the United States, tracheal intubation is performed in approximately 422 000 emergency department visits annually.[3] A scoping review of 22 emergency department based airway registries reported that the most common indication for emergent tracheal intubation in this setting was a medical condition (eg, intracranial stroke, airway protection, overdose).[4] The International Observational Study to Understand the Impact and Best Practices of Airway Management in Critically Ill Patients (INTUBE) is a large study that evaluated

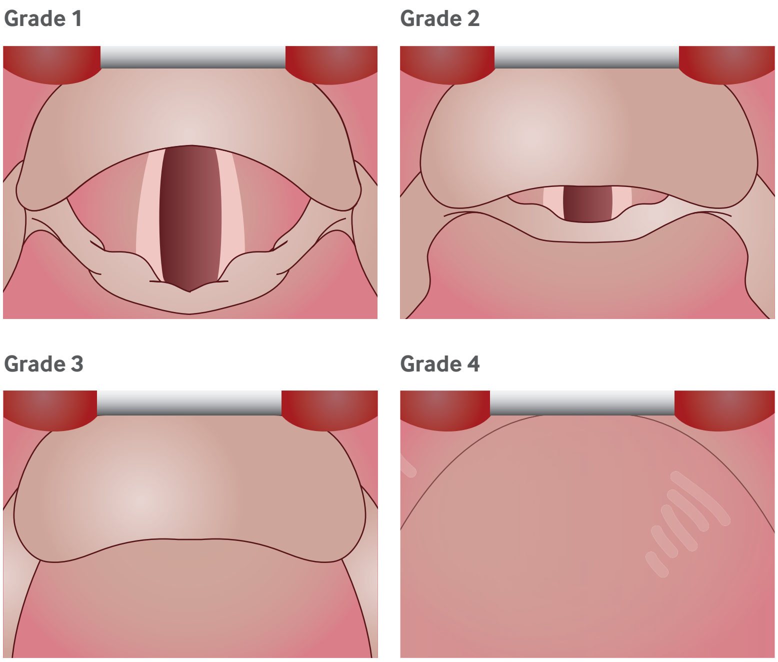

Fig 1 | Cormack-Lehane system for laryngoscopic assessment of airway view. Grade 1: full view of the vocal cords; grade 2: only posterior glottic structures or cartilages visible; grade 3: only epiglottis visible; grade 4: only soft palate visible, whereas neither epiglottis nor glottic structures visible

data from 197 sites across five continents.[1] The study reported that intubation was most common in the ICU (67.2%), followed by the emergency department (21.0%), general medical or surgical floor (8.6%), and other locations (eg, postoperative recovery room, cardiology, radiology, or endoscopic interventional rooms; 3.2%).[1] In that study, intubation was performed by a single operator in 53.0% of instances.[1] The first attempt was performed by a medical resident in 51.9% of patients, staff physician in 31.0%, medical fellow in 13.9%, medical student in 2.6%, and nurse or respiratory therapist in 0.6%.[1] Among those performing the first intubation attempt, the most common specialty was anesthesiology (54.0%), followed by critical care medicine (26.2%), emergency medicine (11.3%), internal medicine (4.6%), and other specialties (3.9%).[1] The most common reasons for intubation were respiratory failure (52.3%), neurological impairment (30.5%), cardiovascular instability (9.4%), airway obstruction (4.6%), and emergent or urgent procedure (1.0%).[1]

The INTUBE study found that serious complications were common during tracheal intubation in the emergency department or ICU, occurring in up to 40% of patients.[1] These complications included cardiovascular instability (eg, low blood pressure, new or increasing vasopressor receipt, dysrhythmias), severe hypoxia, or cardiac arrest.[1] Esophageal intubation occurred in 5.6% of patients.[1] Video laryngoscopy was only used in 17.1% of all intubations in that study and complication rates may no longer generalize to the present day given the widespread adoption of video laryngoscopy.[1] A 2023 systematic review and meta-analysis of 44 articles (n=34 357 intubations) reported serious complications in 30.5% of intubations performed outside the operating theatre, with the highest rate seen among patients with hemodynamic instability before intubation.[5]

Assessment of difficult airway

A difficult airway may be defined as "one where an experienced provider anticipates or encounters difficulty with any or all of face mask ventilation, direct or indirect (e.g., video) laryngoscopy, tracheal intubation, supraglottic device use, or surgical airway."[6] Difficulty may result from anatomical or physiological patient characteristics.

Anatomically difficult airway

Anatomic difficulty refers to difficulty in placing the endotracheal tube (ETT). Such difficulty may result from difficulty obtaining a view of the glottic opening or difficulty in placing the ETT. Glottic view is typically reported through Cormack-Lehane grades in which a grade 3 or 4 view predicts a difficult intubation (fig 1).

Clinical tools for airway assessment often involve a combination of patient history and physical examination features (table 1, table 2). A 2018 Cochrane Review of six studies (n=56 232 assessments) found that the modified Mallampati score predicted difficult bag-valve-mask (BVM) ventilation with 17% sensitivity and 90% specificity.[7] The traditional and modified Mallampati score use the same criteria; however, whereas the original Mallampati test involved visualizing the oropharyngeal structures with the patient's mouth open, the modified version adds the instruction to protrude the tongue maximally (fig 2). A 2023 meta-analysis identified several other factors associated with difficult BVM, with the most predictive elements

Table 1 | Mnemonic for difficult bag-valve-mask ventilation, supraglottic device use, and intubations

Bag-valve-mask ventilation (MOANS)	Supraglottic device (RODS)	Intubation (LEMON)	Front-of-neck airway (SMART)
Mask seal	Restricted mouth opening	Look at head and neck	Surgery
Obesity or obstruction	Obstruction	Evaluate 3-3-2*	Mass
Age >55 years	Distorted airway	Mallampati	Access or anatomy
No teeth	Stiff lungs	Obstruction	Radiation
Stiff lungs	—	Neck mobility	Tumor

*Refers to inter-incisor distance of at least three finger breadths between upper and lower teeth, hyoid bone to mentum distance of at least three finger breadths, and hyoid bone to thyroid cartilage distance of at least two finger breadths.

Table 2 | Scores for predicting difficult intubation

Wilson score*		MACOCHA score†		MONTH score‡	
Criteria	Points	Criteria	Points	Criteria	Points
Weight	0-2	Mallampati class III or IV	5	Mouth opening limited	1
Cervical spine mobility	0-2	Obstructive sleep apnea	2	Obstructed airway	4
Impaired jaw mobility	0-2	Cervical spine movement limited	1	Neck mobility poor	3
Retrognathia	0-2	Mouth opening <3 cm	1	Tongue large	2
Prominent incisors	0-2	Coma	1	Hyomental distance short	5
—	—	Hypoxemia (<80%)	1	—	—
—	—	Non-anesthesiologist intubator	1	—	—

*Coded from 0 to 10; easy: score ≤2, moderate: score 3-7, difficult: score ≥8.
†Coded from 0 (easy) to 12 (very difficult). Typical threshold of MACOCHA ≥3 for difficult intubations.
‡Coded from 0 to 15; low risk of difficulty: score 0, moderate risk of difficulty: score 1-4, high risk of difficulty: score 5-15.

including previous neck radiation (odds ratio 5.00, 95% confidence interval (CI) 3.00 to 8.33), increased neck circumference (4.04, 3.62 to 4.53), obstructive sleep apnea (3.61, 3.04 to 4.29), and presence of a beard (3.35, 2.51 to 4.46; box 1).[8] When possible, reviewing the electronic health records or asking if patients have a history of previous intubation difficulty can also be valuable, with one study reporting a specificity of 99% when present, though the sensitivity was only 14%.[9]

A 2024 systematic review and meta-analysis found that most clinical assessment tools had low to moderate sensitivity with high specificity (table 3).[10] The highest positive likelihood ratio was seen with the upper lip bite test (6.54, 95% CI 4.60 to 9.29). However, these studies were limited to the operating theatre. The MACOCHA score was derived and validated in the ICU setting with moderate sensitivity (76% and 73% in the original and validation cohorts, respectively) and high specificity (90% and 89% in the original and validation cohorts, respectively).[11] However, when the MACOCHA score was evaluated in the emergency department setting for predicting first pass success, it was only 50.0% sensitive and 35.3% specific.[12] In the emergency department setting, the MONTH score has been found to be 74.6% sensitive and 92.8% specific.[13] However, none of the currently available clinical assessment tools perform adequately and are able to be systematically applied to a high enough proportion of tracheal intubations to support their systemic use outside of the preoperative setting.

Point-of-care ultrasound (POCUS) has been increasingly used for predicting difficult intubation. A systematic review of POCUS assessments found that the distance from the skin to the epiglottis (positive likelihood ratio 3.97, 95% CI 2.88 to 5.47) and the hyomental distance ratio (3.62, 2.48 to 5.28) were the strongest predictors (table 4).[10] More recently, researchers have also begun using machine learning algorithms to predict difficulty of intubation using a wide array of parameters with sensitivities and specificities of up to 90%.[14] Given the limitations of the above tools and challenges with performing them among patients who are acutely ill, it is important for clinicians to consider all emergent intubations at risk of anatomical difficulty and ensure appropriate backup options are in place as discussed below.

Physiologically difficult airway

The physiologically difficult airway refers to patients who have comorbidities or conditions placing them at high risk of hypoxemia, hypotension, severe metabolic acidosis, and right ventricular failure

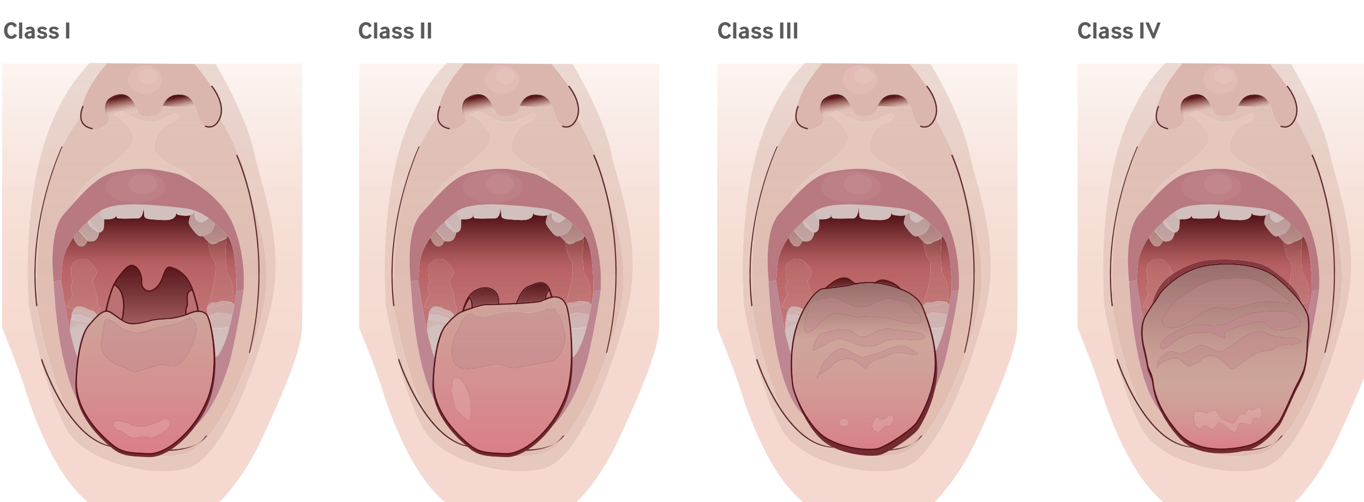

Fig 2 | Modified Mallampati criteria. Class I: any part of epiglottis visible; class II: soft palate, uvula, and pillars visible; class III: soft palate and uvula visible; class IV: only soft palate and base of uvula visible

Box 1: Predictors of difficult bag-valve-mask ventilation: odds ratio (95% confidence interval)[8]

- Neck radiation: 5.00 (3.00 to 8.33)
- Increased neck circumference: 4.04 (3.62 to 4.53)
- Obstructive sleep apnea: 3.61 (3.04 to 4.29)
- Presence of beard: 3.35 (2.51 to 4.46)
- Snoring: 3.06 (2.32 to 4.04)
- Obesity: 2.99 (2.46 to 3.62)
- Male gender: 2.76 (2.22 to 3.43)
- Mallampati class III-IV: 2.36 (1.86 to 3.00)
- Limited mouth opening: 2.18 (1.80 to 2.63)
- Short thyromental distance: 2.12 (1.53 to 2.93)
- Edentulous: 2.12 (1.26 to 3.57)
- Older age: 2.00 (1.46 to 2.75)
- Limited neck movement: 1.98 (1.53 to 2.57)

during the intubation procedure.[15] Hypoxemia is a common complication during tracheal intubation, with increased risk among patients for whom hypoxemic respiratory failure was the indication for intubation (odds ratio 2.70, 95% CI 1.58 to 4.60), lower oxygen saturation at induction (0.92 per 1% increase, 0.89 to 0.96), younger age (0.97 per one year increase, 0.95 to 0.99), and higher body mass index (1.03 per 1 kg/m^2 increase, 1.00 to 1.06).[16]

Hypotension after intubation is also common, with one study showing significantly higher odds of mortality in hospital among those experiencing hypotension after intubation (odds ratio 2.1, 95% CI 1.2 to 3.9).[17] These authors reported the following factors as being predictive of hypotension after intubation: preintubation shock index of 0.8 (odds ratio 55.1, 95% CI 13 to 232), end stage renal disease (3.7, 1.1 to 13.1), chronic renal insufficiency (3.4, 1.2 to 9.6), intubation for respiratory failure (2.1, 1.0 to 4.5), and increased age (1.03, 1.01 to 1.04).[17] Another study reported increased risk of post-intubation hypotension with age 60-75 years (odds ratio 1.96, 95% CI 1.28 to 2.99) and >75 years (2.81, 1.72 to 4.59), acute respiratory failure as a reason for intubation (1.51, 1.01 to 2.26), requiring non-invasive ventilation as a preoxygenation method (1.54, 1.04 to 2.29), and increased simple acute physiological score II (1.02, 1.01 to 1.03).[18]

Metabolic acidosis is associated with worse outcomes, with one study reporting a pH <7.3 was associated with increased risk of hypotension after intubation (odds ratio 4.06, 95% CI 2.31 to 7.11).[19] Among patients with right ventricular failure, rapid increases in intrathoracic pressure during intubation can markedly influence hemodynamic status. One study found that right ventricular dysfunction was associated with increased risk of hemodynamic instability or cardiac arrest after intubation (moderate right ventricular dysfunction odds ratio 2.84, 95% CI 1.34 to 5.98; severe right ventricular dysfunction 3.38, 1.60 to 7.14).[20]

Preparation and personnel

Before intubation, the team leader should ensure critical personnel are present. In the hospital setting, this typically includes at least one person with appropriate training who can perform the intubation, a person who can administer drugs, and a respiratory therapist to assist with BVM ventilation and initiation of invasive mechanical ventilation. When possible, a second person should be available as a backup intubator if the first person is unsuccessful.

The intubating clinician should have sufficient training and experience before attempting intubation. Previous research suggested that approximately 35-50 previous intubations are needed before a plateau is reached in first pass success and lowest oxygen saturation.[21] However, intubation numbers are insufficient indicators in isolation and should also include structured training and reassessments to avoid skill decay.[22] Although a comprehensive review of airway training is beyond the focus of this article, it is important for institutions to ensure that all clinicians with intubation privileges have adequate training and skills assessment.

An example of an airway checklist may be considered to ensure all critical steps are identified and necessary equipment is present (box 2). However, data on the benefits of airway checklists are mixed. One before and after study of patients with trauma found that use of a checklist before intubation was associated with a lower incidence of intubation related complications (absolute risk difference 7.7%, 95% CI 14.8% to 0.5%) and shorter paralysis to intubation time (82 *v* 94 s).[23] Another simulation based assessment found that the percentage of omitted tasks decreased from 45.7% to 13.5% when using an airway checklist.[24] An RCT of 262 patients found no difference in lowest oxygen saturation, lowest systolic blood pressure, or severe life threatening complications.[25] A 2020 meta-analysis of one RCT and 10 observational studies (n=3261 total

Table 3 | Clinical predictors of difficult intubation[10]

Predictor	Sensitivity (95% CI)	Specificity (95% CI)	Positive likelihood ratio (95% CI)	Negative likelihood ratio (95% CI)
Upper lip bite test*	0.52 (0.51 to 0.54)	0.84 (0.83 to 0.84)	6.54 (4.60 to 9.29)	0.51 (0.45 to 0.59)
Wilson's risk score ≥2	0.42 (0.40 to 0.45)	0.81 (0.80 to 0.81)	4.18 (2.82 to 6.18)	0.56 (0.43 to 0.73)
LEMON (≥2 criteria)	0.58 (0.54 to 0.63)	0.85 (0.84 to 0.86)	3.99 (2.57 to 6.19)	0.46 (0.29 to 0.72)
Thyromental distance	0.38 (0.37 to 0.40)	0.83 (0.83 to 0.84)	2.78 (2.44 to 3.17)	0.72 (0.68 to 0.77)
Modified Mallampati class III-IV	0.39 (0.39 to 0.40)	0.86 (0.86 to 0.86)	2.92 (2.70 to 3.15)	0.62 (0.60 to 0.65)
SARI ≥4	0.54 (0.51 to 0.57)	0.80 (0.80 to 0.81)	1.79 (0.33 to 9.81)	1.05 (0.39 to 2.78)

CI=confidence interval; SARI=simplified airway risk index.
*Inability to protrude lower teeth to meet upper teeth.

Table 4 | Ultrasound predictors of difficult intubation[10]

Predictor	Sensitivity (95% CI)	Specificity (95% CI)	Positive likelihood ratio (95% CI)	Negative likelihood ratio (95% CI)
DSE	0.80 (0.75 to 0.84)	0.77 (0.75 to 0.79)	3.97 (2.88 to 5.47)	0.30 (0.23 to 0.38)
HMDR	0.72 (0.63 to 0.80)	0.80 (0.77 to 0.83)	3.62 (2.48 to 5.28)	0.38 (0.26 to 0.56)
DSHB	0.70 (0.63 to 0.76)	0.65 (0.63 to 0.68)	2.04 (1.56 to 2.68)	0.51 (0.39 to 0.66)
DSVC	0.67 (0.59 to 0.75)	0.68 (0.65 to 0.71)	1.96 (1.53 to 2.52)	0.56 (0.45 to 0.70)
Pre-E/E-VC	0.72 (0.62 to 0.80)	0.67 (0.63 to 0.71)	1.89 (1.03 to 3.48)	0.39 (0.04 to 3.84)

CI=confidence interval; DSE=distance from skin to epiglottis; DSHB=distance from skin to hyoid bone; DSVC=distance from skin to vocal cords; HMDR=hyomental distance ratio; Pre-E/E-VC=ratio between depth of pre-epiglottic space and distance from epiglottis to vocal cords.

patients) found a reduction in hypoxic events (relative risk 0.75, 95% CI 0.59 to 0.95), but no difference in mortality or other complications.[26] Figure 3 presents the key components of airway management.

Preoxygenation and physiological optimization

Preoxygenation

Preoxygenation involves administering supplemental oxygen before inducing anesthesia, with the goal of denitrogenating and increasing the oxygen reservoir of the lungs to reduce the incidence of hypoxemia during intubation.[27] Preoxygenation can be administered by a face mask such as a non-rebreather mask (NRB), high flow nasal cannula (HFNC), BVM, or non-invasive positive pressure ventilation (NIPPV). Many BVM devices have one way valves that require positive pressure (eg, manually squeezing the reservoir) or a patient to have maintained adequate respiratory drive to deliver oxygen, which may make effective preoxygenation with BVM challenging.

Non-rebreather mask

Traditionally, preoxygenation in the non-operative environment was administered with a NRB, with an emphasis on increasing the oxygen content provided to denitrogenate the lungs, replacing the typical lung content (78% nitrogen, 21% oxygen) with 100% inhaled oxygen. Using an NRB for preoxygenation requires a good mask seal because the presence of a leak has been shown to substantially reduce end

Box 2: Example intubation checklist

Prepare patient
- Preoxygenate—for at least 3-5 min with a fraction of inspired oxygen of 100% using NIPPV. If contraindicated, use high flow nasal cannula or a facemask with nasal cannula at the maximum available flow rate
- Resuscitate—for patients at risk of hypotension during intubation, consider administering a vasopressor before induction. Administer intravenous fluids if patients have an indication for intravenous fluid separate from intubation procedure
- Access—ensure intravenous catheter or cannula is functioning and that blood pressure cuff is on opposite arm
- Monitor—place blood pressure cuff on opposite arm to SpO_2 monitor
- Position—reposition patient towards end of bed and within reach of operator

Prepare intubation equipment
- First attempt—lubrication, suction, video laryngoscopy, ETT, stylet, bougie (flexible ETT introducer), 10 mL syringe
- Rescue plan—bougie, bag-valve-mask, PEEP valve, oropharyngeal airway, nasopharyngeal airway, supraglottic airway device
- Repeated attempts—downsized ETT, supraglottic airway device, alternative blade geometry not used in previous video laryngoscopy attempt, fiberoptic endoscope
- Surgical airway—bougie, scalpel, 6.0 mm ETT
- Confirmation—end tidal CO_2 detector (waveform capnography or colorimetric), POCUS, ETT securing device

Prepare drugs
- Induction—etomidate, ketamine, propofol
- Paralytics—succinylcholine or rocuronium (if using neuromuscular blockade)
- Vasopressor bolus—phenylephrine, epinephrine
- Vasopressor infusion—norepinephrine primed into pump and tubing
- Intravenous fluids—lactated Ringer's solution in pressure bag
- Sedation after intubation—propofol
- Analgesia before intubation—fentanyl

Prepare room
- Bed—position bed at level of intubating clinician's umbilicus
- Personnel—ensure intubating clinicians, respiratory therapist, bedside nurse, and charge nurse are present
- Assignments—assign roles for team leader, first operator, second operator, drugs administrator, and senior support nurse
- Approach—announce airway plan, including anticipated difficulty and pre-emptive approach to second and third intubation attempts

ETT=endotracheal tube; NIPPV=non-invasive positive pressure ventilation; PEEP=positive end expiratory pressure; POCUS=point-of-care ultrasound; SpO_2=peripheral oxygen saturation

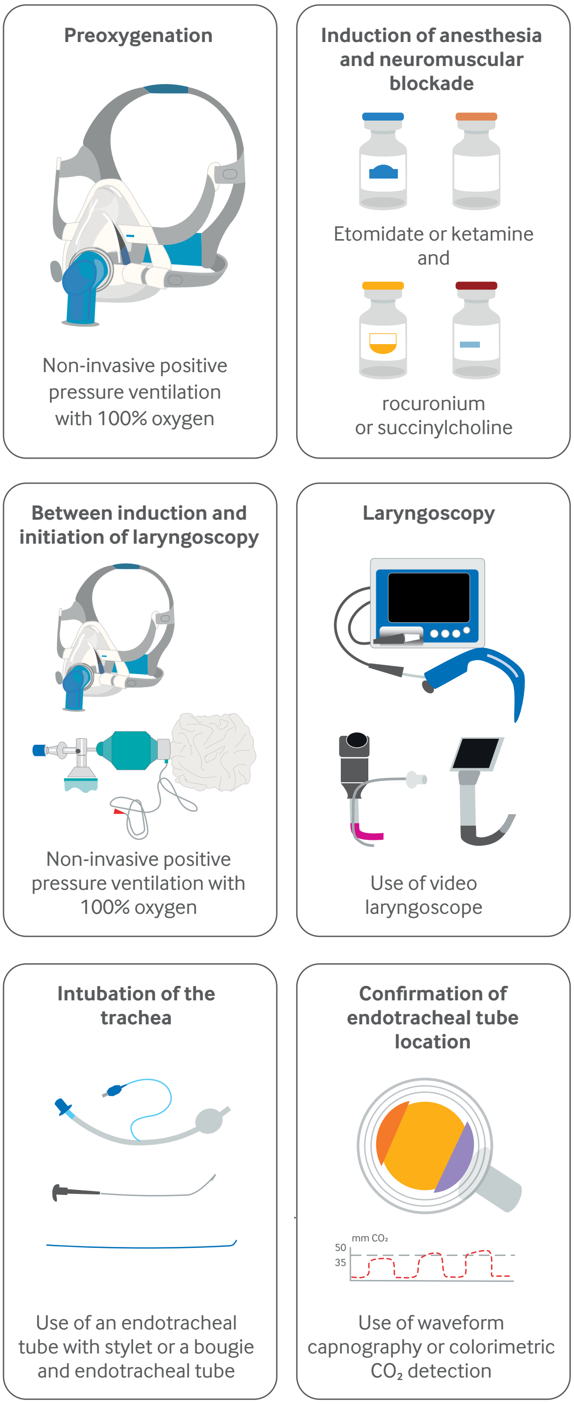

Fig 3 | Key components of airway management

tidal O_2 (a measure of denitrogenation).[28] Moreover, studies have shown that adding a nasal cannula to a NRB can further increase the end tidal O_2, and can potentially compensate for the presence of a mask leak.[28 29] A crossover trial involving healthy volunteers, preoxygenation using flush flow rate oxygen (>40 L/min through a fully opened standard oxygen flowmeter) delivered through a NRB was found to be more effective than 15 L/min through a NRB, and non-inferior to BVM with oxygen at 15 L/min.[30]

High flow nasal cannula

HFNC can facilitate flow rates of up to 60 L/min. A systematic review of 16 RCTs (n=1148 participants) intubated in the operating theatre reported higher partial pressure of arterial oxygen (mean difference 65 mm Hg, 95% CI 32 to 97 mm Hg), longer safe apnea time (131 s, 95% CI 59 to 203 s), and increased patient comfort (1.00/10.00, 95% CI 0.46 to 1.54), but no difference in desaturation during intubation with HFNC compared with NRB.[31] Outside the operating theatre, the evidence is mixed. One ICU trial reported no difference in intubation related complications including desaturation <80% or mortality,[32] while another ICU trial comparing HFNC and BVM reported no difference in the mean lowest saturation, but more substantial reductions in oxygen saturation in the first minute among the BVM group.[33] Another RCT of patients with non-severe hypoxemia in the ICU reported no difference in lowest oxygen saturation during intubation.[34] Together, the currently available data are inconclusive as to whether use of HFNC provides superior preoxygenation for emergency tracheal intubation compared with using a NRB.

Non-invasive positive pressure ventilation

Recent research has focused on the role of non-invasive positive pressure ventilation (NIPPV) in preoxygenation. Compared with HFNC and NRB, NIPPV offers the additional potential benefits of ventilatory support and greater positive pressure to enhance lung recruitment. An early RCT showed higher oxygen saturation in the NIPPV group compared with the NRB control group (93% *v* 81%; P<0.001) and fewer episodes of desaturation <80% (7% *v* 46%; P<0.01).[35] In the FLORALI-2 trial comparing NIPPV with HFNC, there was no difference in severe hypoxemia overall; however, in the subgroup with moderate to severe hypoxemia before intubation, severe hypoxemia <80% was less common in the NIPPV group (24% *v* 35%; adjusted odds ratio 0.56, 95% CI 0.32 to 0.99).[36] The more recent PREOXI RCT (n=1301 participants), conducted at 24 emergency departments and ICUs, compared the effect of preoxygenation with NIPPV versus NRB and found that using NIPPV for preoxygenation decreased the incidence of hypoxia during intubation (9.1% *v* 18.5%; mean difference −9.4%, 95% CI −13.2% to −5.6%) and appeared to reduce the incidence of cardiac arrest (0.2% *v* 1.1%; −0.9%, −1.8% to −0.1%) with no difference in incidence of aspiration.[37]

A 2025 systematic review and network meta-analysis comparing preoxygenation strategies among 15 RCTs (n=3420 participants) found NIPPV reduced the incidence of hypoxemia compared with HFNC (relative risk 0.73, 95% confidence interval 0.55 to 0.98) and NRB (0.69, 0.54 to 0.88).[38] Additionally, NIPPV reduced the risk of serious complications compared with HFNC (0.32, 0.11 to 0.91) and NRB (0.30, 0.12 to 0.77).[38]

Table 5 | Induction agents[62]

Drug	Dosing	Reduced dosing	Onset of action (seconds)	Duration of action (minutes)	Special considerations
Etomidate	Intravenous: 0.3 mg/kg (max 40 mg)	Intravenous: 0.15-0.3 mg/kg	5-15	5-15	Preferred in patients with hemodynamic instability. Causes myoclonus and suppresses cortisol production
Ketamine	Intravenous: 1-2 mg/kg (max 200 mg); intramuscular: 4-6 mg/kg (max 500 mg)	Intravenous: 0.5-1 mg/kg	30-90	Intravenous: 10-30; intramuscular: 25-45	May be preferred for reactive airway disease or seizure. May cause cardiac ischemia or excess oral secretions
Propofol	Intravenous: 1-2 mg/kg (max 200 mg)	Intravenous: 0.5-1 mg/kg	15-30	5-10	May be preferred for seizure or alcohol withdrawal syndrome. Avoid with hemodynamic instability

Delayed sequence intubation

Select patients may require assistance with drugs to facilitate oxygenation or ventilation before induction of anesthesia for tracheal intubation. In these patients, delayed sequence intubation—a technique in which sedation is administered to calm a patient with agitation to optimize preoxygenation and subsequent intubation—may be used. A prospective, observational study of 62 emergency department and ICU patients reported increased oxygenation (89.9% before delayed sequence intubation *v* 98.8% after; mean difference 8.9%, 95% CI 6.4 to 10.9%) with no complications observed.[39] An RCT of 200 critically ill patients with trauma comparing delayed sequence intubation with ketamine versus rapid sequence intubation (RSI) found hypoxia during intubation was lower (8% *v* 35%; P=0.001) and the first attempt success rate was higher (83% *v* 69%; P=0.02) in the delayed sequence intubation group, with no differences in hemodynamic instability or airway related adverse events.[40]

Ramped positioning

Another technique hypothesized to optimize patient physiology before intubation is ramped positioning. In ramped positioning, pillows or a bed tilt is used to elevate the chest and head of the patient. While most used in patients with raised body mass index, this technique can be used for any patient to potentially improve oxygenation and diaphragmatic excursion. Several RCTs and crossover studies in the operating theatre reported improved mask ventilation, improved glottic visualization, easier intubation, and reduced total intubation time when using ramped positioning.[41-45] By contrast, the Check-UP trial, which was performed in four ICUs among 260 adults, found no difference in oxygen saturation between ramped and sniffing positions. The ramped position appeared to increase the incidence of difficult intubation (12.3% *v* 4.6%; P=0.04) and decrease the first pass rate (76.2% *v* 85.4%; P=0.02).[46] Therefore, the ramped position is not routinely recommended in the acute care setting at this time, though more studies are needed to determine if specific subsets (eg, patients with severe obesity or gastrointestinal bleeding) may benefit.

Physiological optimization

To avoid hypotension and cardiovascular collapse, some experts proposed administering a prophylactic bolus of intravenous fluids. However, the PREPARE and PREPARE II randomized trials found that administering a 500 mL bolus of intravenous crystalloid did not decrease the incidences of cardiovascular collapse, cardiac arrest, or mortality.[47 48] A secondary analysis of PREPARE II using propensity matching found that administering prophylactic vasopressors was not associated with reductions in the rates of hypotension during intubation.[49] Randomized trials evaluating the prophylactic administration of vasopressors before induction of anesthesia are ongoing.[50 51] With the currently available data, prophylactic administration of intravenous fluids and vasopressors is not recommended for all patients. However, in patients at risk of hypotension, prophylactic intravenous fluids and vasopressors may be reasonable in this select group.

Pharmacological considerations

Induction drugs

The three drugs most used to induce anesthesia for tracheal intubation in the emergency department or ICU are etomidate, ketamine, and propofol (table 5). Etomidate is a non-barbiturate and non-benzodiazepine sedative with its effect mediated through agonism of γ-aminobutyric acid A ($GABA_A$) receptors. Etomidate has a favorable hemodynamic profile and is preferred in patients with hemodynamic instability. Ketamine is a dissociative agent with the primary effect seen through the N-methyl-D-aspartate (NMDA) receptor antagonism, though several other receptors are also affected. Ketamine has beneficial effects in reactive airway disease and as an anticonvulsant. It is also the only induction agent with analgesic effects. Although initially hypothesized to maintain hemodynamic stability through the release of catecholamines, two recent observational studies and one single center randomized trial have reported higher rates of cardiovascular collapse with ketamine compared with etomidate.

Propofol works on both the $GABA_A$ and NMDA receptors with beneficial effects for use in seizure or severe alcohol withdrawal syndrome. Although RCTs are lacking, observational studies have suggested that use of propofol may be associated with higher rates of hypotension when used for intubation of critically ill adults. In one large study of critically ill patients, propofol was the only factor independently associated with cardiovascular instability (odds ratio 1.23, 95% CI 1.02 to 1.49).[52]

Several previous small to moderately sized randomized trials have compared the effects of ketamine and etomidate as sedative agents during emergency tracheal intubation and have shown conflicting results. A 2025 systematic review and meta-analysis comprising seven RCTs and 2384 patients found no difference in successful intubation on the first attempt, organ dysfunction during the first three days in the ICU, or mortality.[53] However, given persistent concerns about adrenal suppression from etomidate, many countries have withdrawn etomidate from the market. A recently published RCT of 2365 patients performed across 14 emergency departments and ICUs comparing etomidate versus ketamine for RSI found no difference in death in hospital by day 28 (28.1% *v* 29.1%); however, cardiovascular collapse was more common in the ketamine group (22.1% *v* 17.0%; risk difference 5.1%, 95% CI 1.9% to 8.3%).[54]

Neuromuscular blockade agents

Neuromuscular blockade agents were widely adopted for emergency tracheal intubation several decades ago to improve intubating conditions, theoretically making it easier to pass an ETT. The two most used neuromuscular blockade agents in current clinical practice are succinylcholine (a depolarizing agent) and rocuronium (a non-depolarizing agent). Although neuromuscular blockade agents are commonly used in some clinical settings, in select patients they may be contraindicated (eg, known hypersensitivity, contraindications to both agents).

Whether continued use of neuromuscular blockade agents for every emergency tracheal intubation is necessary in an era of widespread use of video laryngoscopy remains unknown. Most high quality data comparing intubating conditions with or without neuromuscular blockade agents are limited to the operating theatre and direct laryngoscopy. A 2017 Cochrane review of 34 RCTs (n=3565 participants) reported increased risk of difficult intubation (relative risk 13.27, 95% CI 8.19 to 21.49) when neuromuscular blockade agents were not used.[55] A 2023 RCT also found reduced first pass success (71.6% *v* 66.1%; mean difference −6.1%, 95% CI −11.6% to −0.5%) when neuromuscular blockade agents were avoided.[56] However, these trials were performed in the operating theatre using direct laryngoscopy, where the risks of hypoxemia are less, which may limit generalizability to the acute care setting (where patients may be at higher risk of hemodynamic decompensation and aspiration of gastric contents) and when using video laryngoscopy (which has a higher first pass success rate). Future trials are needed to better evaluate the benefits and risks of administering neuromuscular blockade agents during emergency tracheal intubation performed using video laryngoscopy.

There are potential risks and benefits associated with each of the two most used neuromuscular blockade agents. Succinylcholine has a faster onset and shorter duration of action than rocuronium (table 6). A 2015 Cochrane Review of 50 trials (n=4151 participants) found succinylcholine was associated with higher rates of excellent intubation conditions (relative risk 0.86, 95% confidence interval 0.81 to 0.92) and clinically acceptable intubation conditions (0.97, 0.95 to 0.99).[57] A subsequent 2019 RCT of 1226 patients in an out-of-hospital setting found a higher rate of successful intubation on the first attempt in the succinylcholine group than the rocuronium group.[58] However, a 2025 secondary analysis of two multicenter RCTs found no significant difference in successful intubation on the first attempt or severe complications between agents.[59] Additional data on whether to use a neuromuscular blockade agent during emergency tracheal intubation, and if so which one, is urgently needed.

Sequence of drugs

The administration of a neuromuscular blockade agent before the sedative could potentially be beneficial owing to differences in time to onset between agents. One study found that administering the neuromuscular blockade agent first led to a 6 s reduction in the total intubation attempt.[60] Another study using a bayesian analysis of 2216 patients reported that administering the neuromuscular agent first was associated with a 95.7% probability of higher first attempt success.[61] Additional prospective data on the order of drug administration during emergency tracheal intubation are needed.

Oxygenation and ventilation between induction and laryngoscopy

After inducing anesthesia and before starting laryngoscopy, substantial variation existed in administering BVM ventilation, with some clinicians advocating for routine administration of BVM to prevent hypoxia and others citing concerns about increased risk of gastric distension and aspiration. The PreVent trial randomized 401 patients in the ICU

Table 6 | Neuromuscular blockade agents[62]

Drug	Dosing	Onset of action (seconds)	Duration of action (minutes)	Special considerations
Succinylcholine	Intravenous: 1.5 mg/kg	30-45	5-15	Preferred when a neurological exam after intubation is needed. Avoid with hyperkalemia, history of malignant hyperthermia, or with upregulation of acetylcholine receptors (eg, spinal cord injury, burn or crush injury >24 hours, sepsis >7 days, muscular dystrophy, demyelinating neuromuscular disease, severe immobility)
Rocuronium	Intravenous: 1-1.2 mg/kg (max 150 mg)	45-60	45-120	Preferred when longer duration of paralysis is needed. Ensure sedation after intubation matches length of paralysis

to BVM ventilation versus no ventilation between induction and laryngoscopy and found reduced hypoxia in the BVM group (10.9% *v* 22.8%; relative risk 0.48, 95% CI 0.30 to 0.77) and no difference in aspiration events.[63] Because the PreVent trial was limited to patients in the ICU, how results generalize to patients in the emergency department was uncertain. However, in the recent PREOXI trial, patients in the emergency department and the ICU in the intervention group received NIPPV for preoxygenation and between induction and laryngoscopy.[37] The PREOXI trial found that this positive pressure ventilation decreased the incidence of hypoxemia (9.1% *v* 18.5%; mean difference −9.4, 95% CI −13.2 to −5.6) and cardiac arrest during intubation (0.2% *v* 1.1%; −0.9, −1.8 to −0.1) without affecting the incidence of aspiration (0.9% *v* 1.4%; −0.4, − 0.6 to 0.7). Additional research is needed to understand whether the approaches to ventilation used in PreVent (10 breaths/min with the smallest volume required to generate a visible chest rise according to the American Heart Association cardiac arrest guidelines) and PREOXI are ideal or if the respiratory rate or tidal volume delivered during this period affect the rates of hypoxemia or aspiration.

Independent of BVM ventilation, another tool proposed to potentially prevent hypoxia after induction is "apneic oxygenation," when supplemental oxygen is administered through nasal cannula throughout the intubation period. Several RCTs in the emergency department and ICU evaluated apneic oxygenation and reported no difference in the lowest oxygen saturation.[32 34 64-66] These results are consistent with a 2023 Cochrane review of 23 RCTs (n=2264 participants) including the emergency department, ICU, and operating theatre settings, which also found no clinically significant difference in lower oxygen saturation, first pass success rate, or adverse events.[67]

Intubation techniques and tools

There are three commonly used laryngoscopes for emergency tracheal intubation: direct laryngoscopy, standard geometry video laryngoscopy (SGVL), and hyperangulated video laryngoscopy (HAVL). SGVL mirrors the angulation seen by direct laryngoscopy (most commonly, a Macintosh curved blade), whereas HAVL uses a blade with a much more acute angle, often with a specialized stylet so that the ETT is advanced under video guidance in the absence of direct line of sight from the mouth. The DEVICE randomized trial compared video laryngoscopy with direct laryngoscopy among 1417 adults in 17 emergency departments and ICUs. Use of video laryngoscopy increased the incidence of first pass success from 70.8% to 85.1% (absolute risk difference 14.3%, 95% CI 9.9% to 19.7%).[68]

When using video laryngoscopy, the decision to use SGVL versus HAVL remains controversial. One large emergency department registry study of 11 927 intubations (61% SGVL, 39% HAVL) reported no difference in successful intubation on the first attempt.[69] One RCT among 182 patients in the operating theatre with anticipated difficult airway reported HAVL improved percentage of glottic opening visualized (89% *v* 54%; P<0.001) and had greater first pass success (97% *v* 67%; P<0.001) than SGVL.[70] By contrast, another RCT of 210 patients in the operating theatre without anticipated difficult airway who required cervical spine immobilization reported improved Cormack-Lehane grade and longer time to intubation with HAVL compared with SGVL, but no difference in first pass or overall intubation success.[71] Ongoing RCTs in emergency departments and ICUs across the US are comparing the effects of SGVL versus HAVL.[72]

Another consideration with video laryngoscopy is the use of channeled versus non-channeled blades. A channeled video laryngoscopy device has a built-in channel on the laryngoscope blade that holds a preloaded ETT and is used to guide the ETT directly into the trachea. A non-channeled video laryngoscopy has the ETT inserted independent of the video laryngoscopy device. A 2025 systematic review and network meta-analysis reported that all classes of video laryngoscopy (including SGVL, HAVL, and channeled) reduced the incidence of failed first pass intubation compared with direct laryngoscopy, but was unable to determine if channeled devices were superior or inferior to non-channeled devices.[73]

Regarding blade size, a size 3 or 4 blade may be used in adults. Although blade sizes are frequently chosen according to patient height, a size 3 blade may offer better maneuverability while a size 4 blade may allow deeper valleculas to be reached for all patients irrespective of height. A secondary analysis of six RCTs (n=979 patients) with patients intubated in the emergency department or ICU found a size 4 direct laryngoscope blade was associated with worse Cormack-Lehane grade (adjusted odds ratio 1.46, 95% CI 1.06 to 2.00) and lower first pass success rate (0.57, 0.37 to 0.85).[74] A recent RCT of 192 patients intubated with video laryngoscopy in the operating theatre found a size 3 blade compared with a size 4 blade resulted in improved grade of glottic view, irrespective of patient height (median percentage glottic opening of 100% *v* 83%).[75]

The STYLETO trial compared a stylet versus no stylet among 32 ICUs and found a higher first pass success rate (78.2% *v* 71.5%; relative risk 1.10, 95% CI 1.02 to 1.18) in the stylet group.[76] Using a flexible ETT introducer (also known as a bougie), a long, thin, plastic rod that can be used to facilitate orotracheal intubation in place of a stylet, has increased in recent years. Although a bougie was traditionally used as a rescue attempt after intubation failure, recent research has evaluated whether a bougie should be used on the first attempt in all patients. The BEAM trial randomized patients in a single emergency department to a bougie versus a stylet and reported higher first pass success with the bougie in the overall cohort (98% *v* 87%; difference 11%, 95% CI 7% to 14%) and among those with a difficult airway (96% *v* 82%; 14%, 8% to 20%).[77] By contrast, the BOUGIE trial randomized 1102 patients in 15 emergency departments and ICUs to a bougie versus a stylet and reported no difference in first pass success.[78] A 2024 meta-analysis including 12 RCTs (n=2991 patients) and observational studies (n=6160 patients) across operative and non-operative settings found the bougie was associated with increased first pass success (relative risk 1.11, 95% CI 1.06 to 1.17), which remained consistent when isolated to those conducted in the emergency department and ICU settings.[79]

In select patients with an anticipated difficult airway, awake intubation can be used outside the operative setting to secure ETT placement while the patient maintains their respiratory effort. Although less common than direct laryngoscopy or video laryngoscopy, national data on awake intubation report an 85% first attempt success rate in the emergency department with a low rate of complications.[80] Awake intubation typically includes premedication to reduce secretions, topical administration of local anesthetics, and use of a flexible endoscope to enable placement. A more expanded discussion of this approach has been described elsewhere.[81]

Alternate and rescue techniques

While tracheal intubation remains the preferred definitive airway management modality, supraglottic airway devices can provide a temporary option in select patients. In the context of cardiac arrest, a supraglottic airway first approach has been proposed because this may be easier and faster to insert, leading to fewer interruptions in ventilation and chest compressions. The literature about this approach has been mixed and limited to settings out of hospital, with one RCT reporting improvement in 72 hour survival (18.3% *v* 15.4%; adjusted difference 2.9%, 95% CI 0.2% to 5.6%).[82] However, two other RCTs found no difference in outcomes, including sustained return of spontaneous circulation, survival to hospital discharge, or survival with favorable functional outcome.[83 84]

When the clinician cannot intubate or ventilate the patient, the next step is emergency front-of-neck access. Unlike elective intubations, waking the patient is rarely an option when there is an emergency requirement for a successful airway. Although the most common emergency front-of-neck access is a cricothyrotomy, it remains rare, with one large registry reporting this occurred in 0.28% of all intubation attempts.[85] A 2024 scoping review showed substantial heterogeneity across the published literature, though the overall success rate was high with a median of 91%.[86] Before performing a cricothyrotomy, POCUS can be used to identify landmarks when feasible. One meta-analysis of eight studies (n=1094 assessments) showed POCUS reduces the failure rate of cricothyroid membrane identification compared with manual palpation (relative risk 0.50, 95% CI 0.33 to 0.76) with no difference in time to performance.[87] This technique is best performed before the intubation attempt and should not delay the cricothyroidotomy procedure. When using POCUS to mark the cricothyroid membrane before intubation, the neck should be in the position that the cricothyroidotomy would be performed because the cricothyroid membrane has been shown to change position with different degrees of head elevation.[88]

When comparing techniques, an RCT of combat medics identified no difference between the open and percutaneous surgical techniques for cricothyrotomy.[89] A newer technique referred to as the bougie guided (or scalpel-finger-bougie technique) has been described, when the provider makes an incision over the cricothyroid membrane, inserts a finger into the space, and then advances the bougie past the finger to maintain the tract. An ETT or cannula is then advanced over the bougie. Compared with the traditional techniques in animal and manikin studies, the bougie guided approach is faster, easier, and has a higher success rate.[90-94]

Confirmation of ETT location and depth

After intubation is performed, it is critical to confirm that the ETT is correctly placed within the trachea and at the appropriate depth. Traditionally, this includes direct visualization by the intubating provider followed by adjunctive techniques. A systematic review and meta-analysis of clinical tests and adjunctive devices for ETT confirmation reported a false positive rate ranging from 5% to 69% (table 7).[95] Among these techniques, the esophageal detector device (a syringe or bulb based device using air aspiration to assess for collapsibility of the trachea *v* esophagus) has shown promise, though some studies have shown markedly lower accuracy outside the operating theatre and it requires a special device that may not be available in many settings.[96 97]

Measuring the level of exhaled CO_2 is generally considered the gold standard for confirmation. Exhaled CO_2 can be assessed qualitatively (ie, color changes on a pH sensitive paper) or quantitatively (ie,

Table 7 | Clinical tests and adjunctive devices for endotracheal tube location confirmation[95]

Test	False positive rate (95% CI)	Sensitivity (95% CI)	Positive likelihood ratio (95% CI)	Negative likelihood ratio (95% CI)
ETT misting	0.69 (0.43 to 0.87)	0.98 (0.89 to 0.99)	1.46 (1.04 to 2.05)	0.02 (0.001 to 0.25)
Lung only auscultation	0.14 (0.08 to 0.23)	0.89 (0.50 to 0.90)	7.13 (4.15 to 12.3)	0.10 (0.01 to 0.64)
Five point (lung and epigastric) auscultation	0.18 (0.08 to 0.36)	0.94 (0.71 to 0.99)	9.47 (2.69 to 33.3)	0.04 (0.01 to 0.32)
Esophageal detector device	0.05 (0.02 to 0.09)	0.96 (0.92 to 0.98)	37.9 (17.3 to 83.0)	0.03 (0.01 to 0.07)

CI=confidence interval; ETT=endotracheal tube.

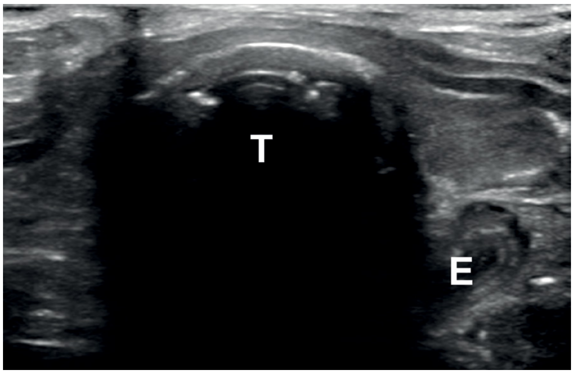

Fig 4 | Tracheal intubation on point-of-care ultrasound. Endotracheal tube visualized as a thin, hyperechoic line behind tracheal cartilage (T) that can be enhanced by gently twisting the tube to create motion artifact. Esophagus (E) is visualized as oval muscular layers and decompressed

capnometry with or without waveform capnography). Although exhaled CO_2 detection has overall high accuracy in most patients, the accuracy is decreased in conditions that reduce CO_2 production or delivery to the pulmonary venous system for gas exchange (eg, cardiac arrest, massive pulmonary embolism). One study of 250 emergency intubations found the colorimetric CO_2 device was 100% sensitive in patients without cardiac arrest, but only 72% sensitive in those in cardiac arrest, including 28 patients where the ETT was correctly placed but had no colorimetric change.[98] Other studies conducted in the emergency department or out of hospital settings reported the sensitivity for quantitative capnography in cardiac arrest to be 65-68%.[96 97 99] Furthermore, inappropriate CO_2 detection can take place in hypopharyngeal placement, where CO_2 exchange can occur but the ETT is not secured within the trachea.[100]

POCUS is another expanding modality for ETT confirmation. POCUS has the advantage of relying on direct visualization of the ETT on the ultrasound screen, rather than indirect measures such as CO_2 production, thereby potentially avoiding the aforementioned issues observed during cardiac arrest. The technique is performed by placing an ultrasound transducer across the suprasternal notch in a transverse plane and looking for a rapid flutter of the ETT passing through the vocal cords (dynamic technique) or assessing for the presence of a single or double tract (static technique; fig 4, fig 5).[101] A systematic review and meta-analysis of 38 studies (n=3268 participants) found POCUS was 98% sensitive (95% CI 97% to 99%) and 95% specific (90% to 98%).[102] Accuracy of POCUS has remained consistent regardless of ETT size, POCUS technique, or transducer type.[103-108]

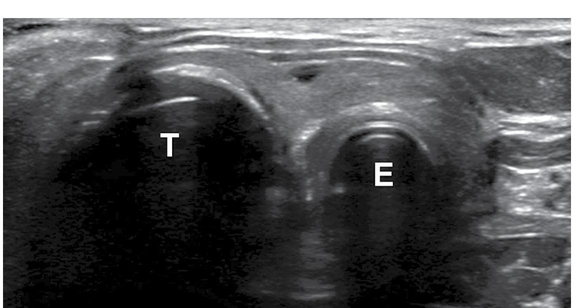

Fig 5 | Esophageal intubation on point-of-care ultrasound. Endotracheal tube visualized as a thin, hyperechoic line within esophagus (E) that is distended and creates appearance of second trachea located laterally to actual trachea (T)

After the intubation attempt, a chest radiograph is typically performed to identify ETT depth. POCUS has also been studied for this application, using lung or transtracheal views. A systematic review and meta-analysis of nine studies (n=617 participants) reported lung ultrasound was 93% sensitive (95% CI 87% to 96%) and 75% specific (57% to 87%).[109] Transtracheal ultrasound involves inflation of the ETT cuff with saline and direct visualization through the anterior neck. This technique has been shown to be 100% sensitive (95% CI 96.7% to 100%) and 100% specific (96.7% to 100%) when assessed by emergency physicians.[110]

Management after intubation

After intubation, it is important to avoid excessive, early, deep sedation as this has been associated with worse patient outcomes.[111] Sedation and analgesia protocols that include assessments of the level of sedation and drug titration should be used once paralysis is no longer present. The 2018 Clinical Practice Guidelines for the Prevention and Management of Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption in Adult Patients in the ICU recommend light sedation of patients on mechanical ventilation.[112] Non-benzodiazepine sedatives (eg, propofol, dexmedetomidine) are preferred over benzodiazepines because benzodiazepines are associated with increased ICU length of stay, duration of mechanical ventilation, and delirium.[112] Opioids (eg, fentanyl) are also recommended to treat associated discomfort from the ETT and mechanical ventilation.[112] A detailed review of managing pain and sedation in the ICU has recently been published.[113]

When neuromuscular blockade agents are used, it is important to ensure they are accompanied by adequate sedation to avoid awareness with paralysis. A systematic review of emergency department and ICU studies found awareness with paralysis was present in 3.4% of patients.[114] The ED-AWARENESS study reported rocuronium was associated with a markedly increased risk of awareness with paralysis (odds ratio 5.1, 95% CI 1.3 to 20.1).[115] A separate study of patients receiving long acting neuromuscular blockade agents (eg, rocuronium, vecuronium) in the emergency department reported that 12% of patients did not receive sedation for up to 30 min after initiation.[116] For each decade of age, the odds of not having concurrent sedation increased by 1.2 (95% CI 1.1 to 1.4).[116] Another study reported that the median time to first dose of sedation after rocuronium was 12 min (interquartile range 7-26 min), and that most patients were underdosed

Table 8 | Analgesic and sedative agents for sedation after intubation (adapted from Freeman and colleagues[119])

Category and drug	Bolus dosing	Infusion dosing	Special considerations
Analgesics			
Fentanyl	0.5-1.0 μg/kg every 30 min	1.0-2.0 μg/kg/h	Rapid onset with less risk of hypotension
Morphine	2-4 mg every 1-2 h	2-30 mg/h	Risk of histamine release; accumulation in renal or hepatic impairment
Hydromorphone	0.2-0.6 mg every 1-2 h	0.5-3.0 mg/h	Accumulation in renal or hepatic impairment
Analgesic or sedative			
Ketamine	0.1-0.5 mg/kg	0.05-0.4 mg/kg/h	Can develop tachycardia or hypertension. Increased risk of hallucinations
Sedatives			
Propofol	5 μg/kg/min	5-50 μg/kg/min	Risk of hypotension
Midazolam	0.01-0.05 mg/kg	0.02-0.10 mg/kg/h	Associated with more prolonged time on mechanical ventilation
Dexmedetomidine	1 μg/kg over 10 min	0.2-0.7 μg/kg/h	Risk of bradycardia and hypotension

when sedation was administered.[117] However, this underdosing must be carefully balanced with oversedation, with one study reporting 52.8% of emergency department patients experienced deep sedation and those experiencing deep sedation had prolonged ICU length of stay.[118] Table 8 presents a list of analgesic and sedative agents for sedation after intubation.

Emerging treatments

Several planned, ongoing, or recently concluded randomized trials in tracheal intubation examine treatment decisions that may inform how tracheal intubation is performed in the future. These studies include comparative effectiveness trials to evaluate the drugs and tools, and techniques used for emergency tracheal intubation.

Several recently completed and upcoming randomized trials are investigating the pharmacological considerations during emergency tracheal intubation. The RSI trial compared the effectiveness of ketamine with etomidate for inducing tracheal intubation across 14 emergency departments and ICUs in the US (ClinicalTrials.gov NCT05277896).[54] The large RSI trial of emergency tracheal intubation aims to address the decades long debate about the optimal drug for inducing anesthesia during tracheal intubation, with longer term outcome collection still ongoing. The PROMINE trial is currently randomizing patients to ketamine or propofol during emergency tracheal intubation in two Brazilian ICUs and will evaluate the effect of these drugs on the lowest blood pressure during intubation (NCT05092152).[120] The INSPIRE trial will examine whether the routine use of neuromuscular blockade is effective and safe in the current era of tracheal intubation using video laryngoscopy. If the INSPIRE trial concludes neuromuscular blockade is required, the optimal agent (succinylcholine *v* rocuronium) remains an important unanswered question. The OPERA trial, an upcoming randomized trial in France by Freund and colleagues, will investigate the effect of the sequence of drugs (sedative then paralytic *v* paralytic then sedative) in the prehospital space on the rate of successful intubation on the first attempt. Finally, the FLUVA trial is evaluating the effect of fluid bolus versus low dose vasopressor infusion on cardiovascular collapse during tracheal intubation (NCT05318066).

Several ongoing trials are evaluating the techniques and tools used during tracheal intubation. To evaluate whether using a HAVL versus SGVL blade affects the incidence of successful intubation on the first attempt, the Pragmatic Critical Care Research Group is enrolling 2500 patients across the US in the ANGLE trial (NCT07223762). A similar trial, the INVIBLADE trial, is ongoing in ICUs in Spain (NCT06322719). Finally, to address the impact of endotracheal tube size on clinical outcome of patients undergoing emergency tracheal intubation in the emergency department or ICU, the Pragmatic Critical Care Research Group is conducting the BREATHE trial. This trial is evaluating whether smaller endotracheal tubes (7.0 mm internal diameter for patients 64 inches or taller; 6.5 mm internal diameter for patients shorter than 64 inches) or larger endotracheal tubes (8.0 mm internal diameter for patients 64 inches or taller; 7.5 mm internal diameter for patients shorter than 64 inches) affect outcomes in hospital (duration of ventilation, survival) or long term outcomes (breathing, speaking, and swallowing at six months; NCT06939361).

Guidelines

Several clinical practice guidelines and consensus documents exist for airway management in the acute care setting. Overall, these guidelines recommend paying attention to risk factors for anatomically or physiologically difficult airways, focused interventions based on specific conditions or complications, preoxygenation with NIPPV, preferential use of video laryngoscopy when

GLOSSARY OF ABBREVIATIONS

- BVM—bag valve mask
- ETT—endotracheal tube
- GABA—γ-aminobutyric acid
- HAVL—hyperangulated video laryngoscopy
- HFNC—high flow nasal cannula
- ICU—intensive care unit
- NIPPV—non-invasive positive pressure ventilation
- NMDA—N-methyl-D-aspartate
- NRB—non-rebreather mask
- POCUS—point-of-care ultrasound
- RCT—randomized controlled trial
- RSI—rapid sequence intubation
- SGVL—standard geometry video laryngoscopy

QUESTIONS FOR FUTURE RESEARCH

- Which tools or combination of tools are most accurate for predicting difficult intubations in the acute care setting?
- Does use of a neuromuscular blockade agent for emergency tracheal intubation affect the incidences of successful intubation on the first attempt, hypoxemia during intubation, awareness with paralysis, or symptoms of post-traumatic stress disorder?
- Does the order of drug administration (sedative first *v* neuromuscular blockade agent first) affect the incidences of successful intubation on the first attempt, complications during intubation, awareness with paralysis, or symptoms of post-traumatic stress disorder?
- When using video laryngoscopy, does the use of a hyperangulated blade increase the incidence of successful intubation on the first attempt and decrease the incidence of complications compared with use of a standard geometry blade?
- When using video laryngoscopy, does the size of the laryngoscope affect the incidence of successful intubation on the first attempt and incidence of complications?

PATIENT INVOLVEMENT

Four patients who had experienced critical illness and underwent tracheal intubation reviewed the content of the manuscript and described their conversations with clinicians before and after the procedure. Patients wished they had been better informed about what to expect during the procedure and the potential complications of tracheal intubation, similar to how anesthetists discuss elective intubation before elective surgery. A lack of information and communication significantly contributed to and increased their distress during critical illness. After awakening from sedation after intubation, the patients felt that conversations with their physicians were delayed. While patients recognized the challenges that can hinder communication during emergency tracheal intubation, both they and their families reported receiving insufficient information about tracheal intubation, both before and after the procedure.

available, and balanced sedation after intubation. Supplementary table 1 presents a summary of the guidelines.[121-124]

Conclusion

Airway management is a critical skill in the acute care setting. Tracheal intubation can be life saving, but it also carries a high rate of complications. Numerous tools are available for assessing difficult BVM ventilation, intubation, and cricothyroidotomy, but these currently have limited predictive ability. Preparation, preoxygenation with NIPPV, and physiological optimization are therefore essential steps for all airways, even if difficulty is not anticipated. Drugs for induction and paralysis, if required, should be tailored to the patient. If RSI is performed, video laryngoscopy increases the likelihood of first pass success. Confirmation should include capnography or POCUS. Ensure adequate analgesia and sedation to avoid awareness with paralysis, while being careful not to oversedate.

The authors thank Barbara Gould, Jasmine McIntosh, Eileen Rubin, and Sherman Transou for sharing their lived experiences and recommendations.

Contributors: MG conceptualized the manuscript. All authors contributed to the literature search, writing—original draft, and writing—review, and editing. MG accepts responsibility for the manuscript as a whole as guarantor.

Competing interests: We have read and understood the BMJ policy on declaration of interests and declare the following interests: MG: none; SCD: none; JDC: personal fees from Reprieve Cardiovascular for serving as medical monitor for a clinical trial; travel support from Fisher and Paykel to attend the 2023 NRSnet Conference; MWS: personal fees for consulting for Baxter International, DynaMedex, and Reprieve Cardiovascular; KGB: none.

Provenance and peer review: Commissioned; externally peer reviewed.

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Web appendix: Supplementary table 1