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Airway Management in the Pre-Hospital Setting

Lamia Tawfik, Mohammad Al Nobani and Tarek Tageldin

Abstract

This chapter explores the different techniques and challenges faced by emergency medical providers during pre-hospital airway management of critically ill patients. It is a crucial topic that has a major impact on patient's safety. Improper airway management in this category of patients can lead to catastrophic results in terms of morbidity and mortality, this fact stimulates the ongoing improvement and evolution in this area of practice. We explore some of the debatable topics in pre-hospital airway management like airway management in the pediatric group, the use of medication assisted intubation and rapid sequence intubation in the field as well as the role of video assisted intubation and its challenges in the field. The up-to-date practices and research findings in the most recent related articles are discussed here in this chapter.

Keywords: airway management, pre-hospital, paramedics, endotracheal intubation, advanced airway management techniques, basic airway management techniques

1. Introduction

Prehospital airway management is a core component of emergency services, it is a vital and challenging skill of emergency service responders around the globe. The advancement of pre-hospital airway control procedures and equipment represents the evolution of pre-hospital triage and emergency care.

The spectrum of airway management outside of the hospital involves a wide array of skills and techniques, starting with basic airway skills that are included in basic life support training (BLS) such as mouth to mouth or mouth to nose ventilation and use of the simple oxygen face masks, moving to intermediate airway management techniques like bag mask ventilation or use of oral and nasal airway devices, ending with advanced airway management techniques like use of supraglottic devices, endotracheal intubation or surgical airway techniques.

Prehospital airway management services are provided by a spectrum of providers who have different levels of training and skills. For example, basic airway skills can be provided by a lay person since it has been taught to the public for decades now. Intermediate and advanced skills are performed by emergency medical service responders, who also have a variable level of training. The majority of the Emergency Medical Service (EMS) systems around the world utilize non-physician providers, while in other countries they do operate with a physician staffed EMS.

2. Challenges in airway management

Airway management in the prehospital setting has major challenges. Achieving a successful airway management requires a collection of adjustments that involve equipment, personnel and medication in a simultaneous fashion. In addition to the logistic challenges an effort in identifying the patient who need urgent advanced airway management techniques from those whom basic airway maneuvers are adequate. Over the years prehospital airway management has become progressively formalized, local and international associations in different countries has put in place guidelines to improve patient safety and standardize the process. Although there are noticeable differences in EMS infrastructure in different countries which are reflected in those different guidelines, needless to say the purpose of those guidelines is the same, with the main focus being the patient safety.

In general, most of the protocols suggest that advanced airway management techniques should only be carried out by appropriately skilled personnel, at the same time attention should focus on performing high quality basic airway maneuvers when personnel with advanced airway skills aren't immediately available.

3. Airway management equipment and techniques in the prehospital setting

3.1 Mouth to mouth ventilation

In certain circumstances, when other airway equipment's aren't available this technique can be used initially to maintain oxygenation and ventilation. A barrier should be used to avoid infection transmission [1].

3.1.1 Techniques

Adults:

Head-tilt/chin-lift to open the airway while pinching the person's nose closed and the hand over his head. The lips have to surround the mouth to create a seal. Start to blow into the person's mouth for one second and watch the chest rise. This maneuver is contraindicated when cervical spine injuries are suspected.

Pediatrics:

Head-tilt/chin-lift to open the airway. The lips have to surround the mouth and nose of the child to create a seal. Blow gently the child's nose mouth for one second. Note that the infant's lungs need a smaller volume of air than an adult., Watch the chest rise while blowing.

3.2 Spontaneous breathing

It is performed when the rescuer is dealing with a spontaneously breathing patient assisting him to maintain adequate oxygenation and ventilation, with the aid of simple of equipment such as oral or nasal airway devices that can maintain upper airway patency.

Oxygenation can be maintained via simple face mask, nasal cannula or non-rebreathing face mask. Continuous positive pressure ventilation (CPAP) by applying a fitting mask to allow CPAP with spontaneous ventilation can also be implemented in special circumstances when deemed appropriate. This method is found to decrease rates of intubation and mortality [2].

3.3 Bag-mask-ventilation (BMV)

It is a standard maneuver for initial airway management, the mask applied to the patient's mouth and nose with a properly tight seal being formed between the patient's mouth and the mask to improve oxygenation and ventilation.

It can also be used if endotracheal intubation is planned to avoid oxygen desaturation during the process of intubation.

BMV can be applied by one person using one hand bag mask ventilation technique or by two providers using two hand bag mask ventilation technique in cases where maintaining proper seal and proper ventilation becomes difficult.

3.4 Oropharyngeal and nasopharyngeal airways

They are used frequently by prehospital rescuers for spontaneous and assisted breathing to improve both oxygenation and ventilation. They should be avoided in patients suffering from facial and head injuries.

The oropharyngeal airway device is ideal for use in unresponsive or unconscious patients who have depressed airway reflexes. Keeping in mind that patient with intact gag reflex might not be able to tolerate the device. On the other hand, The nasopharyngeal airway is usually better tolerated by conscious patients, it is useful also in patients having trauma to oral structures. The proper size should be carefully selected.

3.5 Supra-glottic airway devices (SGA)

SGA is a broad term for devices which sit above the glottic opening, examples include laryngeal masks, Proseal LMA, Intubating LMA (ILMA, Fastrach), LMA Supreme, LMA Protector, i-gel (with non-inflatable cuff).

The ease of use for non-experienced personnel, makes those devices an appealing option for the use in the out of hospital environment or remote setup. SGA insertion does not require sophisticated skills, it provides proper means of ventilation and oxygenation in unconscious patients. Those features helped the adoption of such devices and increased their use worldwide. Moreover, SGA has become a backup tool in failed intubation in accordance with the difficult airway algorithm by the American Society of Anesthesia (ASA) [3]. Unfortunately, these devices do not protect from aspiration and may induce soft tissue trauma.

3.6 Extra-glottic airway devices

These devices have an extra advantage over the other SGA by having large pharyngeal tubes to seal the oropharynx or esophageal balloons to seal the esophagus so they can provide oxygenation and ventilation with reasonable protection from aspiration. They are easy to use and do not require advanced training.

A group of airways includes Laryngeal tube [4], Esophageal tracheal airway (Combitube) which can be either inserted in the trachea or esophagus, King laryngeal tube (LT), Rusch EasyTube unlike the Combitube, Intubating Laryngeal Tube Suction Disposable (iLTS-D).

3.7 Endotracheal intubation (ETI)

Endotracheal intubation is considered the gold standard method of airway management, which allows proper oxygenation, positive pressure ventilation, positive end-expiratory pressure (PEEP), and protection from gastric content aspiration.

The performance of ETI requires advanced training and highly skilled personnel, keeping in mind that out of hospital ETI is carried out in suboptimal environment and unusual positions. First attempt ETI among EMS providers in an Australian cohort study was found to be around 80%, non the less, the paramedic experience was not associated with improved patient survival [5]. But in other studies the first-pass intubation was correlated with improved return of spontaneous circulation rate and survival [6]. Those conflicting result highlights the importance of the approach to airway management, experience in performing one specific procedure like ETI does not warrant a better outcome, moreover literature suggest that out of hospital ETI is not achieving the goals it intended for and that in some cases it might even cause harm [7].

The fundamental role of performing ETI in the Field is to improve patient outcome. There are multiple studies that have looked into the morbidity and mortality of field ETI compared to other airway management maneuvers like the use of supraglottic/extra-glottic devices or bag mask ventilation, most of the studies had an inconclusive results on survival or outcome. In a recent study of the national database of Thailand registry that looked into the return of spontaneous circulation (ROSC) in out of hospital cardiac arrest patients who received ETI vs. bag mask ventilation, both groups had comparable ROSC rate although the bag mask ventilation group had less severe condition and received faster treatment [8]. In a meta-analysis by Benoit and his colleagues that investigated the outcome of out of hospital ETI vs. SGA insertion in patients with cardiac arrest among more than 75,000 patients, they concluded that patients who arrested outside of the hospital had better outcome when they received ETI rather than SGA device by EMS providers, specifically speaking ROSC, survival to hospital admission and neurological outcome were all better in the ETI group [9]. Similar conclusion was demonstrated by a study of the Korean nationwide registry that studied the survival of out of hospital cardiac arrest in approximately 100,000 patients who received bag mask ventilation vs. ETI vs. SGA, ETI group had favorable outcomes compared to both other groups [10].

Out of hospital endotracheal intubation brings a lot of challenges to the provider, other than just performing the procedure itself, other complication can occur, like misplacement of the endotracheal tube, hemodynamic changes associated with the intervention and their pathophysiological impact on the disease process itself, intervention with the resuscitation efforts, airway trauma and others.

In an observational study at level trauma center the rate of endotracheal misplacement without the use of continuous end-tidal carbon dioxide (ETCO₂) monitoring was around 23%, using ETCO₂ continuous monitor reduced it to around zero [11].

3.8 Rapid sequence intubation versus no-medication intubation

Rapid Sequence Intubation (RSI) is an airway management technique that aims toward controlling the airway in the emergency setting in the fastest and safest means possible, that might require the use of anesthetic induction agents and neuromuscular blocking agents in order to minimize the possibility of gastric content aspiration during endotracheal intubation. Rapid sequence induction technique is further discussed in another chapter.

The debate over whether to use RSI vs. intubation without the use of medications to facilitate the process of intubation in the prehospital setting is still ongoing. Despite that the use of medications in RSI provides optimum conditions for successful endotracheal intubation but it does not goes without risks, mainly because of the significant hemodynamic changes associated with the use of anesthetic induction agents and the possibility of development of difficult airway scenario and loss of spontaneous ventilation after the use of muscle relaxants.

The use of medications to assist endotracheal intubation provides conditions that properly optimize the procedure. Factors that might be associated with failure to intubate like inability to pass the tube through the vocal cords, inability to visualize the cords, trismus and presence of gag reflex, can all be resolved with the use of medications to assist the endotracheal tube insertion [12]. Bernard et al. in a randomized clinical trial concluded that the neurological outcome of patients with severe traumatic brain injury was better when out of hospital RSI is performed by paramedics compared with intubation in the hospital setting [13].

In a study that evaluated the outcome in patients with severe traumatic brain injury who received RSI by paramedics compared to matched non intubated historical controls, concluded that RSI group had increase in mortality [14]. Moreover RSI led to prolonged on scene time and thus delayed transfer to the hospital.

Therefor the decision whether to incorporate RSI vs. non medication intubation should be individualized based on the level of training of EMS providers as well as the level of resources provided by the health care system.

4. Special considerations

4.1 Trauma

Management of hypoxia thus management of the airway is of a paramount importance for trauma victims, trauma is one of the leading causes of death among the young adult population, and number of potentially preventable prehospital death is high, reaching up to 43% according to a recent review [15], the majority are due to the missed opportunity of performing a proper basic airway management technique.

Airway management of trauma cases is challenging due to many factors, some are directly related to the type of trauma like trauma to the face or the respiratory tract, while others are related to the hypovolemia as a result of the trauma insult. Cervical spine injuries present a specific set of challenges that would render managing the airway in such population quite difficult and might need special equipment and techniques to maintain patient safety.

Since upper airway obstruction is one of most important factors of morbidity and mortality in trauma victims, identifying the factors that would lead to airway mismanagement is very important. Factor that would contribute to airway mismanagement include [16]:

Inability to recognize an inadequate airway
Inability to establish a clear airway with or without airway device
Inability to recognize a misplaced airway device
Failure of maintenance of a previously established airway due to displacement of the airway device
Inability to recognize the need for ventilation
Aspiration of gastric content

Special attention to patients who might have potential inadequate respiration such as patient with decreased level of consciousness due to head injury or intoxication, patients with direct trauma to the airway, facial and maxillary region, neck, larynx or throat, patient with significant blood loss and patients who might develop respiratory failure due to a blast, inhalational injury or exposure to chemical agent.

In most of the cases of trauma victims, simple maneuvers are usually sufficient to overcome upper airway obstruction, but in cases where simple techniques were ineffective the aim should be toward establishing a definitive airway technique. In an prospective observation study Lockery and his colleagues investigated the effectiveness prehospital advanced airway management in trauma patient, among the patient whom had received advanced airway management technique around 57% of them had airway compromise upon there arrival to the trauma centers, the success rate of ETI for non-physician paramedic was 64% and 11% reached a health care facility with unrecognized esophageal intubation. While physician-paramedic teams achieved definitive airway management for all patients [17]. Therefore, level of training, and availability of expertise are important in situations when advanced airway technique is warranted in trauma patient population group.

Advanced airway management techniques include ETI or a surgical airway. Below is a list of the most common indications for advanced airway technique in trauma victims.

Apneic patient
Protect from aspiration of vomitous content or airway bleeding
Reduced level of consciousness (Glasgow Coma Scale <8)
Significant faciomaxillary fractures
Patient who is at risk of upper airway obstruction: neck hematoma, laryngeal and tracheal injury
Inhalational injury with impending or potential airway compromise
Failure to maintain oxygenation using facemask or BiPAP/CPAP

It is recommended to assume that patients with major trauma, head and facial injuries, decreased level of consciousness or with neck pain as having cervical spine injury thus warranting cervical immobilization techniques to prevent further damage. Cervical immobilization has been known to attribute to difficulties with laryngoscopic view and hence difficult airway management. In a prospective study by Heath, that investigated the effect of different cervical spine immobilization techniques on the ease of laryngoscopy, poor view on laryngoscopy (grade 3 or 4) was more encountered when the cervical spine immobilized using rigid collar, tapes and sandbags compared to in-line manual immobilization. Therefore, manual in-line stabilization of cervical spine is the method of choice during tracheal intubation [18].

5. Pediatrics

Airway management in pediatrics is relatively difficult and requires highly skilled and professional personnel, this difficulty is based on the physiological, anatomical differences between infant, pediatric, and adult airways [19]. These differences included in the following table:

Large occiput
Relatively larger tongue and small mouth
High and anterior larynx
Large and floppy epiglottis
Subglottic narrowing at the cricoid cartilage

Foreign body aspiration is a common problem in the pediatric population, it may cause severe airway obstruction and might mandates immediate intervention. Other causes that might mandate airway intervention in the pediatric group include epiglottitis, viral croup, trauma, seizures, hypoxia, and cardiac arrest.

The use of prehospital advanced airway management techniques in the pediatric population have shown to have a conflicting result, in a recent nationwide cohort study, that looked into the outcome of out of hospital cardiac arrest in the pediatric population of Japan, the use of advanced airway management technique including ETI and supraglottic devices did not demonstrate any improvement in 1-month survival or functional status when compared to the use of basic airway techniques [20].

Despite the conflicting results of the use of advanced airway management techniques, the use of supraglottic airway devices has been shown to be easy, simple and with minimal complications in simulated pediatric cardiac arrest scenarios [21].

A useful tool to help guiding the sizes and dosages of the equipment and medications in the pediatric group is the Broselow Pediatric Emergency Tape, also known as the Broselow Tape, a color-coded tape that matches the measured height to the child's expected weight and other needed information.

6. Inhalation injury

Inhalational injury is a broad non-specific term that encompasses damage inflicted by heat, smoke, or chemical irritants to the respiratory tract or lung tissue.

Inhalational injury is commonly associated with burn injuries, around 10–20% of burn victims also suffered from inhalational injury complications that increased morbidity and mortality [22], moreover inhalation injury is considered an independent predictor of mortality in burn victims.

All burn patients should receive humidified 100% oxygen through a facemask to displace carbon monoxide [23], Advanced Life support of the American burn association recommends early endotracheal intubation, if there is any of the following indicators:

- Signs of Airway obstruction
- Total burn surface area more than 40%
- Extensive facial burns or involvement of the oral cavity
- Significant facial edema.
- Difficult swallowing
- Signs of respiratory distress
- Disturbed level of consciousness
- In patient with large burns, absence of qualified personnel to perform intubation during transfer.

7. Prehospital airway management during COVID 19 pandemic

Current recommendations for the airway management of patient with respiratory failure due to novel Corona virus II infection are focusing on

in-hospital health care providers. While neglecting to provide guidance for EMS providers in the pre-hospital setting.

The in-hospital airway management recommendations of COVID-19 patients can be summarized in the following points:

1. Always use proper personal protective equipment (PPE) during the contact with the patient.
2. A surgical mask should be placed over the patient face to reduce the risk of spreading the infection, it can be placed over a nasal canula as well.
3. Bag-mask-ventilation should be restricted to minimum if any to minimize aerosol generation.
4. Rapid sequence intubation technique with video laryngoscopy is highly recommended.

Regarding the pre-hospital airway management, EMS providers should be able to identify suspected COVID 19 patients. To screen the patients EMS providers should inquire about the following: Recent history of travel, close contact with a known COVID 19 case, or with a person with flu like symptoms, worsening dyspnea, myalgia, sore throat, dry cough and/or GI symptoms. All precautions should be taken when dealing with patients reporting difficulty in breathing, or flu like sickness.

When handling COVID 19 patients appropriate PPE should be worn. That includes N95 mask, gown, gloves, and eye protection. To prevent further contamination a surgical mask should be provided to the suspected patient as soon as possible.

Similar to the in-hospital airway management protocols, rapid sequence intubation with video laryngoscopy is highly recommended when endotracheal intubation is warranted in the prehospital setting. Providers should not attempt more than one endotracheal intubation trial, if it wasn't successful the provider should proceed to SGA insertion. HEPA filter should be applied to avoid equipment contamination. Bag-mask ventilation should be restricted to minimum, but in scenarios where the bag-mask ventilation is inevitable two-person mask ventilation technique, and the use of airway adjuncts are recommended to improve the mask seal [24].

8. Future developments

The use of video assisted devices for endotracheal intubation has been gaining solid ground over the past recent years, especially as the cost of the technology has become lower.

Several recent studies have concluded that the use of video assisted devices has significantly increased the first-pass success rate as well as the overall success rate compared to the use of direct laryngoscopy [25–27]. Moreover, the use of video assisted devices for intubation has shown a faster learning curve compared to direct laryngoscopy [28], such feature might increase the use of advanced airway techniques by the paramedics in the field over time.

One of the downsides of using video assisted devices in the field is the potential difficulty of visualizing the vocal cords in the presence of blood and vomitus specially in trauma patients, another downside is that direct sun light might interfere with the visualization of video monitor [29].

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