Chapter 3

Indications for Endotracheal Intubation

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Additional information is available at the end of the chapter

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Abstract

Endotracheal intubation may be required when respiratory distress or airway integrity cannot be achieved or maintained for any reason. It should be considered that intubation may be required when evaluating the patient, and that in the long term, airway protection will be needed or that the problem cannot be solved by noninvasive ventilation via airway aids and devices. Identifying the problem causing the patient's respiratory failure helps in making the decision to intubate. In fact, the clinician must be fast and self-confident when deciding on intubation. It is difficult to decide in some complex situations. It is very important to evaluate the patient, according to clinical status, age, and comorbidity, and to determine urgent intubation need. In non-diagnostic cases, further research is needed to investigate the causes of the condition such as hypoxia/hypercapnia resulting in patient respiratory distress. Different voice tone, swallowing difficulties, coughing attacks, stridor, dyspnea can be a sign of upper airway obstruction. Arterial blood gas analysis will facilitate our decision to make intubation. Noninvasive pulse oximetry and continuous capnography values may also be a guide, but the most important thing is that delayed intubation decision may bring life-threatening situations.

Keywords: intubation, endotracheal, indications, airway problems, rapid sequence intubation, nasotracheal intubation

1. Introduction

Endotracheal intubation is the placement of a tube into the trachea, either orally or nasally for airway management. Endotracheal tube forms an open passage in the upper airways. To be able to ventilate the lungs, the air must be free to enter and exit the lungs. The patient is connected to the mechanical ventilator to provide continuous respiration with an endotracheal

tube. The utilized tube is a flexible plastic tube which is called endotracheal tube placed on the trachea and has a cuff part that can be inflated with air to prevent airway leakage. To facilitate the placement of the endotracheal tube, general anesthesia induction is applied to patients who will be operated and have sufficient fasting time. In emergency cases, endotracheal intubation is performed with various stages and procedures. Sometimes, patients are intubated at the scene or in the emergency room of the hospital. Because the patients' clinical status cannot be fully evaluated during the intubation procedure at the scene, sometimes drugs cannot be given [1, 2]. Deep sedation, rapid sequence intubation (RSI), is performed according to the patient's clinical condition in the hospital and also in patients with Glasgow coma scale (GCS) 4, and, below, the procedures are done without medication. Intubation without medication to trauma patients with high GCS (above 4) is not safe, resulting in intracranial pressure increase, vomiting, esophageal intubation, and aspiration risk. Special procedures are required in pediatric patients and newborns, and their indications for endotracheal intubation can show variability.

Airway management is one of the most important skills of the physician; failure to provide required airflow can cause death or sequelae of the patient, especially in emergency conditions. The control of circulation and intubation, without losing time, in cardiac and respiratory arrest, saves the patient from hypoxia, improving quality of life in the long term [3–6]. If the difficulties in patient airway management are predictable (forced airway, lack of mask ventilation), it is important to take precautions and to ensure that adequate instruments and equipment are available [7]. Studies have shown that the likelihood of the rescue of the patient's life increases if life support is initiated within the first 4–8 minutes [8]. It is known that the treatment of nasal oxygen moistened with high flow prevents hypoxia and desaturation, while intubation is performed under emergency conditions [9, 10]. Its use is becoming widespread in the intensive care unit because of its reliability, ease of use, accessibility, and reduction of complication rate [11]. Although high-flow nasal oxygen therapy is sometimes considered an alternative to intubation, it should be remembered that these patients may need noninvasive ventilation (NIV) and intubation in the long term [12]. Although hypoxemia is a component of respiratory failure, tissue hypoxia and lactic acidosis are frequently encountered as a result of ventilation and perfusion imbalance as well as gas exchange dysfunction. As a result, complex and difficult-to-treat metabolic disorders and sometimes mixed decompensated respiratory and metabolic disorders can develop, bringing the clinical situation of a patient to an irreversible state, resulting often in organ failure [13, 14].

Endotracheal intubation using rapid sequence intubation (RSI) is the cornerstone of emergency airway management. RSI is a safe method in patients with a full stomach but is not beneficial in apneic unconscious patients (GCS <4). A patient suspected of difficult respiratory tract should be approached carefully for RSI. If a difficulty is expected, an awake technique (e.g., fiber optic intubation) is recommended. Alternatively, an anesthesiologist may be called to help secure the airway of a patient having intubation difficulty. It may be beneficial to use evidence-based and scientific techniques when deciding on intubation in emergency situations, but these procedures should be a standard practice in that clinic [6, 15, 16].

It is sometimes difficult to determine the intubation decision and its indications while evaluating a patient. Clinical experience is required to identify signs of respiratory failure and determine

whether it will be reversible in the long term [17, 18]. Before the patient is intubated or until the intubation decision is made, mask ventilation is made, or high-flow nasal oxygen is used [19, 20]. High-flow oxygen therapy helps in difficult airway conditions such as in obesity or in the difficulty of mask ventilation [21, 22].

The fact that the procedure to be performed after the endotracheal intubation decision is invasive, requiring multiple medications and not waking up of the patient due to the sedatives for hours and hypotension risk are the disadvantages of endotracheal intubation [23]. In the opposite case, the patient's clinical condition that can worsen is unpredictable. If tardy for endotracheal intubation, hypercapnia, hypoxia, acidosis, and arrest as a result of circulation collapse in cases where it cannot be compensated take place. For this reason, the patient's clinic, existing diseases, laboratory tests, and blood gas results should be evaluated together, resulting in a better decision. Although evaluation is not possible in case of emergency, the simple imaging methods and ultrasonography can help physicians. In conscious patients with spontaneous breathing and hypoxia without hypercarbia in room air, improvement of saturation after oxygen treatment with 2–4 L/min nasal/mask and reaching a normal value of spontaneous respiration after noninvasive ventilation treatment of 1–2 hours may be the clinical signs that the patient will benefit from noninvasive ventilation. Patients requiring intubation have at least one of the following five indications:

I. Inability to keep airway open (dislocation of the tongue toward the pharynx, obstruction of the upper respiratory tract, obstructive sleep apnea, burns).

II. Failure to protect airway from aspiration (oral and nasal bleeding in trauma patients, secretion, fullness of stomach, gastroesophageal reflux).

III. Ventilation failure (abnormalities in airway anatomy: short neck, wide mandible, the upper jaw being in front, mandible being behind, small mouth, obesity) and difficult mask ventilation may be accompanied with difficult intubation.

IV. Insufficiency in oxygenation (cyanosis, insufficiency of chest wall movements, presence of obstruction findings in lower respiratory tracts in auscultation, gradual decrease of saturation, inadequacy of spirometric and expiratory measurements).

V. Possible conditions that may lead to respiratory failure (hemodynamic changes as a result of progressive hypoxemia and hypercarbia such as tachycardia-hypertension-arrhythmia).

Tracheal intubation is generally used in patients unconscious or with respiratory failure to keep the airway open and to ensure ventilation of the patient. Endotracheal intubation is also performed in cases where general anesthesia will be applied for the operation. Endotracheal intubation is performed in various situations such as failure of noninvasive ventilation in intensive care patients [24, 25].

Acute respiratory failure is one of the most common events in the intensive care unit [26]. Airway management in intensive care unit is often more problematic than in operating theater. In general, the lack of physiological reserves is observed after induction of anesthesia during airway intervention, and some complications are seen after intubation. The person

who manages the difficult airway must recognize the patients who will face the airway problem, must plan to deal with the air, review the algorithms, and use the right agent for induction. Also, the emergency airway kit should be pulled to the bedside, and the end-tidal carbon dioxide values should be monitored for each patient [27, 28]. Although studies have emphasized in recent years that there are changes in the treatment of these patients after high-flow oxygen therapy, most of these patients need invasive mechanical ventilation and tracheal intubation [29]. When planning the treatment of these patients in the long term, the patient comfort should be improved by avoiding complications related to the endotracheal tube by opening percutaneous/surgical tracheostomy without delay [30].

The most common complication of intubation at the bedside is life-threatening hypoxemia [29]. Despite regular preoxygenation, a desaturation can develop. For this reason, various strategies have been developed for the preoxygenation period when the patient is intubated [19]. The intubation stage can be classified into two steps. The first step is the preoxygenation stage, and the second step is the laryngoscopy stage which requires induction [31]. NIV improves preoxygenation and limits desaturation, but its disadvantage is that oxygen flow is separated from the patient during laryngoscopy. In patients with hypoxic respiratory failure, high-flow oxygen is generally used, and uninterrupted oxygen supply is its advantage during intubation [32, 33]. Apneic oxygenation seems to be superior when compared with high-flow oxygen and mask ventilation [34]. It should be noted that in situations where high-flow oxygen is used, the patient's head must be positioned allowing an open airway (jaw thrust), and oxygen up to 60 liters per minute, not less than 15 liters, must be provided. After laryngoscopy, it is necessary to avoid hyperoxia and its complications and decrease oxygen flow [9, 35].

Endotracheal intubation indications can be summarized as follows [6, 24, 28, 29, 36, 37]:

- Airway problems: external pressures on the airway, vocal cord paralysis, tumor, infection, and laryngospasm.
- Respiratory deficiencies: patients with poor general condition, hypoxemic/hypercarbic respiratory insufficiency (respiratory rate less than 8 or more than 30 per minute, PO_2 in blood gas less than 55 mmHg, PCO_2 above 55 mmHg, and non-compensated acidosis-alkalosis).
- Inadequate circulation: cardiac arrest in hypothermic and hypotensive cases.
- Muscle and central nervous system problems and metabolic disorders: diseases of the muscles of respiratory system and auxiliary muscle disorders allowing respiratory failure and central apnea syndromes (Guillain-Barre, amyotrophic lateral sclerosis, myasthenia gravis, muscular dystrophy, acid-maltase insufficiency, phrenic nerve injury, botulism, polymyositis, spinal cord injury, electrolyte imbalance, hypophosphatemia, hypomagnesaemia, hypocalcemia, brainstem infarction, etc.).
- For the purpose of examination and transfer of patients: MRI scan under sedation, interventional radiology, endoscopic procedures.
- If urgent aggressive sedation is required to protect the patient: to avoid postoperative intracranial pressure increase, to provide cerebral protection with controlled hypotension and

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sedation in cerebral blood, to control recurrent attacks of seizures and contractions (status epilepticus and tetanus).

- In head and neck surgery: in case the airway remains in the surgical team site and the mask ventilation is not possible.
- The patient positions that make it difficult to control the airway: in the positions of the face down sit, side down, upside down, and lithotomy.
- Thoracic and abdominal interventions: intrathoracic interventions and abdominal interventions require respiratory control and muscle relaxation. Also, interventions such as cystoscopy and hemorrhoidectomy, which may develop the reflex bradycardia, vasospasm, and laryngospasm through the vagal stimulation.
- Patients at risk of aspiration of the stomach contents, blood, mucus, or secretion.
- Rare cases requiring airway protection such as Stevens-Johnson syndrome and toxic epidermal necrolysis.

2. Indications of endotracheal intubation under emergency conditions

In emergency conditions, equipment, technical skills, and quickness are very important when deciding on intubation indications at the bedside. Endotracheal intubation can be performed under emergency conditions in the following circumstances [6, 7, 25, 28, 29]:

- Apnea, respiratory failure.
- Airway obstruction: variable-level obstruction in the upper and lower airways.
- Inadequate oxygenation (hypoxia), inadequate ventilation (hypercarbia).
- Disruption of the airway reflex.
- In case the patient is hemodynamically unstable.
- The consciousness changes as far as being unable to protect airway (GCS <8).
- Cardiopulmonary resuscitation.
- Flail chest/pulmonary contusion, in case the breathing effort puts the patient's life in danger. In case the treatment of patient is not successful without intubation.

In urgent conditions, nasal, oral, awake, fiber optic, and rigid intubation and, if necessary, intubation through the laryngeal tube can be technically applied, and the choice of method is decided according to the patient's clinic.

When endotracheal intubation is performed under emergency conditions, it may be beneficial to consider the following conditions:

a. Equipment: intravenous (IV) catheter, laryngoscope, and blade, endotracheal tube in appropriate size, injector to inflate cuff, Magill forceps, nasal/oral airway, aspiration catheter, tube changer, guide wire, nasogastric tube, tube fixation.

b. Drugs: atropine, midazolam, lidocaine (1–4%), lidocaine gel, propofol, suxamethonium, thiopental, non-depolarizing muscle relaxants, morphine/fentanyl.

c. Patient history and airway evaluation: difficult airway assessment, risk of aspiration of gastric contents.

d. Aspiration catheter in various sizes should be kept ready.

e. The oxygen source must be switched on and tied; the ambu, anesthesia device, and mechanical ventilator must be in working position, and its circuit must be plugged in.

f. Patient position: the use of a small cushion together with the head extension brings the oral, pharyngeal, and laryngeal axis to the same alignment. If cervical trauma is present, the head is fixed in neutral position, and endotracheal intubation is performed.

Comparison of intubation performed under emergency conditions and intubation performed under elective conditions.

Emergency	Elective
Difficult intubation may not be predictable.	Predict airway difficulty.
There may not be enough time for preparation.	Prepare equipment and assistants for intubation.
It can be difficult to reach experienced personnel.	Confirm availability of help in an emergency.
There may be a risk of full stomach/aspiration.	Safely perform the intubation.
Patient status may not be stable.	Patient is more stable than emergency situations.

Cases where the NIV is contraindicated (coma, postoperative agitation, delirium, noncooperative patients, patients with gastric distention risk) may be in the semi-urgent or urgent category [31, 32]. It is decided according to the deterioration of the clinical course of the patient whose blood gas is followed and having spontaneous respiration.

3. Endotracheal intubation management

After the administration of an induction agent and neuromuscular blocker with rapid effect and high potency to provide adequate mask ventilation, direct laryngoscopy and intubation are performed. Suxamethonium is often preferred because it provides fast and ideal intubation conditions. Non-depolarizing muscle relaxants such as rocuronium, atracurium, and vecuronium can also be used because they provide acceptable intubation conditions. An

important point to consider is that if sufficient mask ventilation is provided, muscle relaxants can be given. Preoxygenation applied to patients gains time for intubation. Patients with a high-risk group (coronary artery disease, cerebral aneurysm) may be given additional pharmacological agents to provide hemodynamic stability. Different techniques, equipment, and agents can be used. Insertion of endotracheal tube into the trachea is essential. Anesthetic agents are not needed in patients under GCS 4 and with cardiac arrest [18, 25].

Generally, Macintosh and Miller blades are used for a direct laryngoscopy. The Macintosh blade is inserted into the gap called vallecula between the tongue base and the pharyngeal surface of the epiglottis. It provides a good passage for minimal epiglottic trauma and endotracheal tube. Miller blade extends to the laryngeal surface area of the epiglottis, making it easier to open the glottis but narrowing the oropharyngeal angle of view. There should be a certain distance between the operator's eye and the patient's airway. A close look at the patient will narrow the angle of vision. The laryngoscope's blade is moved from left to right in the airway by providing adequate mouth opening without damaging the lips and tongue. The blade should never be leaning on the upper jaw and upper incisors, and intubation should not be done by leaning on there. Pressing out of the cricoid cartilage is beneficial for better visualization of the glottis gap [4, 28].

The endotracheal intubation tube is held in the right hand and moved from the right of the patient's mouth toward the vocal cords. If there is a problem of routing the tube, it may be possible to orient the tube anteriorly using a probe. The cuff of the endotracheal tube is fixed after passing the vocal cords and is inflated with an air of 3–4 mL.

3.1. Rapid sequence intubation (RSI) indications

Adequate time and equipment often may not be available for endotracheal intubation. In some cases, it may be decided to intubate very quickly. For example, in various clinical situations that threaten the patient's life, time loss is more dangerous than the risks associated with rapid sequence intubation. In general, rapid sequence intubation is applied in situations indicated below [15, 38]:

a. The presence of all kinds of obstacles blocking the airway:

- Upper respiratory tract edema, as in anaphylaxis or infection
- Face or neck trauma with oropharyngeal bleeding or hematoma
- Obesity, short neck, short jaw, airway deformity

b. Loss of consciousness and airway reflex:

- Failure to protect airway against aspiration
- Loss of consciousness and concomitant vomiting, increased secretion, or risk of blood aspiration

c. Lack of intubation:

- Failure to protect the airway
- Long-term breathing effort resulting in fatigue or failure in respiratory muscles, as in severe chronic obstructive pulmonary disease

d. Failure of oxygenation (pulmonary shunt):

- If the airway is not protected or intubation fails
- Diffuse pulmonary edema, diffuse pneumonia, or emphysema
- Acute respiratory distress syndrome (ARDS), pulmonary embolism
- Cyanide toxicity, carbon monoxide, local anesthetic toxicity, methemoglobinemia

e. Expected clinical course or deterioration (e.g., need for status epilepticus control, except for tests and procedures):

- Patient with a life-threatening injury (such as a chest tube), or with a nonsurgical trauma, who needs urgent computerized tomography
- Hematoma in the enlarged neck region
- Septic shock
- Cerebral hemorrhages requiring close control of blood pressure
- Loss of airway opening as a result of spinal fracture and edema in the cervical region

3.2. General overview of intubation indications

I. The presence of depressive mental disorders:

a. Patients with GCS 8 and lower head trauma, having indications for intubation:

b. Associated with increased intracranial pressure, associated with surgical situation

c. In the presence of hypoxemia and hypercarbia, which increases morbidity and mortality

d. For airway control within 24–48 hours following overdose drug intake

II. Upper airway edema:

a. Inhalation damage: it is among the life-threatening conditions. The inhalation injury without skin burns has a mortality rate of around 10%; if the skin is burned, the mortality is doubled. Fluid resuscitation is needed and the risk of pneumonia is increased. There is an indication of early intubation because the upper airways are precarious [39]. This is because it is difficult to make a clinical decision about inhalation injury. The burn story

in the enclosed area, the carboxyhemoglobin (COHb) value of the patient at the time of admission to hospital, and the presence of coated phlegm are important. The accidents by oxygen therapy that is applied at home in diseases such as chronic obstructive pulmonary may cause inhalation damage, and it can be understood from the story of the patient [40]. Computed tomography (CT) is meaningful to understand the degree of inhalation damage and to see the anatomic changes, and it is valuable to calculate the V/Q (ventilation/perfusion) ratio to evaluate the gas change [41]. Tracheobronchial protease inhibitors in plasma and alveolar fluid have also been investigated in this regard and are valuable in terms of understanding the degree of damage [42]. Although observing the degree of damage in the fiber optic bronchoscope is useful, previous studies have shown that it has no correlation with ARDS [43]. In conclusion, if the inhalational damage is at the upper level of the glottis, the physical findings are more important to decide on intubation (participation of auxiliary breathing muscles to respiration, audible respiratory sounds). But if there is a damage at the lower level of the glottis, it is necessary to assess the thickness of the bronchial wall (BWT) in the COHb level and computed tomography [44, 45]. In cases of shock, inadequate oxygenation, or coma, it is difficult to make an early intubation decision because the intubation tube causes edema around the glottis [39].

b. Ludwig's angina: it is an aggressive cellulitis that affects submandibular and sublingual tissue areas, placed on the mouth base and mylohyoid diaphragm as bilateral. Endotracheal intubation is required because it will be associated with respiratory distress.

c. Epiglottitis: it is a rare but life-threatening case. It is seen in children between 1 and 6 years of age. The cause is *Haemophilus influenzae* type B. Unlike viral croup, there is no cough or very few. Fever is very high and toxic appearance is present. The child sits still to open the airways, the mouth is open and secretions flow. There is a lack of appetite for food because it is difficult to swallow. Oral examination with tongue pushers is very dangerous and can lead to complete obstruction of the respiratory tract and death. Minutes are important even in this disease, and the patient should be taken to the intensive care unit immediately and intubated under general anesthesia.

d. Bacterial tracheitis: it is a rare but dangerous case. Clinically, it resembles heavy viral croup. However, there is a high fever and a toxic appearance. The cause is usually *Staphylococcus aureus* or *Haemophilus influenzae*. In tracheal intubation, dense and viscous secretions are observed.

III. In the case of chronic obstructive pulmonary disease, asthma, restrictive lung disease, tumors, granulomatous diseases, and pulmonary retention of systemic diseases, the patient may need to be intubated, decided as a result of the laboratory evaluation.

IV. Conditions requiring rapid sequence intubation (RSI):

a. Patients with a full stomach: patients are accepted to be full in the case of feeding with clear liquids up to 4 hours before intubation and feeding with solid foods up to 8 hours. In cases where intra-abdominal pressure increases (pregnancy, ascites), gastrointestinal passages out of action (ileus) and the patient's story cannot be reached.

b. Loss of sympathetic stimulation: rapid sequence intubation need may occur in cases where gastric emptying time is prolonged, as in gastric dilation and diabetic patients.

V. Persistent hypotension that needs vasopressor support:

- Cardiac dysfunction, hypovolemia, sepsis

VI. Organ failure:

- Renal failure, hepatic failure

3.3. Deciding on endotracheal intubation in pediatric patients

Inadequate airway management can cause cessation of attempts to save lives and even cause cardiac arrest and death. Various airway equipments have been developed to provide adequate ventilation and oxygenation so far [46]. Although supraglottic airway devices developed for this purpose are available, they should be used cautiously because of the possibility of displacement, not suitability for patients with full stomach, and the possibility of increasing airway edema [33, 47]. If the patient is unable to breathe through the mask, oxygenation is inadequate, or in case of bleeding, edema or big foreign material in the upper airway, the patient should be intubated immediately [46, 48]. As in adult patients, the process of nasal preoxygenation with high flow provides the advantage of reducing inspiratory resistance, filling the nasopharyngeal dead area, reducing the metabolic work caused by gas exchange (conditioning), and supporting respiration through improving airway conductance and clearance. Lower levels of positive airway pressure are applied in children compared to adults. For newborns, 2 l/min is high-flow rate, whereas for older children, 4–6 lt/min is accepted as high [49].

3.3.1. Indications of endotracheal intubation in pediatric patients

If the child trauma patient is awaking, talking, or crying, being able to maintain breathing, he will be treated with supportive therapy as a conservative (oxygen supply with a facial mask or nasal cannula). If intubation is decided, the safest and most appropriate technique is applied according to the condition of the patient (traumatic injury, cord damage, the special anatomy of pediatric patients, and experience of the practitioner) [50]. Studies have shown that respiratory arrest is more likely in adults than in children and usually mediated by extrinsic factors [51]. The need for emergency intubation, number of recurrent interventions, tube diameter, and existing cardiovascular disease brings some complications such as desaturation, hypotension, and bradycardia. If we review intubation indications in general in children [50, 52–54]:

- Traumatic brain injury
- Hemorrhagic shock
- Respiratory failure due to pneumonia
- Muscle and metabolic diseases
- Foreign material in airways, upper airway obstruction
- Elective surgical procedure
- Pulmonary secretion control, therapeutic hyperventilation

- Seizure
- Cardiac disease
- Drug intoxication, poisoning
- Acute laryngospasm, epiglottitis, inspiratory stridor

3.3.2. Indications of endotracheal intubation in newborns

Considering intubation for the newborn patient group to be difficult, it is also crucial to have full preparation; aspirator and ancillary equipment should be kept ready [55]. Intubation indications of a newborn can be classified as follows:

- Apnea.
- Bradycardia (pulse below 100). The most important cause of bradycardia is hypoxia.
- Stubborn cyanosis. Premature babies can be intubated electively.
- In cases where tracheal aspiration is required (baby painted with meconium).
- Inadequate positive-pressure ventilation applied through airway and mask.
- Extended NIV. Respiratory distress syndrome: lack of surfactant and structurally lower gas exchange area and excessive respiratory activity.
- Need for application of chest pressure (cardiac arrest). Endotracheal drug intake.
- Diaphragm hernia.

3.3.3. Rapid sequence intubation (RSI) protocol in pediatric patients

Rapid sequence intubation (RSI) is a method in which a number of neuromuscular blockers and sedative agents are used to make intubation safer, easier, faster, and less traumatic. It is a safe way for emergency service pediatricians experienced on the advanced airway management and sedative paralytic dosage [51].

RSI has 7 P rule (preparation, preoxygenation, premedication, paralysis with sedation, protection of the airway, passage of the tube and confirmation, and post-intubation management).

The success of the method depends on the following criteria:

1. To eliminate protective airway reflexes and spontaneous respiration with sedation and paralysis.
2. The most important determinant of the choice of sedative and paralytic agent is the response of the patient to the drug and the effects of the drug on the patient. Diseases such as asthma and tendency to hypotension should be questioned in particular.
3. Systematic preparation for the implementation of the method is necessary to make the intubation faster and safer.
4. Preoxygenation with 100% oxygen, two intravenous vascular access.

5. Atropine 0.02 mg/kg IV, lidocaine 1.0 mg/kg IV, etomidate 0.3 mg/kg IV, or thiopental 4.0 mg/kg IV.
6. Sellick's maneuver application: if Sellick's maneuver is performed while the patient is vomiting, there is a risk of esophageal perforation; therefore, the head should be placed down in case of vomiting.
7. Succinylcholine 1.0 mg/kg IV or rocuronium 0.6–1.0 mg/kg IV.
8. Intubation after 1 minute.

In children, especially infants, vagal response to the laryngoscopy and tracheal intubation is much more than in adults [51]. Due to this medication, bradycardia and even an asystole in children who were given succinylcholine were reported in the literature [56].

A common recommendation from the American pediatric association is that rapid sequence intubation is done with atropine in the following situations [57]:

- All children under 1 year old
- Children under the age of 5 who are given succinylcholine
- Patients developing bradycardia during intubation

The use of atropine in rapid sequence intubation is still controversial. Following atropine, sinus tachycardia, mydriasis, xerostomia, a decrease in the amount of urine, and hyperthermia can be seen. In addition to the side effects, when used in premedication, salivation and secretion reduction effect is not fast, so it is important to be careful when using it and to determine its indications well. Atropine makes it difficult for the patient to be evaluated in terms of neurologic and cardiological aspects, and its effect on cardiac muscle may last for several hours. Since small doses have a bradycardia-initiating effect, the smallest dose should be at least 0.1 mg. The recommended dose is 0.02 mg/kg [58, 59]. Succinylcholine is contraindicated in children with muscular dystrophy because it forms the rhabdomyolysis and the hyperkalemia that threatens life. It should be avoided in patients with a risk of malignant hyperthermia, large body burn, multi-trauma, spinal cord injury, intracranial injury, brain tumors, and penetrating eye traumas. Rocuronium is an agent that offers better intubation than succinylcholine. The preferred dose is 1 mg/kg.

Etomidate is an imidazole derivative and acts as a well-known sedative agent. Its effect begins immediately, providing hemodynamic stable intubation. The effect on adrenal cortex and mechanisms of action of myoclonic jerk side effect in induction were investigated. Patients who have undergone a convulsion after etomidate have previously been reported to have convulsion story. The recommended dose is 0.3 mg/kg. Thiopental sodium, an ultrashort acting barbiturate, should be used with caution because of its known systolic blood pressure-lowering effect, although anticonvulsive properties are preferred. Its dosage is 3–5 mg/kg, but not recommended for children. Ketamine is a sedative and hypnotic agent. It is favorable in terms of protecting the upper airway reflexes, but not recommended in cases where it will increase intracranial pressure. It has an anticonvulsive and a bronchodilator effect. The recommended dose is 1–2 mg/kg. Propofol may be preferred in children under 3 years of age,

which may cause hypotension, and the recommended dose is 1.5 mg/kg. The recommended dose of midazolam which has anxiolytic, sedative, and anticonvulsant properties is 0.3 mg/kg. It should not be forgotten that it may cause respiratory depression because it is slightly more than the sedation dose. It is cheap, is easy to access, and is a drug that clinicians are accustomed to [60].

After endotracheal intubation, pediatric patients should be treated with extra caution. A delicate balance should be established in drug selection, dosage adjustment, and mechanical ventilator settings. Children are at risk for acute hypoxemia; although dead-space ventilation is similar to adults, oxygen consumption is much higher [61].

Because preoxygenation is not sufficient during intubation, high-flow oxygen therapy with a nasal cannula, that is, apneic oxygenation, can enable us to pass the apneic period, without hypoxemia [49]. Intubation in one attempt, especially with video laryngoscopes, minimizes the risk of vagal stimulation due to hypoxemia, hypercarbia, and multiple attempts. Univariate analysis of studies has shown that the use of neuromuscular blockage for intubation reduces complications [62].

Intensive care unit and emergency tracheal intubation cases of 3 years, involving 3366 pediatric patients, were investigated; it was observed that fentanyl (64%) and midazolam (58%) as induction agents and rocuronium (64%) and vecuronium (20%) as muscle relaxants had been used, and succinylcholine (0.7%) and etomidate (1.6%) had been less preferred. It was observed that vagolytic agents (51% of infants and 28% of babies over 1 year old) and ketamine (27%) had been preferred in unstability hemodynamic conditions (39%). However, it was found that the use of ketamine was not associated with low prevalence of hypotension [63].

3.4. Intubation indications in intensive care and rapid decision-making

Intensive care patients may be intubated more difficult than those in the operating room. Previous studies have shown that saturations decrease faster in respiratory failure and they remain under the risk of hypoxemia. Intubation timing should be optimal to avoid desaturation. If patients with hypoxic respiratory failure have spontaneous breathing, it is important when to switch to invasive ventilation. On this subject, some of the criteria related to intensive care patients with respiratory complaints were introduced in the study of Florali.

Criteria used in the study of Florali [9]:

1. The presence of evidence for persistent or worsening respiratory failure: respiration at 40 F/min, situations in which respiratory and tracheal secretion increase, and acidosis (below pH 7.35), situations in which saturation does not exceed 90% for 5 minutes despite oxygen therapy
2. Systolic blood pressure under 90 mmHg or mean arterial pressure less than 65 mmHg or the need for vasopressors
3. Deterioration of neurological condition and GCS under 12

Preoxygenation is a common and time-saving approach to prevent desaturation in patients who are treated in intensive care unit when intubation is done. Special protocols have been

developed to standardize the treatment of preoxygenation. The number 10 scalar Montpellier protocol or its modified form, number 8 scalar, is used for preoxygenation [64]. Preoxygenation is known to be used in rapid sequence intubation.

Preoxygenation application routes:

a. Using 10/5 cm H_2O 100% O_2 with nasal intermittent positive-pressure ventilation.

b. Using 40 L/min 100% O_2 with a high-flow nasal cannula.

c. Applying non-rebreather mask (non-accumulating CO_2) over 15 L/min, which permits maximum oxygen flow, also known as flush flow rate.

d. If rapid intravenous administration of 500 ml of fluids per hour is not clinically contraindicated, sedative, hypnotic agent and muscle relaxant medication are followed by intubation. Intubation made by two personnel who are skilled must be reviewed in terms of RSI. Capnography is used for intubation verification [64].

3.5. Indications of nasotracheal intubation

Nasotracheal intubation is technically similar to intubation but difficult to administer. Firstly, a vasoconstrictor is dripped through an open nostril, and then the tube developed for nasal intubation is driven forward. While the tube Magill is seen in the oral cavity in the laryngoscope being directed toward the vocal cords with the help of Magill forceps, an assistant staff helps to drive the tube forward. Since the tube may curl and cause trauma to the nose, it is necessary to use the spiral tube and select the largest suitable tube diameter. Resistance in ventilation, nasal bleeding, pressure necrosis, and adenoid trauma may occur in the respiratory tract depending on the diameter of the selected tube. It is contraindicated in sinusitis, local abscesses, in cranial fractures, and in zygoma fractures.

It is indicated in maxillofacial and dental surgery and in cases where the jaw opening is limited. In the past, difficult intubation was called blind nasal intubation, but nowadays it is not preferred because there is the chance to reach video laryngoscopy, fiber optic intubation, lighted probes, and similar tools and equipment with the developing technology [65–68].

3.6. Indications of retrograde intubation

Retrograde intubation surgery is an alternative technique to cricothyroidotomy. Following preoxygenation, the cricothyroid area is given local anesthesia. Following the arrival of air from the injector entered with the Seldinger technique, the guide wire is moved through the needle and removed with Magill forceps from the mouth. The endotracheal tube is then driven over the wire. The wire is passed through Murphy's eye, and the guide wire is stretched while the tube is driven. The guide wire is drawn back after the procedure [69].

Indications: lack of glottic imaging due to secretion, vomiting or bleeding, and failure in conventional methods, in cases where intubation cannot be performed. Patients with a congenital anomaly, upper airway tumor, acute epiglottitis, severe kyphosis, cervical arthrosis, or trauma.

Contraindications: it is contraindicated in such situations, upper airway obstruction, larynx trauma, large thyroid gland, infection in the area of cricothyroid, and coagulopathy.

3.7. Additional conditions

The experienced practitioner, who can always detect incorrect intubation, and additional personnel facilitate airway management and may help us avoid complications. There is always a need of the presence of aspirator working at the bedside to prevent aspiration risk. Long-acting muscle relaxants are not given in patients who cannot be ventilated with a mask. If the patient is hemodynamically unstable and the induction drugs cannot be applied, if the patient has a difficult airway history, and if severe airway obstruction is detected during examination and/or laryngoscopy, awake intubation can be performed.

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Conflict of interest

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References

[1] Karch SB, Lewis T, Young S, Hales D, Ho CH. Field intubation of trauma patients: Complications, indications, and outcomes. The American Journal of Emergency Medicine. 1996;**14**(7):617-619. DOI: 10.1016/S0735-6757(96)90073-X

[2] Lockey D, Davies G, Coats T. Survival of trauma patients who have prehospital tracheal intubation without anaesthesia or muscle relaxants: Observational study. BMJ. 2001;**323**(7305):141

[3] Berg RA, Nadkarni VM, Clark AE, Moler F, Meert K, Harrison RE, et al. Incidence and outcomes of cardiopulmonary resuscitation in PICUs. Critical Care Medicine. 2016;**44**(4):798-808. DOI: 10.1097/CCM.0000000000001484

[4] Heffner AC, Swords DS, Neale MN, Jones AE. Incidence and factors associated with cardiac arrest complicating emergency airway management. Resuscitation. 2013;**84**(11):1500-1504. DOI: 10.1016/j.resuscitation.2013.07.022

[5] Roppolo LP, Wigginton JG. Preventing severe hypoxia during emergent intubation: Is nasopharyngeal oxygenation the answer? Critical Care. 2010;**14**(6):1005. DOI: 10.1186/cc9197

[6] Brown CA 3rd, Bair AE, Pallin DJ, Walls RM, Investigators NI. Techniques, success, and adverse events of emergency department adult intubations. Annals of Emergency Medicine. 2015;**65**(4):363-370 e1. DOI: 10.1016/j.annemergmed.2014.10.036

[7] Isono S, Ishikawa T. Oxygenation, not intubation, does matter. Anesthesiology. 2011;**114**(1):7-9. DOI: 10.1097/ALN.0b013e318201c8b9

[8] Mort TC, Waberski BH, Clive J. Extending the preoxygenation period from 4 to 8 mins in critically ill patients undergoing emergency intubation. Critical Care Medicine. 2009;**37**(1):68-71. DOI: 10.1097/CCM.0b013e318192845e

[9] Frat JP, Thille AW, Mercat A, Girault C, Ragot S, Perbet S, et al. High-flow oxygen through nasal cannula in acute hypoxemic respiratory failure. The New England Journal of Medicine. 2015;**372**(23):2185-2196. DOI: 10.1056/NEJMoa1503326

[10] Lenglet H, Sztrymf B, Leroy C, Brun P, Dreyfuss D, Ricard JD. Humidified high flow nasal oxygen during respiratory failure in the emergency department: Feasibility and efficacy. Respiratory Care. 2012;**57**(11):1873-1878. DOI: 10.4187/respcare.01575

[11] Sztrymf B, Messika J, Mayot T, Lenglet H, Dreyfuss D, Ricard JD. Impact of high-flow nasal cannula oxygen therapy on intensive care unit patients with acute respiratory failure: a prospective observational study. Journal of Critical Care. 2012;**27**(3):324 e9-324 13. DOI: 10.1016/j.jcrc.2011.07.075

[12] Roca O, de Acilu MG, Caralt B, Sacanell J, Masclans JR, collaborators ICU. Humidified high flow nasal cannula supportive therapy improves outcomes in lung transplant recipients readmitted to the intensive care unit because of acute respiratory failure. Transplantation. 2015;**99**(5):1092-1098. DOI: 10.1097/TP.0000000000000460

[13] Kang BJ, Koh Y, Lim CM, Huh JW, Baek S, Han M, et al. Failure of high-flow nasal cannula therapy may delay intubation and increase mortality. Intensive Care Medicine. 2015;**41**(4):623-632. DOI: 10.1007/s00134-015-3693-5

[14] Ricard JD, Messika J, Sztrymf B, Gaudry S. Impact on outcome of delayed intubation with high-flow nasal cannula oxygen: Is the device solely responsible? Intensive Care Medicine. 2015;**41**(6):1157-1158. DOI: 10.1007/s00134-015-3766-5

[15] Stollings JL, Diedrich DA, Oyen LJ, Brown DR. Rapid-sequence intubation: A review of the process and considerations when choosing medications. The Annals of Pharmacotherapy. 2014;**48**(1):62-76. DOI: 10.1177/1060028013510488

[16] Vignati G, Colonna P, Zavota L, Musto B. Diagnostic and therapeutic guidelines in arrhythmias with onset in childhood. Giornale Italiano di Cardiologia. 1991;**21**(12):1337-1353

[17] Martin LD, Mhyre JM, Shanks AM, Tremper KK, Kheterpal S. 3,423 emergency tracheal intubations at a university hospital: Airway outcomes and complications. Anesthesiology. 2011;**114**(1):42-48. DOI: 10.1097/ALN.0b013e318201c415

[18] Sagarin MJ, Barton ED, Chng YM, Walls RM. National Emergency Airway Registry I. Airway management by US and Canadian emergency medicine residents: A multicenter analysis of more than 6,000 endotracheal intubation attempts. Annals of Emergency Medicine. 2005;**46**(4):328-336

[19] Frat JP, Thille AW, Mercat A, Girault C, Ragot S, Perbet S, et al. High-flow oxygen through nasal cannula in acute hypoxemic respiratory failure. The New England Journal of Medicine. 2015;**372**(23):2185-2196. DOI: 10.1056/NEJMoa1503326

[20] Stockinger ZT, McSwain NE Jr. Prehospital supplemental oxygen in trauma patients: Its efficacy and implications for military medical care. Military Medicine. 2004;**169**(8):609-612

[21] Ramachandran SK, Cosnowski A, Shanks A, Turner CR. Apneic oxygenation during prolonged laryngoscopy in obese patients: A randomized, controlled trial of nasal oxygen administration. Journal of Clinical Anesthesia. 2010;**22**(3):164-168. DOI: 10.1016/j.jclinane.2009.05.006

[22] Sakles JC, Mosier JM, Patanwala AE, Dicken JM. Apneic oxygenation is associated with a reduction in the incidence of hypoxemia during the RSI of patients with intracranial hemorrhage in the emergency department. Internal and Emergency Medicine. 2016;**11**(7):983-992. DOI: 10.1007/s11739-016-1396-8

[23] Heffner AC, Swords DS, Nussbaum ML, Kline JA, Jones AE. Predictors of the complication of postintubation hypotension during emergency airway management. Journal of Critical Care. 2012;**27**(6):587-593. DOI: 10.1016/j.jcrc.2012.04.022

[24] De Jong A, Jung B, Jaber S. Intubation in the ICU: We could improve our practice. Critical Care. 2014;**18**(2):209. DOI: 10.1186/cc13776

[25] Simpson GD, Ross MJ, McKeown DW, Ray DC. Tracheal intubation in the critically ill: A multi-Centre national study of practice and complications. British Journal of Anaesthesia. 2012;**108**(5):792-799. DOI: 10.1093/bja/aer504

[26] Kim DK, Lee J, Park JH, Yoo KH. What can we apply to manage acute exacerbation of chronic obstructive pulmonary disease with acute respiratory failure? Tuberculosis and Respiratory Diseases (Seoul). 2018. DOI: 10.4046/trd.2017.0094

[27] Sztrymf B, Messika J, Bertrand F, Hurel D, Leon R, Dreyfuss D, et al. Beneficial effects of humidified high flow nasal oxygen in critical care patients: A prospective pilot study. Intensive Care Medicine. 2011;**37**(11):1780-1786. DOI: 10.1007/s00134-011-2354-6

[28] Nolan JP, Kelly FE. Airway challenges in critical care. Anaesthesia. 2011;**66**(Suppl 2):81-92. DOI: 10.1111/j.1365-2044.2011.06937.x

[29] Benedetto WJ, Hess DR, Gettings E, Bigatello LM, Toon H, Hurford WE, et al. Urgent tracheal intubation in general hospital units: An observational study. Journal of Clinical Anesthesia. 2007;**19**(1):20-24. DOI: 10.1016/j.jclinane.2006.05.018

[30] Sahiner IT, Sahiner Y. Bedside percutaneous dilatational tracheostomy by Griggs technique: A single-center experience. Medical Science Monitor. 2017;**23**:4684-4688. DOI: 10.12659/MSM.907006

[31] Leibowitz AB. Tracheal intubation in the intensive care unit: Extremely hazardous even in the best of hands. Critical Care Medicine. 2006;**34**(9):2497-2498. DOI: 10.1097/01.CCM.0000235993.47514.8F

[32] Baillard C, Fosse JP, Sebbane M, Chanques G, Vincent F, Courouble P, et al. Noninvasive ventilation improves preoxygenation before intubation of hypoxic patients. American Journal of Respiratory and Critical Care Medicine. 2006;**174**(2):171-177. DOI: 10.1164/rccm.200509-1507OC

[33] American Heart A, American Academy of P. 2005 American Heart Association (AHA) guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC) of pediatric and neonatal patients: Neonatal resuscitation guidelines. Pediatrics. 2006;**117**(5):e1029-e1038. DOI: 10.1542/peds.2006-0349

[34] Sakles JC, Mosier JM, Patanwala AE, Arcaris B, Dicken JM. First pass success without hypoxemia is increased with the use of apneic oxygenation during rapid sequence intubation in the emergency department. Academic Emergency Medicine. 2016;**23**(6):703. DOI: 10.10.1111/acem.12931

[35] Driver BE, Prekker ME, Kornas RL, Cales EK, Reardon RF. Flush rate oxygen for emergency airway Preoxygenation. Annals of Emergency Medicine. 2017;**69**(1):1-6. DOI: 10.1016/j.annemergmed.2016.06.018

[36] Cobas MA, Martin ND, Barkin HB. Two lost airways and one unexpected problem: Undiagnosed tracheal stenosis in a morbidly obese patient. Journal of Clinical Anesthesia. 2016;**35**:225-227. DOI: 10.1016/j.jclinane.2016.07.026

[37] Williams R, Hodge J, Ingram W. Indications for intubation and early tracheostomy in patients with Stevens-Johnson syndrome and toxic epidermal necrolysis. American Journal of Surgery. 2016;**211**(4):684-688 e1. DOI: 10.1016/j.amjsurg.2015.12.011

[38] Di Filippo A, Gonnelli C. Rapid sequence intubation: A review of recent evidences. Reviews on Recent Clinical Trials. 2009;**4**(3):175-178

[39] Onishi S, Osuka A, Kuroki Y, Ueyama M. Indications of early intubation for patients with inhalation injury. Acute Medicine & Surgery. 2017;**4**(3):278-285. DOI: 10.1002/ams2.269

[40] Amani H, Lozano DD, Blome-Eberwein S. Brother, have you got a light? Assessing the need for intubation in patients sustaining burn injury secondary to home oxygen therapy. Journal of Burn Care & Research. 2012;**33**(6):e280-e285. DOI: 10.1097/BCR.0b013e31824d1b3c

[41] Hassan Z, Wong JK, Bush J, Bayat A, Dunn KW. Assessing the severity of inhalation injuries in adults. Burns. 2010;**36**(2):212-216. DOI: 10.1016/j.burns.2009.06.205

[42] Albright JM, Romero J, Saini V, Sixt SU, Bird MD, Kovacs EJ, et al. Proteasomes in human bronchoalveolar lavage fluid after burn and inhalation injury. Journal of Burn Care & Research. 2009;**30**(6):948-956. DOI: 10.1097/BCR.0b013e3181c07f37

[43] Marek K, Piotr W, Stanislaw S, Stefan G, Justyna G, Mariusz N, et al. Fibreoptic bronchoscopy in routine clinical practice in confirming the diagnosis and treatment of inhalation burns. Burns. 2007;**33**(5):554-560. DOI: 10.1016/j.burns.2006.08.030

[44] Yamamura H, Kaga S, Kaneda K, Mizobata Y. Chest computed tomography performed on admission helps predict the severity of smoke-inhalation injury. Critical Care. 2013;**17**(3):R95. DOI: 10.1186/cc12740

[45] Cancio LC, Batchinsky AI, Dubick MA, Park MS, Black IH, Gomez R, et al. Inhalation injury: Pathophysiology and clinical care proceedings of a symposium conducted at the trauma Institute of San Antonio, on 28 March 2006. Burns. 2007;**33**(6):681-692. DOI: 10.1016/j.burns.2006.11.009

[46] Hernandez MC, Antiel RM, Balakrishnan K, Zielinski MD, Klinkner DB. Definitive airway management after prehospital supraglottic rescue airway in pediatric trauma. Journal of Pediatric Surgery. 2017. DOI: 10.1016/j.jpedsurg.2017.10.004

[47] Link MS, Berkow LC, Kudenchuk PJ, Halperin HR, Hess EP, Moitra VK, et al. Part 7: Adult advanced cardiovascular life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2015;**132**(18 Suppl 2):S444-S464. DOI: 10.1161/CIR.0000000000000261

[48] Hansen M, Lambert W, Guise JM, Warden CR, Mann NC, Wang H. Out-of-hospital pediatric airway management in the United States. Resuscitation. 2015;**90**:104-110. DOI: 10.1016/j.resuscitation.2015.02.018

[49] Slain KN, Shein SL, Rotta AT. The use of high-flow nasal cannula in the pediatric emergency department. Jornal de Pediatria. 2017;**93**(Suppl 1):36-45. DOI: 10.1016/j.jped.2017.06.006

[50] Ehrlich PF, Seidman PS, Atallah O, Haque A, Helmkamp J. Endotracheal intubations in rural pediatric trauma patients. Journal of Pediatric Surgery. 2004;**39**(9):1376-1380

[51] Marvez-Valls E, Houry D, Ernst AA, Weiss SJ, Killeen J. Protocol for rapid sequence intubation in pediatric patients – a four-year study. Medical Science Monitor. 2002;**8**(4):CR229-CR234

[52] Davis DP, Hoyt DB, Ochs M, Fortlage D, Holbrook T, Marshall LK, et al. The effect of paramedic rapid sequence intubation on outcome in patients with severe traumatic brain injury. The Journal of Trauma. 2003;**54**(3):444-453. DOI: 10.1097/01.TA.0000053396.02126.CD

[53] Carroll CL, Spinella PC, Corsi JM, Stoltz P, Zucker AR. Emergent endotracheal intubations in children: Be careful if it's late when you intubate. Pediatric Critical Care Medicine. 2010;**11**(3):343-348

[54] Easley RB, Segeleon JE, Haun SE, Tobias JD. Prospective study of airway management of children requiring endotracheal intubation before admission to a pediatric intensive care unit. Critical Care Medicine. 2000;**28**(6):2058-2063

[55] Davidson LA, Utarnachitt RB, Mason A, Sawyer T. Development and testing of a neonatal intubation checklist for an air medical transport team. Air Medical Journal. 2018;**37**(1):41-45. DOI: 10.1016/j.amj.2017.09.010

[56] Smith CE. Trauma Anesthesia. New York: Cambridge University Press; 2015

[57] Kleinman ME, Chameides L, Schexnayder SM, Samson RA, Hazinski MF, Atkins DL, et al. Part 14: Pediatric advanced life support. Circulation. 2010;**122**(18 suppl 3):S876-S908

[58] Fastle RK, Roback MG. Pediatric rapid sequence intubation: Incidence of reflex bradycardia and effects of pretreatment with atropine. Pediatric Emergency Care. 2004;**20**(10):651-655

[59] Jones P, Dauger S, Peters MJ. Bradycardia during critical care intubation: Mechanisms, significance and atropine. Archives of Disease in Childhood. 2012;**97**(2):139-144. DOI: 10.1136/adc.2010.210518

[60] Bledsoe GH, Schexnayder SM. Pediatric rapid sequence intubation: A review. Pediatric Emergency Care. 2004;**20**(5):339-344

[61] Pardo M, Miller RD. Basics of Anesthesia E-Book. Philadelphia, USA: Elsevier Health Sciences; 2017

[62] Shiima Y, Berg RA, Bogner HR, Morales KH, Nadkarni VM, Nishisaki A, et al. Cardiac arrests associated with tracheal intubations in PICUs: A multicenter cohort study. Critical Care Medicine. 2016;**44**(9):1675-1682. DOI: 10.1097/CCM.0000000000001741

[63] Tarquinio KM, Howell JD, Montgomery V, Turner DA, Hsing DD, Parker MM, et al. Current medication practice and tracheal intubation safety outcomes from a prospective multicenter observational cohort study. Pediatric Critical Care Medicine. 2015;**16**(3):210-218. DOI: 10.1097/PCC.0000000000000319

[64] Corl KA, Dado C, Agarwal A, Azab N, Amass T, Marks SJ, et al. A modified Montpellier protocol for intubating intensive care unit patients is associated with an increase in first-pass intubation success and fewer complications. Journal of Critical Care. 2017;**44**:191-195. DOI: 10.1016/j.jcrc.2017.11.014

[65] Man JY, Fiadjoe JE, Hsu G. Technique utilizing a modified oral ring-Adair-Elwyn tube to provide continuous oxygen and sevoflurane delivery during Nasotracheal intubation in an infant with a difficult airway: A case report. A & A Case Reports. 2017. DOI: 10.1213/XAA.0000000000000677

[66] Solanki SL, Kaur J. "Two-hand-manoeuver" during nasotracheal intubation. Saudi Journal of Anaesthesia. 2017;**11**(4):512. DOI: 10.4103/sja.SJA_229_17

[67] Bihani P, Bhatia PK, Mohhammad S, Sethi P. Use of stylet in armored tube for nasotracheal intubation: Why not?? Saudi Journal of Anaesthesia. 2017;**11**(3):367-368. DOI: 10.4103/1658-354X.206800

[68] Jazayeri-Moghaddas OP, Tse W, Herzing KA, Markert RJ, Gans AJ, McCarthy MC. Is nasotracheal intubation safe in facial trauma patients? American Journal of Surgery. 2017;**213**(3):572-574. DOI: 10.1016/j.amjsurg.2016.11.003

[69] Sanguanwit P, Trainarongsakul T, Kaewsawang N, Sawanyawisuth K, Sitthichanbuncha Y. Is retrograde intubation more successful than direct laryngoscopic technique in difficult endotracheal intubation? The American Journal of Emergency Medicine. 2016;**34**(12):2384-2387. DOI: 10.1016/j.ajem.2016.08.063