Rapid Sequence Intubation

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Background

Airway management is arguably one of the most important skills for an emergency physician to master because failure to secure an adequate airway can quickly lead to death or disability.[1] Endotracheal intubation using rapid sequence intubation (RSI) is the cornerstone of emergency airway management.[2, 3]

The decision to intubate is sometimes difficult. Clinical experience is required to recognize signs of impending respiratory failure. Patients who require intubation have at least one of the following five indications:

- Inability to maintain airway patency
- Inability to protect the airway against aspiration
- Failure to ventilate
- Failure to oxygenate
- Anticipation of a deteriorating course that will eventually lead to respiratory failure

RSI is the preferred method of endotracheal tube intubation (ETTI) in the emergency department (ED). This is because it results in rapid unconsciousness (induction) and neuromuscular blockade (paralysis). This is important in patients who have not fasted and because of this are at much greater risk for vomiting and aspiration. To this end, the goal of RSI is to intubate the trachea without having to use bag-valve-mask (BVM) ventilation, which is often necessary when attempting to achieve intubating conditions with sedative agents alone (eg, ketamine, etomidate, propofol).

Instead of titrating to effect, RSI involves administration of weight-based doses of an induction agent (eg, ketamine, etomidate) immediately followed by a paralytic agent (eg, rocuronium, succinylcholine) to render the patient unconscious and paralyzed within 1 minute. These medications share commonality in short onset/offset times and potent efficacies. This method has been proven safe and effective in EDs over the past 4 decades, and it is considered the standard of care. When administered by experienced, well-trained emergency physicians, use of neuromuscular blocking agents in patients undergoing emergent tracheal intubation is associated with a significant decrease in procedure-related complications. [4]

RSI is not indicated in a patient who is unconscious and apneic. This situation is considered a "crash" airway, and immediate BVM ventilation and endotracheal intubation without pretreatment, induction, or paralysis is indicated.

RSI should be approached with caution in a patient with a suspected difficult airway. If difficulty is anticipated, then an awake technique or the use of airway adjuncts (eg, fiberoptic intubation) is recommended. Alternatively, anesthesia personnel may be called upon to assist in securing the airway of a difficult-to-intubate patient.

Extrapolating known techniques and procedures that are intuitive and evidence-based from the emergency department to the field often makes sound clinical sense. However, the same standards that govern such modalities should apply wherever they are practiced. Recent literature has questioned the benefit of RSI in the prehospital setting. [5] Contributing factors may be the inducement of hyperventilation and hypoxia, both of which have been shown to increase mortality in trauma patients undergoing prehospital RSI. [6]

Additional studies have shown that the use of prehospital RSI is associated with an increased incidence of transient and prolonged hypoxia (57% of patients with a median hypoxic time of 60 s), often going unnoticed by the paramedic. [7] Lack of initial and ongoing training, national variability in paramedic protocols, and inadequate experience must be studied and monitored. Randomized prospective studies are needed to better delineate and define the use of prehospital RSI. The ubiquitous use of video-assisted laryngoscopes (VALs) in EDs has been shown to decrease complications in RSI, and, as more prehospital personal train in this modality, similar results may be shown. Indeed, the amount of training required in VAL compared with direct laryngoscopy is less and glotic visualization has been proven to be easier.

There is a general lack of clinical evidence in several areas of RSI, including use of atropine as an adjunct agent for children, the role of lidocaine in pretreatment, the role of a "defasciculating" or priming dose of a nondepolarizing paralytic agent, relative contraindications for use of succinylcholine, and even the amount and methods of preoxygenation and the need to use cricoid pressure (Sellick maneuver). Use of the Sellick maneuver in preventing aspiration has never been proven, but it has been confirmed in increasing airway resistance and decreasing tidal volumes. Also, MRI studies have shown that the esophagus more consistently lies to the right of the trachea than posterior. This article highlights some of these controversies, and the interested reader can also review El-Orbany's 2010 article. [8]

This article focuses on direct laryngoscopy using a traditional direct laryngoscope. VAL is discussed as well.

Indications

Failure to maintain airway patency, as follows:

- Swelling of upper airway as in anaphylaxis or infection
- Facial or neck trauma with oropharyngeal bleeding or hematoma
- Angioedema

Decreased consciousness and loss of airway reflexes, as follows:

- Failure to protect airway against aspiration - Decreased consciousness that leads to regurgitation of vomit, secretions, or blood

Failure to ventilate, as follows:

- End result of failure to maintain and protect airway
- Prolonged respiratory effort that results in fatigue or failure, as in status asthmaticus or severe COPD

Failure to oxygenate (ie, transport oxygen to pulmonary capillary blood), as follows:

- End result of failure to maintain and protect airway or failure to ventilate
- Diffuse pulmonary edema
- Acute respiratory distress syndrome
- Large pneumonia or air-space disease
- Pulmonary embolism
- Cyanide toxicity, carbon monoxide toxicity, methemoglobinemia

Anticipated clinical course or deterioration (eg, need for situation control, tests, procedures), as follows:

- Uncooperative trauma patient with life-threatening injuries who needs procedures (eg, chest tube) or immediate CT scanning
- Stab wound to neck with expanding hematoma
- Septic shock with high minute-ventilation and poor peripheral perfusion
- Intracranial hemorrhage with altered mental status and need for close blood pressure control
- Cervical spine fracture with concern for edema and loss of airway patency

Contraindications

Absolute contraindications include the following:

- Total upper airway obstruction, which requires a surgical airway
- Total loss of facial/oropharyngeal landmarks, which requires a surgical airway

Relative contraindications include the following:

- Anticipated "difficult" airway, in which endotracheal intubation may be unsuccessful, resulting in reliance on successful bag-valve-mask (BVM) ventilation to keep an unconscious patient alive: In this scenario, techniques for awake intubation and difficult airway adjuncts can be used. Multiple methods can be used to evaluate the airway and the risk of difficult intubation (eg, LEMON rule, 3-3-2, Mallampati class, McCormack and Lehane grade). Please refer to the Difficult Airway Assessment section below for details.
- The "crash" airway, in which the patient is in an arrest situation, unconscious and apneic: In this scenario, the patient is already unconscious and may be flaccid; further, no time is available for preoxygenation, pretreatment, or induction and paralysis. BVM ventilation, intubation, or both should be performed immediately without medications.

Best Practices

To simplify rapid sequence intubation (RSI), one can think of administering essentially two drugs: an induction agent (etomidate) and a paralytic agent (succinylcholine). These fulfill the criteria of possessing a short onset/duration and high potency.

To intubate a trauma patient with C-spine precautions, the cervical collar may be removed with a dedicated assistant providing inline immobilization. Removing the anterior part of the cervical collar while maintaining inline cervical spine immobilization is acceptable and may cause less cervical spine movement than cervical collar immobilization during laryngoscopy for endotracheal intubation.

Position the head and neck in the sniffing position by flexing the neck and extending the atlanto-occipital joint. Reposition the head if an adequate view of the glottic opening is not achieved.

The patient must be adequately preoxygenated to prevent desaturation during the period of apnea after the paralytic agent has been administered (to minimize the risk of gastric content aspiration). The least amount of ventilation support required to obtain good oxygen saturation should be used during this period. Blow-by high-flow oxygen via a nonrebreather mask is usually used, but for patients who are noted to desaturate (eg, beyond 90%), breaths delivered via 100% oxygen bag-valve-mask (BVM) may be required.

To minimize the risk of gastric aspiration, the Sellick maneuver (firm pressure over the thyroid cartilage) may be initiated as soon as positive-pressure ventilation is started (eg, during pretreatment if the patient is not able to maintain airway reflexes) and should be continued until inflation of the tracheal cuff of the endotracheal tube in the trachea. Note, however, that recent evidence questions the benefit of this modality. [9, 10]

Firm backward, upward, and rightward pressure (BURP) on the patient's thyroid cartilage can improve the Cormack/Lehane view up to one full grade. Typically, the assistant performing the Sellick maneuver can assist, resulting in a combined Sellick-BURP maneuver.

A No. 3 Macintosh or No. 3 Miller blade is generally sufficient for most patients, but a No. 4 blade (ie, next larger size) may be required in some adults. Note, some clinicians routinely use a No. 4 Macintosh blade, as it can be used in substitution of a Miller without switching blades.

A recent study by Brown III et al shows an overall improvement in glottic exposure with video compared to direct laryngoscopy. [11] More importantly, 25% of patients undergoing direct laryngoscopy displayed a poor glottic view; the use of video laryngoscopy improved this to a good view in nearly 80% of these patients.

Provide appropriate analgesia and sedation for patient comfort after RSI is successfully completed, especially if the patient is chemically paralyzed with a longer-acting paralytic agent (eg, vecuronium).

RSI is a procedure for patients with a critical disease or traumatic process. The selection of technique and specific agents is determined individually for each patient and situation. This article focuses on straightforward RSI for adults. Different techniques, equipment, and agents may be used for complex or rescue situations.

Accurate confirmation of correct placement of the tube in the trachea is essential. Direct visualization of the tube was previously the criterion standard for confirming placement; however, this method can be fraught with human error. The current criterion standard is end-tidal carbon dioxide detection, using either a calorimetric capnometer that changes color from purple to yellow with CO_2 exposure or a quantitative capnometer that measures CO_2 levels and can display a waveform. The yellow color change should occur rapidly within 1-2 breaths, and esophageal or supraglottic placement should be assumed if the color change is less rapid or does not occur at all. Important to note is that color change with a calorimetric capnometer can occur with esophageal placement and can be misleading. For this reason, a capnography with continuous waveforms is the preferred modality. Color change may not be reliable in cases of prolonged cardiac arrest. Clinical parameters such as pulse oximetry readings or tube condensation may be nonspecific and misleading. A canine study by Kelly and colleagues demonstrated tube condensation in up to 83% of esophageal intubations. [12]

The step of preoxygenation maximizes hemoglobin and plasma oxygen saturation and creates an oxygen reservoir in the lungs by replacing nitrogen at the alveolar level and supersaturating the blood with oxygen (nitrogen washout). This oxygen reservoir in the lungs can eliminate the need for BVM ventilation for most patients undergoing RSI during the iatrogenically created period of apnea. Preoxygenation is accomplished by delivering 100% oxygen at high flow given to a spontaneously breathing patient through a nonrebreather mask for 3 minutes without "bagging" the patient.

Studies such as the one by Barker and colleagues have shown that 8 vital capacity breaths over 60 seconds results in the same degree of preoxygenation as the standard 3 minutes of tidal volume breathing of 100% oxygen by mask. This technique may be used as an alternate to the traditional 3-minute tidal volume technique. Comorbidities such as the presence of a hypermetabolic state, obesity, or a primary respiratory problem (eg, congestive heart failure, acute respiratory distress syndrome, pneumonia) cause patients to desaturate rapidly despite attempts at adequate preoxygenation.

A patient who is hypoxemic during attempts at intubation should undergo positive pressure ventilation with a BVM to raise PaO_2 levels. Consider applying cricoid pressure.

Guidelines

Guidelines on intubation and extubation in the ICU were released in January 2019 by the French Society of Anaesthesia and Intensive Care Medicine (SFAR) and the French-Speaking Intensive Care Society (SRLF). [13]

Complicated ICU intubation

Consider all patients admitted to ICUs at risk of complicated intubation.

In order to reduce the risk of a complicated intubation, use careful preparation and take steps to maintain oxygenation and cardiovascular stability, which will help anticipate and prevent respiratory and hemodynamic complications.

Differentiate risk factors for a complicated intubation from predictive factors of a difficult intubation.

An additional recommendation for pediatric patients is to consider all patients to be at risk for complicated intubation.

Equipment for difficult intubation

To confirm the correct position of the endotracheal tube, supraglottic device, or direct approach through the trachea, capnographic control is necessary.

A difficult airway trolley and a bronchoscope (conventional or single use) are needed for emergent management of a difficult intubation.

To improve the success rate of endotracheal intubation, use metal blades for direct laryngoscopy.

Videolaryngoscopes should be used initially or after failure of direct laryngoscopy in order to limit intubation failures.

For oxygenation and to facilitate intubation under bronchoscopic control, use supraglottic devices.

For pediatric patients, laryngoscopic blades used should be suited to the habits of the practitioners (eg, Miller straight blade, Macintosh curved blade). Exposition failure warrants a change in the type of blade used. Additionally, oral intubation is preferred, as are cuffed tubes to limit reintubations due to leakage.

Drugs in difficult intubation

Hypnotic agents (eg, etomidate, ketamine, propofol) facilitate rapid sequence induction. The choice of agent depends on patient history and clinical situation.

Succinylcholine can be used in critically ill patients to facilitate tracheal intubation during rapid sequence induction. If succinylcholine is contraindicated, rocuronium dosed above 0.9

mg/kg (1-1.2 mg/kg) is an alternative. Note that sugammadex should be available for possible emergent use if rocuronium is used.

An additional recommendation for pediatric patients is the use of atropine before intubation and during induction for those older than 28 days up to age 8 years, particularly in children with septic shock or hypovolemia or if suxamethonium is used.

Protocols and algorithms in difficult intubation

Noninvasive ventilation should be used for preoxygenation of hypoxemic patients. For patients who are not severely hypoxemic, high-flow nasal oxygen can be used.

Include a respiratory component in the intubation protocol in order to decrease respiratory complications. Integrate a postintubation recruitment maneuver into the respiratory component for hypoxemic patients.

After intubation of hypoxemic patients, a positive end-expiratory pressure of at least 5 cm water is recommended.

A cardiovascular component to the protocol to address fluid challenges and early administration of amines to decrease cardiovascular complications is recommended.

Extubation prerequisites

To decrease the risk of extubation failure, a spontaneous breathing trial is recommended before any extubation in ICU patients ventilated for greater than 48 hours.

However, the spontaneous breathing trial is not adequate as a lone method for detecting extubation failure risk. As such, it is suggested that screening be conducted for other risk factors, such as excessive tracheobronchial secretions, swallowing disorders, ineffective cough, and altered consciousness.

Extubation failure

To predict the occurrence of laryngeal edema, perform a cuff leak test before extubation. If the patient has at least one risk factor for inspiratory stridor, the cuff leak test is recommended before extubation to reduce the risk of failure related to laryngeal edema.

During mechanical ventilation, it is recommended to institute measures to prevent and treat laryngeal pathology.

In the event the leak volume is low or zero, corticosteroids can be prescribed to help prevent extubation failure related to laryngeal edema. If corticosteroid therapy is selected, the recommendation is to start it at least 6 hours before extubation.

For pediatric patients, corticosteroid therapy should be started 24 hours pre-extubation in order to be effective.

Extubation and respiratory therapy

Suggested prophylactic measures include high-flow oxygen therapy via a nasal cannula (1) after cardiothoracic surgery, (2) after extubation in hypoxemic patients, and (3) in patients at low risk of reintubation. Additionally, noninvasive ventilation is suggested as a prophylactic measure in patients at high-risk of reintubation, especially hypercapnic patients.

Noninvasive ventilation is suggested as a therapeutic measure to treat acute postoperative respiratory failure, especially after lung resection or abdominal surgery.

Noninvasive ventilation is not suggested as treatment for acute respiratory failure after extubation in the ICU unless the patient has underlying COPD or if blatant cardiogenic pulmonary edema is present.

For pediatric patients, noninvasive ventilation is not recommended in low-risk patients.

Physiotherapist treatment is likely required before and after endotracheal extubation following mechanical ventilation for more than 48 hours to reduce weaning duration and risk of extubation failure. A physiotherapist also should probably attend endotracheal extubation; this may help limit immediate complications (eg, bronchial obstruction in patients at high risk for extubation failure).

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