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Contemporary principles of airway management and artificial respiration

Key words: cardiopulmonary resuscitation, airway management, artificial ventilation.

The purpose of writing this article is to simplify a lot of information that is full of studying emergency medicine and to make it possible to get an idea of the current approaches for providing emergency care of conditions that have led to the acute asphyxia in outpatient department.

Asphyxia – a pathological condition caused by lack of oxygen in the body and is manifested by signs and symptoms of disorders of the vital functions of the body, especially the nervous system, breathing and circulation. Acute asphyxia develops due to various pulmonary and extrapulmonary factors.

Among the pulmonary factors it is necessary to emphasize processes that violate the airway (obstruction by foreign bodies, mucus, blood, vomit), also triggered by allergic processes edema of the larynx and vocal cords. Neoplasms, thermal and chemical injury, and severe inflammation localized in the trachea, bronchi, and severe degree of asthma can also cause acute asphyxia associated with violations of the airway.

The life-threatening signs of an exacerbation of asthma include (Order of the Ministry of Health of Ukraine #868 of October 8, 2013):

- $PEFR < 33\%$ of best or normal;
- $SaO_2 < 92\%$;
- «Silent» lung, cyanosis or insufficient respiratory effort;
- Arrhythmia or hypotension;
- Exhaustion, altered consciousness.

The frequent pulmonary factors that cause acute asphyxia include also inflammation of the lung parenchyma, pulmonary atelectasis, pneumothorax or pleural effusion and pulmonary embolism.

Providing emergency care for acute asphyxia depends primarily on the reasons which have caused it and must be directed to them. In case of asphyxia, leading to respiratory

failure, among treatment measures it is especially necessary providing timely artificial ventilation, which is the most effective method of eliminating acute hypoxia, due to the respiratory arrest [2, 3]. Before the artificial ventilation you must first verify the airway and if it needs to provide that.

Today there are different methods of providing airway in case of their obstruction with foreign body. When you remove a foreign body from the airway, in our view, it is appropriate to comply with the so-called method of «five plus five» which was proposed by the Red Cross. It is important to put five sharp blows by the base of the hands between the shoulder blades to the victim. Then you must perform five subdiaphragmatic abdominal thrusts (Heimlich Maneuver, Fig. 1) [9]. Then it is necessary to continue interchange five blows to the back and five subdiaphragmatic thrusts as long as the foreign body will not move from the place or the victim will lose consciousness.

Putting five blows between the shoulder blades is carried out as follows:

- Stand behind and slightly to one side to the victim.
- Supporting with one hand chest, you need to tilt the victim so that his body was below the horizontal line.
- Put increasing in intensity blows between the shoulder blades by the bottom of the palm.



Figure 1. Heimlich maneuver

- After each struck necessary to assess the degree of restoration of the airway.
- In case of a positive result, the number of inflicted blows could reach less than 5.

Perform the Heimlich maneuver, also known as abdominal thrusts: for the proper implementation of this technique requires more forward tilt of the victim, to stand behind the victim and cover him around his waist. Optionally, a little sit down to be on the same level with the body of the victim. Compact one hand into a fist and place it just above the navel of the victim, and the other hand to cover fist. A quick, upward movement of the press on his stomach, as if you trying to lift the victim. If it is necessary, do all the series of the five subdiaphragmatic shocks.

In providing assistance to the affected child, a young child can be put on your forearms to apply several light blows between the shoulder blades (Fig. 2. A) or put to the feet and easy to shake (Fig. 2. B) [9].

To recover airway in pregnant fist your hands should be placed directly under the xiphoid processus of the sternum. During the Heimlich maneuver, quickly press in the direction of the diaphragm, as well as directly on the chest.

If the foreign body has failed to budge, you need to repeat the cycle («five plus five») for as long as it will be able push out, or until the victim will lose consciousness.

Providing the airway in the the victim who is unconscious:

You must carefully lay the victim on his back. You must put your foot between the legs of the victim and when he loses consciousness, he will slip on the floor. To release airways – sit on top of the victim's legs and both your hands quickly press into subdiaphragmatic area toward the diaphragm or directly to the costal arch. Repeat the series of pressures (up to 5 times) to remove a foreign body.

In case of failure of the above techniques you need to create **additional respiratory tract** (to hold koniotomy or tracheotomy). Koniotom – a tube of small diameter with a sharp mandren (fig. 5) [3].

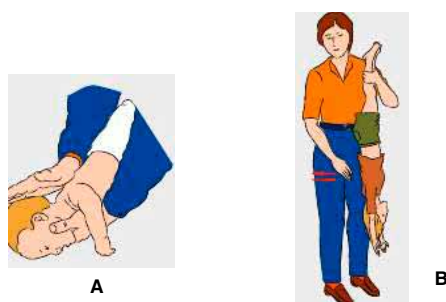


Figure 2. Releasing airways in children



Figure 3. Providing the airway in the the victim who is unconscious [9]



Fig. 4. Koniotom

Without koniotom it is possible to inject into the trachea in the midline below the thyroid cartilage 24 thick needles from disposable systems for intravenous infusion, followed by submitting through them oxygen (Fig. 5)

Tracheostomy – is an emergency surgical procedure, which is the introduction of a special tube into the trachea through an incision made on the anterior surface of the neck. In case of emergency, in the absence of tracheostomy tubes any tube can be used (preferably sterile) [4, 7].

If the victim is diagnosed cardiac arrest, you should immediately begin to conduct basic cardiopulmonary resuscitation.

Methods of artificial ventilation

In case of arrest breathing (the main feature of clinical death) put the victim on his back, on a flat, hard surface and quickly release him from compressive garments. Primarily to carry revision of the oropharynx and upper airway using direct laryngoscopy. If it is necessary to clean the oral cavity: remove dentures and remove mucus by fingers (too perform rapid circular motion clearing mouth by one or two fingers wrapped in a napkin or handkerchief) or by suction (electrical or mechanical) remove mucus. With the same purpose, you can use a rubber syringe, first of all cutting off its thin tip [5, 6].

In persons with injuries of the face and TMJ is recommended use of method Schaeffer (mechanical compression of the thorax) and Sylvester's method, which is a way to evoke inhaling through the abduction of the victim's hands, and exhale – after compression of the chest through adduction of his hands (*These methods are contraindicated in injuries of the chest*) [6].

Artificial respiration by blowing air can be achieved in different ways. If there are no additional devices, the ventilator can be carried out by the method of “mouth to mouth” or “mouth



Figure 5. Place of section and puncture of the cricothyroid membrane is indicated by arrows (by V.D. Malyshev, 1989).

1 – thyroid cartilage; 2 – cricoid cartilage; 3 – cricothyroid membrane.

to nose.” It is possible to avoid directly touching the mouth of the patient through providing the blowing of air through gauze, scarf or any other loose fabric.

Technique of artificial ventilation «mouth to mouth» or «mouth to nose»

To ensure the airway triple method Sahara is performed - over-extension heads in atlanto-occipital joint, forward displacement of the mandible and opening of the mouth (fig. 6) [10].

To perform this technique savior must kneel at the head of the patient, put one hand under his neck, another on his forehead and throw his head back as much as possible (preferably beneath the neck roll of clothing), simultaneously hold down the nose thumb and index finger by the hand that lies on the forehead. Next, push the lower jaw forward.

This manipulation is accompanied by the opening of the mouth, pulling the tongue to the hyoid bone and the maximum alignment of the airways. Remember that over-abduction of the head can cause narrowing of the airways. After a deep breath, the rescuer should cover the mouth of the victim and make a brief energetic exhalation. At the same time it is necessary to monitor the excursion of the chest of the patient, based on which you can evaluate the effectiveness of artificial respiration.

If the cause of clinical death was asphyxia, resuscitation should begin with the restoration of the airway and mechanical ventilation. First 5–10 breaths performed for 20–30 seconds. During the first 2–3 minutes the number of breaths per minute should be at least 16–20, next – 12–15 per minute [3, 4].

If ventilation is performed in infancy, it is better to capture her lips once the mouth and nose, and blow air in small portions so as not to damage the lungs.

Exhalation is performed passively by elastic forces of the chest. Duration of inspiration should be 2 times smaller than exhalation.

You must see to the air that is inhaled, did not lead to excessive stretching of the stomach. In this case, there is a risk of food masses penetration in the bronchi.

Artificial respiration by blowing air «mouth to mouth» creates some hygienic inconvenience. In addition, conducting technically correct performance ventilation is not easy for non-medical staff. Therefore, according to the latest international recommendations for non medical staff it is required to conduct only chest compressions due to which there is also passive excursion of the lungs.

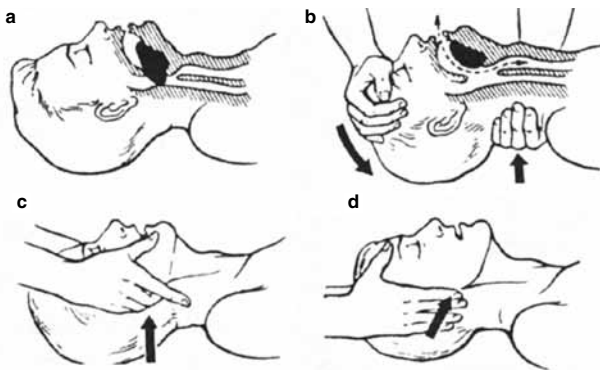


Figure 6. Triple method of Sahara

Artificial ventilation with hand respirators

For convenience artificial respiration manual devices were developed – a rubber Ambu bag, ARD-1 and others with a mask (Fig. 7). **These bags, respirators should be equipped with all medical facilities.** The ambulances and rescue station on the beach must be equipped with handheld respirators. Special automatic respirators are using at the hospital.

After the restoration of the airway, nose and mouth of the patient is closely imposed by mask. Compressing the bag, you make inhale, exhalation is carried out through the valve of the bag.

The use of air tubes

If you can use any type of air tube, it significantly simplifies the process of mechanical ventilation. Among the tubes are distinguished: nasopharyngeal and oropharyngeal (Fig. 8). Air tube is a relatively short T-shaped or S-shaped rubber tube in various sizes. To select the correct size of oropharyngeal air tube you need to determine the victim's distance from the angle of the lower jaw to the ear lobe and enter in the throat to prevent retraction of the tongue.



Figure 7. Ambu bag with face mask

Figure 8. Different size of oropharyngeal air tubes

The most common in clinical practice is Guedel and Safar tube. Safar air tube sometimes called «two Guedel» as S-tube resembles two interconnected flat Guedel tubes [11]. Their using does not solve the problem of protecting airways from aspiration, but allows to restore patency and to buy time in the provision of first aid in the absence of the possibility of using more reliable methods.

The nasopharyngeal Mahilla tubes have certain benefits compared with oropharyngeal tubes (Fig. 10), since less provoke vomiting and can simultaneously carry out sanitation of the oropharynx. In order to prevent complications should follow the proper technique to installation, which involves, first, moistening air conduit furatsillina, sterile isotonic solution of sodium chloride or neutral gel; manipulation carried out careful slow rotational movements based on individual patient anatomic features (size comparison air tubes and nasal passages).

Recently, for airway management modern modification of the overlaryngeal air tubes of second generation have become increasingly popular [6, 12]. Their main advantage compared with the first generation of air tubes are:

- A reliable hermetization of the larynx.
- Ability much longer mechanical ventilation at higher airway pressure.
- Reducing the probability of inflating the stomach with air, as provided for out excess respiratory gas through the gastric tract/
- Simultaneous drainage of the stomach/
- Availability of reliable protection from damaging teeth
- Ability to protection against aspiration of gastric contents.
- Simple in execution, so in the outpatient department today they are gaining in popularity.

Laryngeal tube – a short tube with one lumen (Fig. 11), which has advantages compared with air tubes (rapid and atraumatic setting), but the efficiency is inferior to tracheal intubation [12].

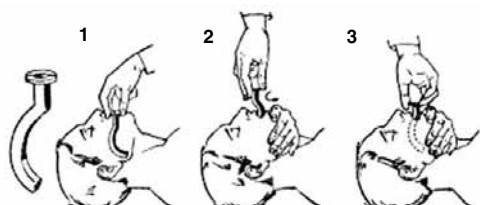


Figure 9 Technique of introduction of oropharyngeal Guedel tube



Figure 10 Nasopharyngeal tubes

Using combitube – combined esophageal-tracheal tube

When entering the combitube into the oropharynx its distal end enters the esophagus. Two cuffs that inflate and side openings between them provide adequate airway and prevent the risk of aspiration of gastric contents (Fig. 12). The main advantages of applying combitube are its rapid introduction and minimum time mastering techniques. The disadvantage is the inability of prolonged use, and inefficiency in the case of aspiration syndrome.

Laryngeal mask airway (Fig. 13) is used in clinical practice to avoid the dangers of endotracheal intubation and to maintain a reliable airway during the outpatient phase. Using laryngeal mask provides free penetration mix of breathing circuit to the airway of the patient by creating a hermetic contact.

The size and shape of laryngeal mask has certain advantages compared with the endotracheal tube: the inability to mask's tube penetration into the esophagus or trachea, there is no risk of damage to the vocal cords, rarely occur laryngospasm and cough.

Universality of design and ease of use of technique allowing it to apply paramedical personnel and paramedics for airway [2, 6].

Application of laryngeal mask provides a high success rate during ventilation, helping to solve the problem in the case of serious disturbances of the airway and allows sanation bronchoscopy. **In conducting cardiopulmonary resuscitation laryngeal mask is used to provide emergency airway management**, especially in cases of impossible intubation.

Application of laryngeal mask is shown in patients with diseases and **injuries of the cervical spine** and during mechanical ventilation in the outpatient phase.

There are many different modifications of laryngeal masks, including a special gel-like material in the obturator (i-Gel) [8].

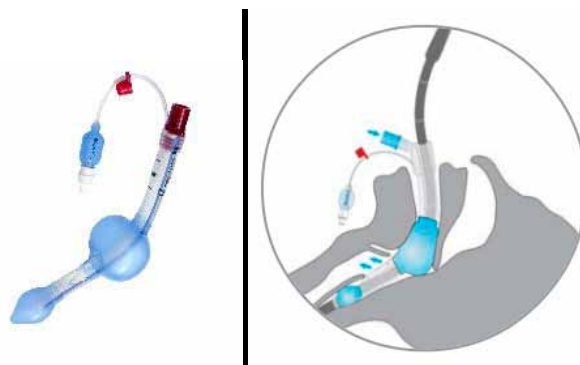


Figure 11 Laryngeal tube

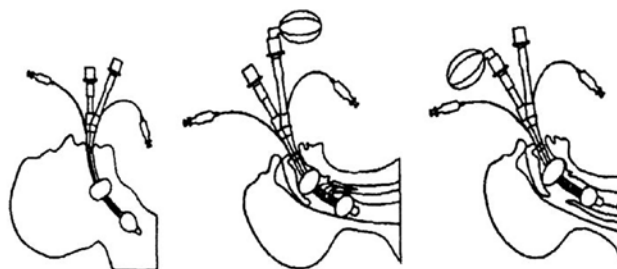


Figure 12 Technique of the introduction of the combitube
Application of the laryngeal mask airway

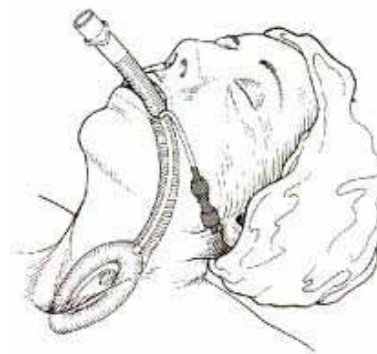


Figure 13 Laryngeal mask



Figure 14. The tracheal intubation



Figure 15. Handheld machine of artificial lung ventilation.

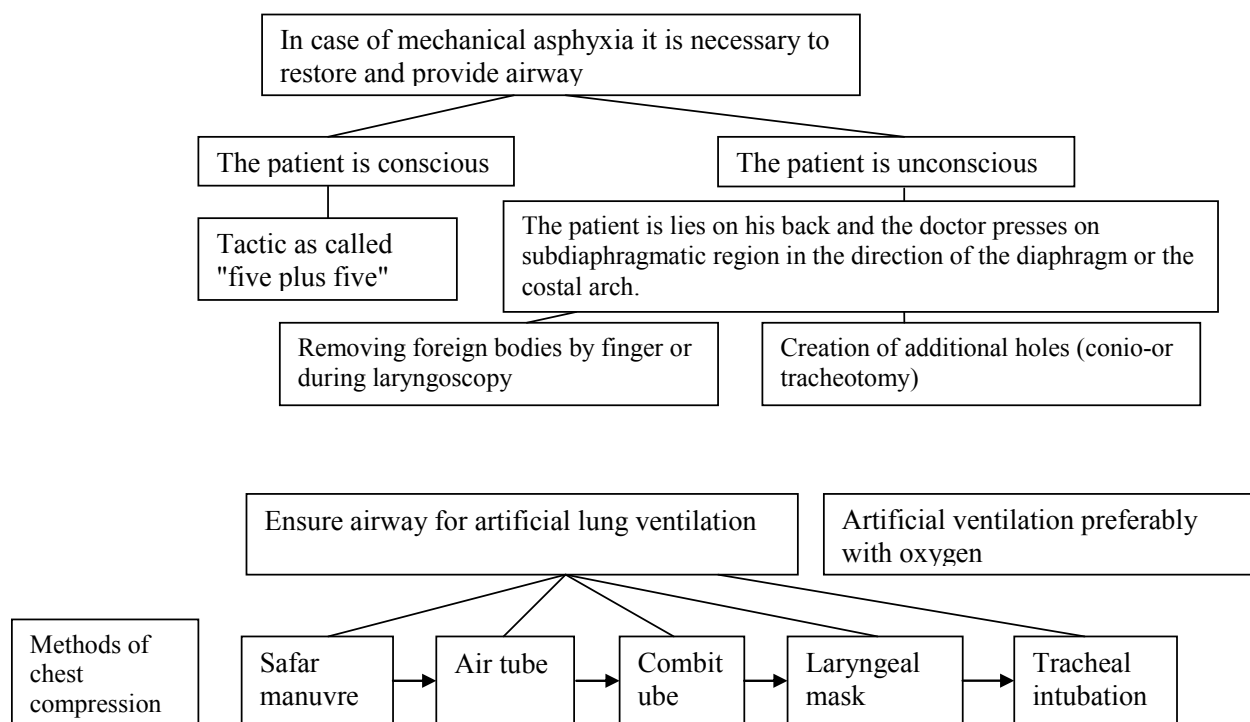


Figure 16. Airway management and artificial respiration

The size of the mask is different, depending on body weight and conforms to the anatomical and physiological characteristics of the patient.

Method of administration laryngeal mask: the patient's head bent in atlanto-occipital joint and easily bend the neck forward, which may use a pillow of small size (up 7–10 sm).

With the mask removed obturator air and provide a flat shape with curved front edge back. The dorsum of masks and obturator smeared neutral gel. The index finger serves as a fulcrum for the advancement of the mask in the correct position.

During the preparation and early introduction of the tip of

the mask is placed in front of the hard palate. Then cuff promoted deeper into the mouth, while pressing on the hard palate. With further advancement of the mask keep pressure on the contour of hard and soft palate. Then inflate cuff by introducing air into syringe connector [6, 7].

The use of tracheal intubation

The most effective method of ensuring the airway is endotracheal intubation. In case of the tracheal intubation there are no risk of retraction of the tongue and aspiration of vomitus. Indications for its use: reliable recovery of airway management, artificial ventilation, sanitation of the tracheo-bronchial tree, airway protection during gastric lavage for patients in a coma. In the outpatient department tracheal intubation rarely used due to lack of knowledge and skills of health workers and the necessary equipment.

Carrying out artificial lung ventilation using special devices

The most common methods of oxygen administration include: inhalation via nasal catheters, facial masks, oxygen tents, self breathing with continuous positive pressure, inhalation of oxygen through the breathing apparatus, hyperbaric oxygenation.

If prolong artificial lung ventilation is necessary tracheal intubation must be performed. Artificial respiration can be carrying out through the endotracheal tube – from mouth to tube and ventilation with special devices (Fig. 15). These devices allow for artificial respiration for many days or even months. If artificial respiration is necessary for 3–4 days and more tracheotomy is performing [3].

One of the simplest and at the same time effective treatments for patients with acute respiratory failure is oxygen.

The main conditions for oxygen therapy are continuous humidification of oxygen, as in the case of the removal of cyanosis – the use of oxygen at a concentration not exceeding 40 %.

For humidification of oxygen you can use Bobrov machine, and if it is absence, using humidified cloth.

During medical care in the outpatient phase, it is important as soon as possible medical emergencies or to transport the victim to a medical facility to provide quality medical care [1].

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СОВРЕМЕННЫЕ ПРИНЦИПЫ ОБЕСПЕЧЕНИЯ ПРОХОДИМОСТИ ДЫХАТЕЛЬНЫХ ПУТЕЙ И ПРОВЕДЕНИЯ ИСКУССТВЕННОЙ ВЕНТИЛЯЦИИ ЛЕГКИХ

П. Ф. Дудка, Д. В. Добрянский, О. И. Бодарецкая, И. П. Тарченко, Л. Б. Петелицкая

Резюме. В работе освещены наиболее простые в исполнении, эффективные приемы, необходимые для обеспечения проходимости дыхательных путей при попадании в них инородного тела, а также методы контроля проходимости дыхательных путей в медицине неотложных состояний.

Представлены современные аспекты проведения искусственной вентиляции легких (ИВЛ), а также основные приемы и средства, необходимые для обеспечения проходимости дыхательных путей и проведения ИВЛ на догоспитальном этапе оказания медицинской помощи: прием Гейлиха, тройной прием Сафара, воздуховод, комбитрубка, ларингеальный масочный воздуховод и др. Описаны основные характеристики устройств для оказания неотложной медицинской помощи и проведения ИВЛ, даны практические рекомендации по технике их применения.

Ключевые слова: сердечно-легочная реанимация, проходимость дыхательных путей, искусственная вентиляция легких.

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CONTEMPORARY PRINCIPLES OF AIRWAY MANAGEMENT AND ARTIFICIAL RESPIRATION

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Abstract. The article highlights the most simple and effective techniques of airway management in case of foreign body ingestion in the respiratory tract and methods of control airway in medical emergency conditions. It presents contemporary aspects of artificial ventilation, as well as methods and tools for airway management and artificial ventilation in the out of hospital care: Geymliha's method, Safar's triple manoeuvre, laryngeal tube, combitube, laryngeal mask airway, and others. The basic characteristics of the devices for emergency medical care and artificial ventilation are described and practical recommendations for their application technique are given.

Key words: cardiopulmonary resuscitation, airway management, artificial ventilation.

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