

# **CARDIOPULMONARY RESUSCITATION**

## **I. Basic cardiopulmonary resuscitation**

### **1.1. Methods of recovery**

Uniform International Guidelines in reviviscence of the body were first developed after the first World Science Conference (2000) for cardiopulmonary resuscitation and emergency cardiovascular care. In medical practice CPR is the "gold standard" which can be divided into 2 stages:

**1. Basic CPR (Basic Life Support)** which can be rendered by rescuers, firefighters, trained non-medical and medical workers and others.

Basic CPR establishes an adequate Airway, artificial respiration (Breathing) and external cardiac massage (Circulation) - ABC technique. This is the initial stage of recovery when the rescuer is one-to-one with the injured and must render resuscitation only with his bare hands.

**2. Specialized cardiopulmonary resuscitation** (Advanced Cardiovascular Life Support) are performed by medical staff (emergency services, doctors of the intensive care unit), trained and provided with appropriate medical equipment and medicines.

Specialized CPR requires consistent execution of basic techniques but with intensive care facilities, equipment, medical supplies for the efficient recovery. Effectiveness of resuscitation after the clinical death will depend on the scene (at home, in the street, in the emergency department and intensive care), rescuer, clear consistent implementation of the ABC techniques. Violation of these rules may lead to the transition of the clinical death to the biological death.

Survivability will depend on (early and timely):

- Recognition of blood circulation arrest (breathing arrest), and calling medical emergencies or resuscitation teams for specialized CPR;
- Performing of the basic CPR;
- Implementation of electrical defibrillation;
- Early performing of the specialized CPR.

### **Indications for cardiopulmonary resuscitation.**

The main indication for cardiopulmonary resuscitation (CPR) is a blood circulation (cardiac) arrest and respiratory arrest.

**1. Circulation (cardiac) arrest.** Blood circulation, the supply of the vital organs with oxygen, nutrients stop after cardiac arrest. The agonal type of breath failure is possible at this time, and it must be differentiated with adequate breathing in order not to make mistakes in rendering assistance. Cardiac arrhythmias (ventricular fibrillation, ventricular tachycardia, asystole) can lead to the cardiac arrest.

**2. Respiratory arrest.** The reasons are drowning, falling foreign objects into the airway, smoke inhalation, asphyxiation, lightning, stroke, coma of various origin, drug overdose, etc. In primary respiratory arrest the heart and lungs continue to deliver oxygen to the brain and other organs for a few minutes. If the victim has respiratory arrest or inadequate breathing it is necessary to use breathing resuscitation which can prevent heart failure.

### **Sequence of basic resuscitation.**

**1. Checking of consciousness.** You must make sure that the patient has persistent loss of consciousness.



Fig. 1. Checking of consciousness.

***Performing skill: Checking of consciousness.***

Depending on the position of the patient's body: sitting (the drivers of different transport types after an accident), lying (on the bed, on the ground) you should loudly talk to patient or take the shoulder and shake gently asking for his name (Fig. 1). If the victim does not respond (no consciousness), you need to call the ambulance (103, 112), than to start the restoration of the airway.

**2. Restoration and maintenance of the airway.**

If the injured is unconscious, the rescuer must assess airway and breathing efficiency. It is necessary that person is lying on his back on a firm flat surface. If the injured is lying on his stomach, he/she must be carefully turned back in order to move the head, shoulders and trunk like one. The rescuer takes the comfortable position to be able to perform CPR and artificial breathing.

In unconsciousness muscle tone is feebly marked, it leads to the retraction of the tongue, which is a common cause of airway obstruction. Anatomically the tongue associated with the lower jaw, so after pulling the lower jaw forward the tongue shifts ahead from the back of the throat and opens the airway. This technique will be more effective if the rescuer will do head-tilt and jaw thrust simultaneously. It is important to inspect the neck from all sides (no deformation, damage of the neck and head) before that. If trauma of the head or neck is absent - perform skill: *head-tilt and jaw thrust*. You should remove foreign objects (blood clots, vomit, dentures, etc.) from the mouth before performing this skill.

***Performing skill: Cleaningn mouth with your finger.***

It is possible to open injured's mouth with the thumb and forefinger of one hand fixing the jaw. Inspect mouth. If there is a foreign objects inside, turn victim's head to the side (if there is no damage of the head or neck). Try to release the oral cavity from foreign objects, vomit, blood clots, dentures, sputum with the index finger of the other hand, wrapped with gauze (handkerchief) (Fig. 2). If there are no foreign objects inside, inspection of the mouth with finger is not carried out.



Fig.2. Cleaning the mouth with finger

***Performing skill: head-tilt and jaw thrust*** . The injured lies on his back on a firm flat surface. With one hand placed on the forehead of the victim, tilt his head, while with other hand lift his chin up. The lower jaw is moved forward (Fig. 3). The head is in the position when chin is raised, teeth are closed.

If there is a damage of the neck and tilt of the head is prohibited, perform only lower jaw thrust.

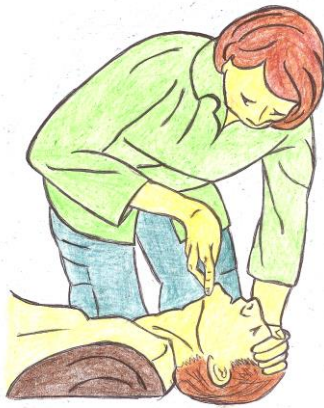


Fig.3. Head tilt–chin lift and jaw thrust.

**Performing skill: Only the lower jaw thrust.**

Not only professional rescuers but everyone have to master this skill. Only the lower jaw thrust without the victim's head tilt is the safest technique for suspected cervical spine injury. To do this, stand at the head of the injured, who lies on a firm flat surface, place II-IV fingers of both hands on the left and right side of the lower jaw. The thumbs of both hands are on the chin, and the other fingers capture the angle of the mandible. Fix jaw, slightly raise and push it

forward (Fig. 4). Turning of the injured's head to the side is prohibited in order not to exacerbate the damage and injure the spinal cord. This technique makes it possible to eliminate the sunken tongue and maintain a clear airway.

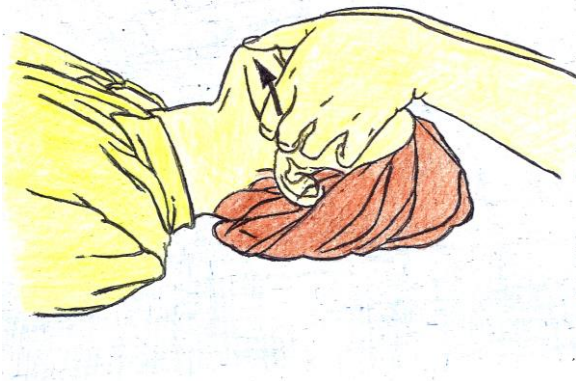


Fig.4. Only the lower jaw thrust.

**3. Checking of breathing. Evaluation of the breathing effectiveness.**

After the restoration of the airway you must evaluate the effectiveness of independent injured's breathing!

**Performing skill: Checking of the spontaneous injured's breathing.**

The injured lies on his back on a firm flat surface. With one hand placed on the forehead of the injured unbend his head, while the fingers of the second hand lift the injured's chin. Supporting the jaw rescue bows his head so that the ear is near the mouth and nose of the injured, and the gaze is directed to the chest monitoring respiratory excursion. Such a position of the rescuer's head allows to feel the movement of the victim's exhaled air and to observe the movement of the chest (Fig. 5). Do assessment of breathing quickly, no more than 10 seconds! If breathing is present, and there are signs of circulation, the injured is placed in a safe position (recovery position).



Fig.5. Checking of the spontaneous injured's breathing.



**Performing skill: Safe position for spontaneous injured's breathing.**

If the injured is unconscious but breathing is adequate, you need to put injured in a safe position, call the ambulance (103, 112). The safe position is the position of the injured's body when breathing is correct and vomit can not get into the respiratory tract. This does not always happen, so you need to check the breath of the injured regularly. Injured is on his back, right upper limb is removed from the body and bent at a right angle at the elbow joint (Fig. 6 a).

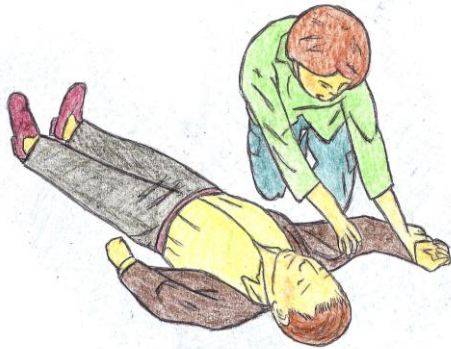


Fig. 6 a. Safe position for spontaneous breathing

The left upper limb also bend at the elbow and lead to the body so that the palm of the hand covers his right cheek and right ear (Fig. 6 b). Rescuer with one hand fixes injured's left hand at the right cheek and ear, with second hand bend the left lower limb in the knee joint, fixing the place of bending with arm (Fig. 6 c).



b



c

Fig.6. Safe position for spontaneous breathing

Rescuer moves his left hand on the left shoulder of the injured. He gently rotates the trunk with both hands on the right side. Rescuer tries to put the injured's head on the forearm of his left hand. Right leg is straight. Curved limbs ensure stability of the injured's body (Fig. 6d). Rotation of the trunk to the left side into a safe position is possible with a similar bent limbs.

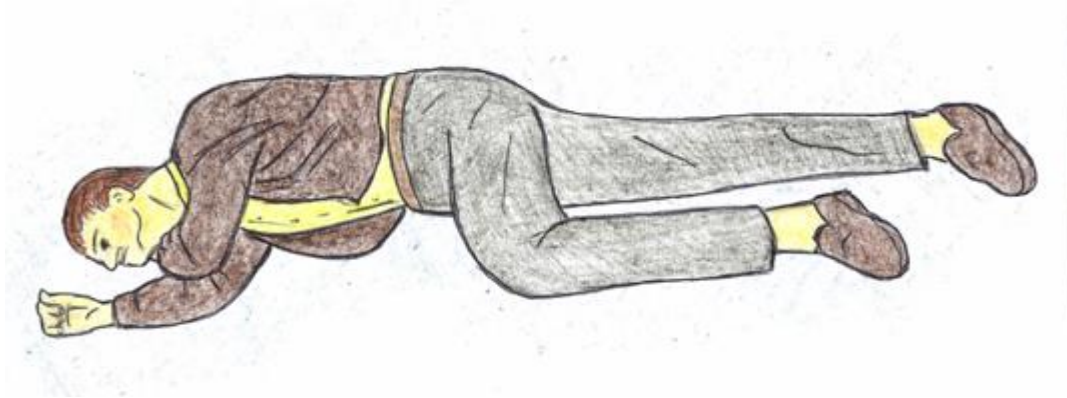


Fig. 6 d. Safe position for spontaneous breathing

### **Chest compressions (Circulation)**

Heart is located in the mediastinum between the sternum and the spine. The blood from the pulmonary vessels does not reach the heart after its arrest. When you press on the sternum the heart is compressed, the blood is pushed out from the cavity into the small and large circulation. Chest rises due to the elasticity - the heart fills with blood again.

If the patient has no respiratory excursion, no air is inhaled and exhaled - breathing is absent. You need to call an ambulance (103, 112) and start CPR.

There are two methods of cardiac massage: direct and indirect. Direct cardiac massage is possible when chest is open during cardiothoracic operations. Indirect cardiac massage mechanism is possible due to two types of actions: a breast pump and direct compression of the heart. If cardiopulmonary resuscitation does not last long - it is a mechanism of cardiac pump, and if it is long - the heart gradually reduces its pumping action. In this case the breast pump is predominant, cardiac output after chest compressions is significantly reduced. Properly performed chest compressions may increase systolic blood pressure from 60 to 80 mm Hg, diastolic pressure remains low. Average pressure in the carotid artery seldom exceeds 40 mm Hg. The volume of cardiac output is 1/4 or 1/3 of the normal output. Volume of blood output decreases during prolonged cardiopulmonary resuscitation. The importance of chest compressions with the frequency at least 100 times per minute is shown with experimental and clinical studies. It is possible to increase the frequency of chest compressions in order to achieve a higher level of coronary and cerebral blood flow.

#### ***Performing skill: Chest compressions.***

The injured lies on his back on a firm flat surface, the head is not above the level of the chest (not to impair the blood supply to the brain during its compression), the lower limbs of the injured are lifted to increase central blood volume. You should to unbutton clothes to avoid squeezing the chest and abdomen. Rescuer may be on either side of the injured. Define a point of the hands location (Fig. 7).

It is located on the sternum two fingers above the xiphoid process.

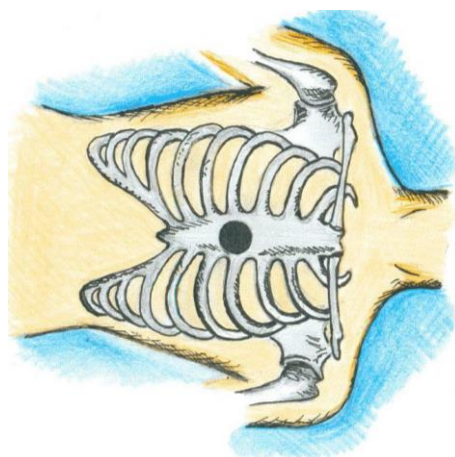


Fig.7. Point of the hands location during chest compressions

Place the palm of the one hand on the lower third of the sternum (the projection of the heart ventricles), and cover it with the second hand, to fix "the castle" (Fig. 8). Give 30 chest compressions. First compression is done slowly to determine the elasticity of the chest, next compressions should be performed without pushes with straight elbow joints (Fig. 9). Not only the power of the hands but the weight of the body is used in this case, which will provide power saving and increase the effectiveness of the massage. Compression rates is 100 per 1 minute, the depth of compression is 4-5 cm. Start the resuscitation with 30 chest compressions followed by two breaths of air into the injured's airway (30:2).



Fig.8. Chest compressions. The hands are in "the castle"



Fig. 9. Perpendicular location of hands during CPR

### **Typical errors during chest compressions.**

The most common error is insufficient intensity of chest compressions. It is possible when resuscitation is carried out on a soft surface, or when the intensity of compressions is not enough force. The synchronous pulse on large arteries is absent in this case.

By the way, the rest during cardiac massage more than 5-10 seconds is a great mistake (for example, during the treatment or diagnostic procedures).

Frequent complication during cardiac massage is broken bone skeleton of the chest, especially in the elderly. Such fractures lead to mechanical lung damage, function of breast pump and the suction of venous blood from the systemic circulation into the right atrium are impaired. If the fracture occurred, resuscitation continues in full.

### **Artificial respiration (breathing): respirogenesis**

After inspection of the oral cavity (absence of foreign objects) and 30 chest compressions you may to begin rescue breathing.

Exhaled rescuer air contains oxygen, carbon dioxide, it enters into the lungs fast and in efficient way. If the expiration is strong, partial pressure of oxygen in the alveolar air can sometimes reach up to 80 mm Hg.

Many bystanders want to do CPR, but they have a psychological barrier (fear of the infection). To eliminate the possibility of contact infection it is better to use simple mask with one-way air flow valve, napkins, handkerchiefs, airway tube, S-tube.





Fig.10. Ventilation "mouth to mouth."

***Performing skill: Ventilation "mouth to mouth."***

The injured lies on his back on a firm flat surface. With one hand placed on the forehead of the victim rescuer unbends his head, while the fingers of the second hand lifts chin up(Fig. 10).

Rescuer supports the jaw with one hand, quickly covers injured's mouth with a napkin (handkerchief), tightly grips the nose with second hand, takes a deep breath, tightly covers the injured's mouth with lips and blows the air. Simultaneously should observe the

movement of the chest, it rises during exhalation air by rescuer and falls during expiration by the injured.

Rescuer does second exhalation after the chest down. Thus, it should be done 30 chest compressions, then 2 exhalations of air to the injured "mouth to mouth" in the ratio 30:2 until rescue ambulance will come.

**Typical errors and complications during CPR.**

The most common mistake is the lack of tightness in the "loop" Rescuer - Injured. Rescuer, who performs it at a first time, forgets to grip tightly injured's noses, or to cover tightly his mouth. The lack of excursion (movement) of the chest would indicate about this. Second mistake is unliquidated blocking of the injured's tongue, because of air goes into the stomach. The appearance and increase bulge in the epigastric area (under the xiphoid process) would indicate about this. You should to turn quickly the injured to the side and to push on the epigastric region in this case. It is possible ingress of the gastric contents into the upper respiratory tract at this time. This manipulation is allowed for intensive care physician with presence of electrical or other type of suction.

If there is damage of the mouth and it is impossible to perform CPR "mouth to mouth" - perform "mouth to nose." Injured position does not change. With one hand placed on the forehead of the injured rescuer unbends his head, while the fingers of the second hand press the lower jaw to the top, puts the napkin on the injured's nose, tightly covers his mouth and blows the air into nose. The ratio of compressions to breath remains constant - 30:2.

**1.2. Basic life support, automated external defibrillation (AED) (European Conference, 2000.)**

Realization of early defibrillation is necessary for saving the victims after cardiac arrest, especially in the first 6-10 minutes, and when cardiopulmonary resuscitation performed. Ventricular fibrillation (VF) is a frequent initial manifestation of the sudden cardiac arrest, and tends to go into asystole within minutes. Successful of the defibrillation decreases within time, so it must be done as soon as possible. If electrical defibrillation is used in the resuscitation process right after cardiac arrest, the result of survival is 80%, a delay of 5 minutes reduces patient survival to 50%.

In the USA and some European countries there is a widespread so-called "AED". Modern apparatus AED is a computer device that analyzes the heart rhythm and its change, automatically switch on a defibrillator. Just click "Discharge". AED

takes proper account of the chest resistance and automatically selects appropriate discharge energy. The analyzer is able to detect not only ventricular fibrillation but ventricular tachycardia. Therefore, the discharge is performed even when the frequency rate exceeds a preset limit.

If injured is unconscious with cardiac or respiratory arrest, algorithm doesn't differ from the previous one. Start by checking of injured's consciousness - to call out to him loudly, easily shake the shoulder. If reaction is absence, open airway with subsequent determination of breathing. If the injured is not breathing or is breathing properly, call the ambulance (103,112). Immediately begin cardiopulmonary resuscitation (CPR) with chest compressions (30 compressions at 100 per 1 minute) followed by 2 blowing air into the injured's airways. The ratio of compressions to breath does not change - 30:2, connects a defibrillator. For this purpose, the skin of the chest must be dry (water is a dielectric). Prepare the defibrillator. Most models have a picture how to stick electrodes. Before this you need:

- Assess moisture of skin chest (may be increased because of the intense sweating, after removing the injured from the water). Quickly and carefully wipe sticking places for the electrodes.

- Pay attention to the hair side of the chest, this can interfere the tight sticking of the electrodes. In this case you can use the devices to shave, take into account state of the injured and the loss of valuable time.

- The patient (victim) may use different patches for therapeutic purposes, located in the areas where you plan to attach the electrodes. It should to be removed quickly in a purpose as not to cause burns during defibrillation.

- The injured may have implanted pacemaker (cardioactivator) under the skin on the chest. Most often it is implanted below the collarbone. In this case, the defibrillator electrodes are placed below or to the side of the pacemaker (not on it).

- If the injured (patient) has the metal jewelry (piercing, etc.), it is needed to be removed. If this is not possible, the electrodes is not stucked on the jewelry to prevent contact electrodes with metal.

The first electrode (projection apex) should stick below the left armpit, the second electrode - right in II intercostal space under the clavicle near the sternum (Fig. 11).

Connect the automatic defibrillator. Make sure that no one touches the injured. If there is a person who is trained in the first aid, you should allow him to compress the chest and do rescue breaths, and second person does defibrillation (AED) (Fig. 12).





Fig.11. The electrodes on the body of the victim



Fig.12. Caution when performing defibrillation

Need to listen to a defibrillator. If the AED gives the command to start CPR, you must immediately do chest compressions, rescue breaths. Recommended parameters defibrillation in adults are: the first attempt - 200 J, the second - 300 J, after a failed attempt - 360 joules (200 J is equal to 2500 V). If the victim began to breathe properly, but he is unconscious, it is necessary to put him in safe position.

**Common mistakes during defibrillation:**

- Late connection of the defibrillator.
- Absence of CPR in preparation for defibrillation.
- Not enough of contact between the electrode and tissue.
- The wrong measure of the defibrillator energy.

**1.3. Resuscitation in the hospital.**

The necessity of reanimation may occur at any department of the hospital (therapeutic, ophthalmological, neurological, etc.), without professional rescuers nearby. If the patient is unconscious - nurse (doctor) does resuscitation according to the above scheme. It is necessary to check the consciousness - loudly call out, call the name, gently shake the shoulder. If there is no response, call for help of colleagues and start resuscitation, check the breath and the presence of the pulse at the carotid or femoral arteries. If the signs of life are absence, call resuscitation team and begin CPR at a ratio of 30:2. You should lay the patient on a firm flat surface, put head to chest level, lightly bend lower extremities. Compressions should be made by the method written above, do not forget about the rules of personal safety (always use rubber gloves, mask, glasses (Fig. 13). During external cardiac massage (30) with the use of respiratory devices (laryngeal mask, Ambu bag, airway tube, S- tube) make two rescue breaths.

Laryngeal Mask Airway(LMA) or laryngeal mask (LM) (Fig. 14) provides free entry of air from the rescuer to the injured by creating a tight contact with soft tissues of the laryngopharynx above the entrance to the larynx.



Fig.13. Personal safety while performing resuscitation

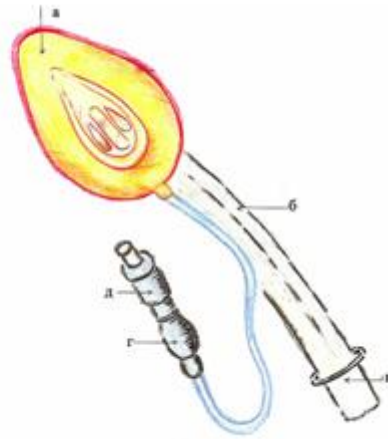


Fig.14. Laryngeal Mask:  
a –mask obturator, b-airway tubus, c-connector, d-control inflatable balloon, e-valve.

The proximal end of the tube is connected to the air breathing system with a standard connector with the diameter 15 mm, and the distal end of the tube is connected with cuff of mask obturator. Cuff becomes elliptical shape after filling with air through a tube with a valve.

Laryngeal mask is tight up to the root of the tongue after insertion it into the upper respiratory tract, pushing tongue forward and up to the upper edge of the epiglottis, epiglottis lifts above the entrance to the larynx (Fig. 15).

The tip of the obturator cuff reaches upper esophageal sphincter, gas mixture does not come into the esophagus and oropharyngeal secretions – into the larynx. Mask obturator fits to oropharyngeal tissues (pressure - no more than 60 cm H<sub>2</sub>O) without irritating protective reflexes of the pharynx and larynx.

Indications for using of laryngeal mask are: restoring and controlling the airway and ventilation in patients with traumatic brain injury, stroke, poisoning, cardiopulmonary resuscitation, when intubation is not possible (no expert).

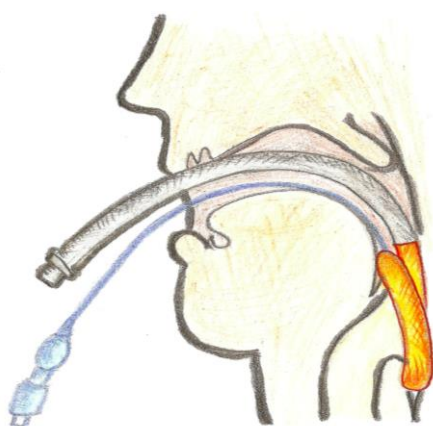


Fig. 15. The ratio of the anatomical structures of hypopharynx and obturator mask in an ideal position of L.M.

**Performing skill: the standard technique of laryngeal airway mask using** (Suslov VV, 2007).

Select laryngeal mask not less than three sizes to the injured, depending on the weight of the body. Smear outer surface of the mask and the obturator with neutral gel. Pay attention to the fact that the gel in its composition does not contain anesthetics (lidocaine). Do preoxygenation before the insertion of masks. Introduce muscle relaxants to the athletic patients. If the injured has coma, you shouldn't perform anesthesia for inserting laryngeal mask during CPR. The injured lies on his back, his head back and then straighten slightly bending forward. Take laryngeal mask with your right hand holding the tube between thumb and forefinger. Open mouth with your left hand, gently put the mask

slightly bending forward. Take laryngeal mask with your right hand holding the tube between thumb and forefinger. Open mouth with your left hand, gently put the mask

with your right hand while pressing the middle finger on the lower jaw keeping mouth opened. Move your left hand to the occiput and push forward a little bit (Fig. 16a)

Place the index finger of the right hand on the inner surface of the cuff above the holes that complete airway tube. Direct cuff with this finger, holding tube to the palate, lower the mask with sliding movements until you feel resistance. Tilt patient's head slightly forward (Fig. 16 b, c). Pull the index finger of your right hand from the mouth of the injured, holding the laryngeal mask with your left hand (Fig. 16 d).

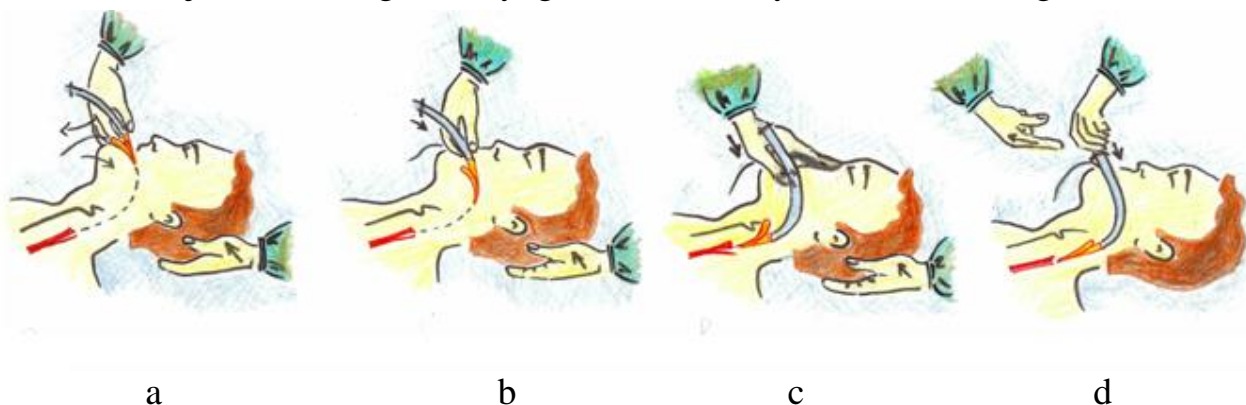


Fig.16. The standard technique of laryngeal airway mask using

Head tilt – chin lift with jaw thrust and fixing above airway is obligatory when using a breathing apparatus for artificial respiration (Fig. 17 a, b).

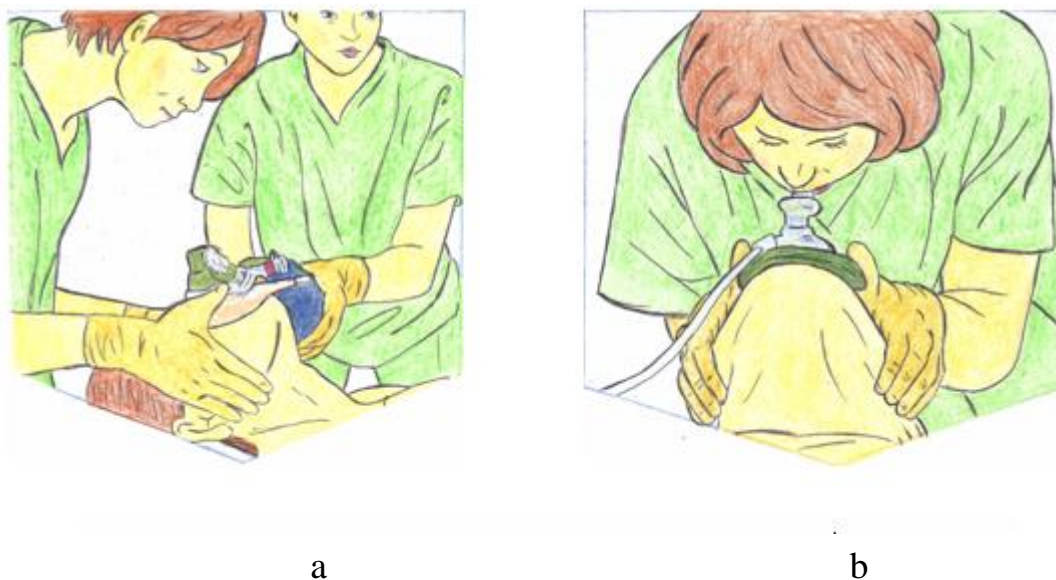


Fig.17. Fixing devices for respiratory airway.

To reduce infection of resuscitator (rescuer) mechanical ventilation may be performed using S- tube (Fig. 18).

***Performing skill: Introduction S- tube.***

The proximal end of the S-tube is passed into the mouth with curved (convex) surface to the upper jaw, the inner surface - to the tongue, put it to the root while slipping on it. There is the limit in the middle of the S- tube (level of injured's lips), it does not allow to enter the tube deeper.



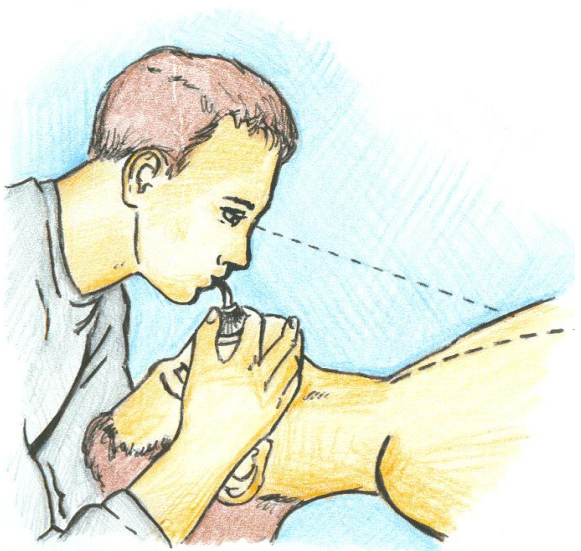


Fig.18. Artificial ventilation with S- tube

The airway tube should be put in the same way. If airway is not blocked with tongue, the insertion of S-tube, airway tube is possible. If airway is blocked with tongue and it is impossible to do head-tilt (in case of cervical spine damage), S-tube is inserted with curved (convex) surface to the tongue. At the level of tongue root it is rotated 180 degrees. Tube fixes and keeps the tongue and prevent the airway obstruction. Breaths are possible through the distal end of the tube.

Ventilation through a mask with the Ambu bag (Fig. 19) is effective.

Mask size is selected according to the age of a child or an adult, tightly apply to the face, and the configuration of the mask should suit for the nose and chin. Number of compressed bag and blowing air into the airways may be used depending on the age of the victim.

Give two breaths after every 30

compressions. Assistants set up the defibrillator and connect it (Figure 20).



Fig. 19. Artificial ventilation with help of Ambu bag.



Fig.20. Connecting the defibrillator to the patient.

Special team of resuscitators takes the patient for further specialized manipulations.

After the inspection, if the signs of patient's life were found, it is necessary to identify the cause of the critical state urgently. View airway, breathing rate, heart rate, connect oxygen, monitor blood pressure, heart rate, ECG, at the same time call specialized team and transfer the patient to the resuscitation team.

#### 1.4. Children basic life support.

Children's resuscitation is conducted to the age. Infants basic life support is conducted by trained personnel at the hospital. Basic life support for children older than 8 years is the same like for adults.



If the child has breathing or cardiac arrest it is important to assess the degree of safety for both the rescuer and child. It all depends on where the tragedy occurred: at the hospital, on the road, at home. Find out whether the effect of external factors: fire, smoke, chemicals and other substances, the danger of explosion mix in case of an accident. You should immediately call for help, examine the injured, the area around it in order to exclude the impact of different means (drugs, bottles, etc.), which could lead to a terminal state. Examine airways, restore their patency. Use the described scheme to assess the presence of breath. If the child breaths - put him to a safe position and carefully follow the act of breathing.

If breath is absent - give five rescue breaths. If the chest does not rise, no excursion (movement) of the chest, you should skip the evaluation of blood circulation and re-examine the airways, to restore their patency of the above methods. After the re-examination of the respiratory tract you should assess the state of blood circulation by determining the pulse at the carotid artery. If signs of life are absent - perform 15 chest compressions synchronously (simultaneously) with two rescue breaths, then continue CPR during 1 minute (100 compressions). Young children have heart placed 2-4 cm higher than adults, give compressions with two fingers of one hand (Fig. 21), or both thumbs of both hands, placing them on the sternum, and covering the body of the child with others (Fig. 22).



Fig.21. Chest compressions for baby with one hand

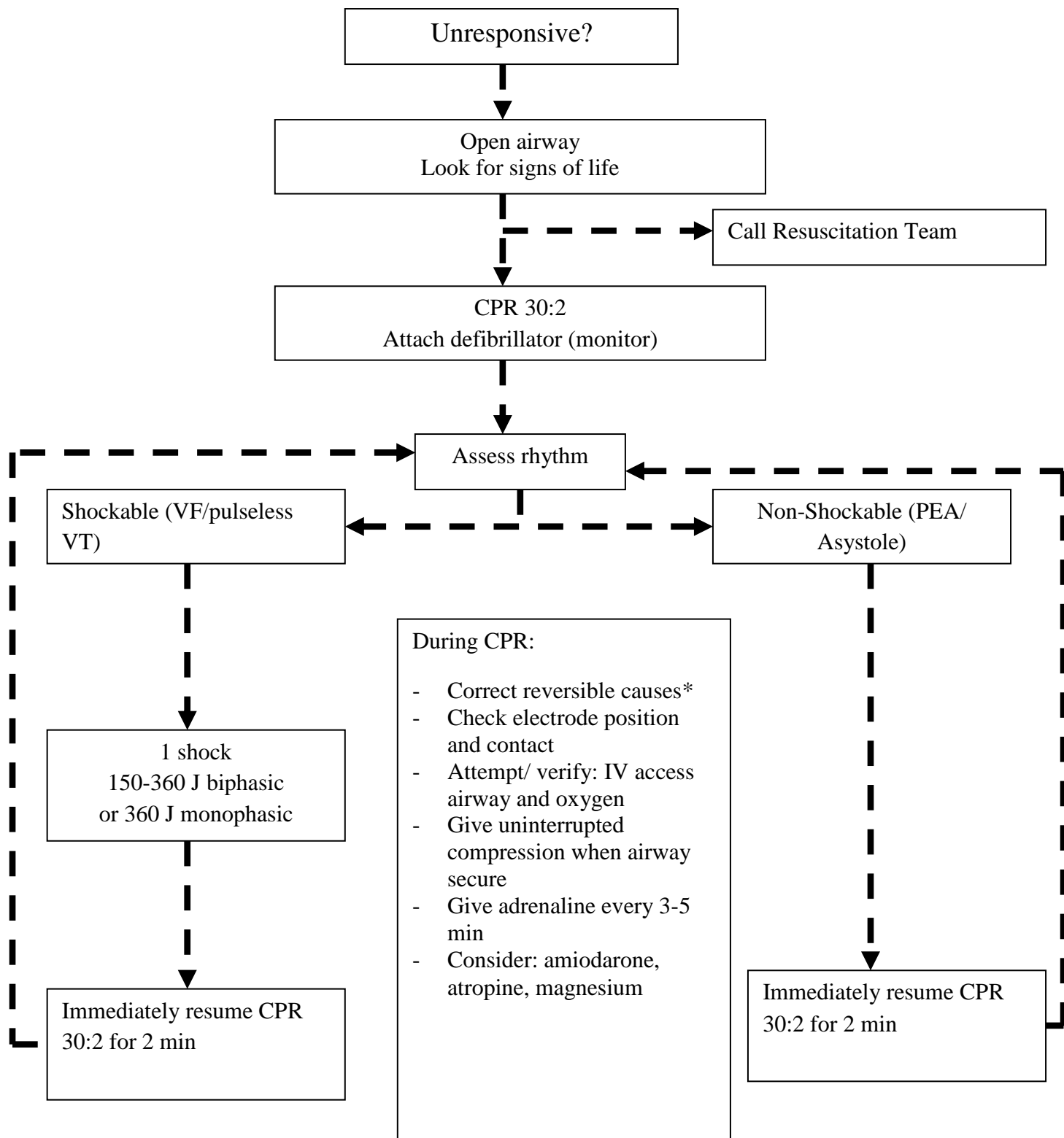


Fig.22. Chest compressions for baby with two hands

During CPR for children under 1 year it is important to follow the rules of the amount of compression: more than 100 per 1 minute - 2 compression in 1 second, from one to eight years - at least 100 compressions per 1 min. Again assess the state of the child (respiration and circulation are present), if breathing and circulation are absent - you must call the emergency services.

## 1.5. Special events

Universal algorithm (according to the European Conference 2000)



\*Reversible causes

Hypoxia

Hypovolaemia

Hypo/hyperkalaemia/metabolic disorders

Hypothermia

Tension pneumothorax

Tamponade, cardiac

Toxins

Thrombosis (coronary or pulmonary)

## **II. The American Heart Association (AHA) Recommendations of about CPR and first aid in case of cardiovascular diseases.**

The International Conference (Dallas 2010) has developed Guidelines for cardiopulmonary resuscitation (CPR) and first aid in case of cardiovascular diseases (CVD). Tens of thousands of materials about resuscitation were studied. 36 experts-resuscitators from 29 countries took part in evaluating of the data, within 36 months they analyzed the published material and made 411 scientific reviews from 277 subjects related to resuscitation.

The American Heart Association (AHA) in cardiopulmonary resuscitation (CPR) and first aid CVD 2010 covers the principles of resuscitation and recommendations that change the theory and practice of resuscitation. These recommendations are aimed at reducing death and disability due to cardiovascular disease, stroke.

The main issues of Recommendations:

1) The quality of chest compression requires improvement (although the quality of CPR was improved and survival rate of victims was increased thanks to the recommendations by the AHA CPR 2005);

2) survival may vary depending on the services that provide emergency care in case of cardiac arrest outside of health facilities;

3) the majority of patients with cardiac arrest outside the medical facilities need urgent CPR and get it from bystanders.

Changes in the AHA Guidelines for CPR and first aid CVD 2010 were direct to solve these problems and to reduce the impact after cardiac arrest.

According to Recommendations the AHA emphasizes the importance of quality CPR:

1. Frequency of compressions must be at least 100 per minute. (Instead of "at about 100 compressions per 1 min.").

2. Compression depth should be at least 5 cm (2 inches) for adults and at least one third of the chest diameter for children (infants - about 4 cm (1.5 inches), older age - 5 cm (2 inches). Pay attention that the depth of 4-5 cm (1.5-2 inches) for adults is not used. Absolute depth for children was increased as compared to the depth specified in previous versions of the AHA Guidelines for CPR and first aid for cardiovascular disease.

3. After each compression chest should be fully straightened.

4. The intervals between chest compressions should be minimal.

5. You should avoid excessive lungs ventilation.

Proposed ratio of "compression-breath" 30:2 for one rescuer in providing assistance to adults and children (except infants) has not changed. Inspiratory duration specified in the Guidelines for CPR AHA has not changed and is in 1 second.

Chest compressions after insertion of an endotracheal tube can be performed without interruption (with a frequency of <100 compressions per 1 minute), without a break for artificial respiration. Rescue breathing can be performed with a frequency of approximately 1 breath every 6-8 seconds (about 8-10 breaths per 1 minute). You should avoid excessive lungs ventilation.

**Change the sequence of the A-B-C to C-A-B**

In AHA Guidelines for CPR and first aid CVD 2010 change of the sequence of basic actions to maintain vital A-B-C ( open airway, artificial breathing, chest compressions) to C-A-B (chest compressions, open airway, artificial breathing) for adults and children (except infants) is proposed. Such fundamental changes in the sequence of CPR require **retraining** of all those who was trained for CPR. According to all the authors of the AHA recommendations expended efforts are justified.

***Key issues and major changes in accordance with the AHA Guidelines for CPR for medical personnel and rescuers:***

1. Recognize cardiac arrest and call the ambulance.
2. To start CPR in time with an emphasis on compressions.
3. To make defibrillation in time.
4. Effective intensive therapy.
5. Complex therapy after cardiac arrest.

- If the patient isn't breathing or isn't breathing properly (suffocates), has signs of consciousness loss, you may miss the point "look, listen and feel the breath" from Recommendations algorithm.

- Proper performance of CPR is important (chest compression should be performed at 100 per 1 min, a depth is 5 cm for children and adults, with a full straightening of the chest after each compression, minimum intervals between compressions and the absence of excessive ventilation).

- *For one rescuer* sequence is changed: chest compression should be preceded by artificial respiration (C-A-B instead of A-B-C). Alone rescuer should begin CPR with 30 chest compression instead of the rescue breath to reduce the time before first chest compression, open the airways and give two breaths.

- The frequency of chest compression is at least 100 per 1 minute (instead of "at about 100 compressions per minute").

- Depth is changed for adults from 4-5 cm (1.5-2 inches) to 5 cm (2 inches).

- If the care is provided by *two rescuers*, the first rescuer begins with chest compression (to provide the necessary blood flow and delivery oxygen, energy to the heart and brain), while the second one opens the airway and gets ready to give artificial respiration. An amount of compression depends on the frequency and duration. The total number of chest compressions increases with their frequency (it can be compared to riding in a car - the distance in miles for a day depends not only on speed but also on the number and duration of stops on the way). Once the first rescuer completes a series of 30 compressions, the second rescuer gives two breaths after cleaning the airway.

The Recommendations for the *untrained rescuers* by the AHA are: if the injured isn't breathing or isn't breathing properly, emergency medical dispatcher must give clear instructions about CPR without ventilation. If the injured has cardiac arrest outside of health institution and CPR is performed by bystander, it is easier to perform CPR without ventilation, that improves survivability comparing to the case when the injured does not get help at all. CPR should be performed until emergency medical services arrives. It is not necessary in cardiac arrest to pressure cricoid. It was held (2005) in order to push the trachea back and press the esophagus to the cervical vertebrae, to prevent bloating of the stomach, to reduce the risk of regurgitation and aspiration during mechanical ventilation with a mask.



Studies suggest that the pressure on the cricoid delay the insertion of the endotracheal tube, and does not guarantee the avoidance of aspiration.

**Calling teams of ambulance.**

If the injured is unconscious and not breathing or not breathing properly (suffocates), a medical officer is required to call the ambulance team (this condition may indicate a cardiac arrest). You need to get a defibrillator, or ask other rescuer to help you. Quickly (within 10 seconds) determine the pulse on big vessels and begin CPR, and then conduct defibrillation.

If there is *one rescuer*, he/she may eliminate the option "look, listen and feel the breath" according to the Recommendations and perform 30 chest compressions, check consciousness to identify the symptoms of heart failure, relieve airway, give 2 breaths.

If the *resuscitation team* is conducted CPR, according to the AHA guidelines for CPR and first aid in case of cardiovascular diseases 2010: one rescuer calls ambulance crews, the second one begins to perform chest compression, the third gives the artificial respiration, or uses the mask bag, the fourth sets defibrillator.

Frequency of the chest compressions during CPR is an important factor for the restoration of spontaneous circulation, survivability of patients with preservation of the normal functions of the nervous system. It should be at least 100 per 1 min. Compressions are an important element of CPR, they must be performed at a certain frequency with short intervals between them. It stimulates blood circulation by increasing intrathoracic pressure and direct compression of the heart. This provides the necessary blood flow, oxygen delivery to the heart and brain. Adequate chest compression at least 5 cm (2 inches) is important. Depth of compression near 4 cm gives a smaller effect.

In case of sudden cardiac arrest the use of automatic external defibrillators (AED) significantly increases the survivability of injured. If cardiac arrest occurs *outside the hospital*, in accordance with the Recommendations of the AHA the CPR should be started with chest compression, if it is possible – use a defibrillator. If cardiac arrest occurs *in the hospital*, where defibrillator is, you should start with cardiopulmonary resuscitation and if it is necessary - use a defibrillator.

Defibrillator electrodes must be put on the chest without clothing. The skin must be dry. Define three defibrillator electrode positions:

**Anterolateral** - right (chest) electrode is applied below the collarbone on the right and left (apical) on the lower left side of the chest near the left breast (at the top of the heart). There may be other provisions of electrodes: anterior-posterior, anterior-left subscapularis, anterior-right subscapularis.

**Algorithm of the base resuscitation for adults and children according to the AHA Guidelines for CPR and first aid CVD (2010)**

Component	Adults	Children	Infants
Recognition	Unresponsive (for all ages)		
	no breathing or no normal breathing	no breathing or only gasping	

	(only gasping)		
	No pulse palpated within 10 seconds for all ages (HCP only)		
CPR sequence	C-A-B		
Compression rate	at least 100 compression/min		
Compression depth	At least 5 cm (2 inches)	At least 1/3 AP diameter, about 5 cm (2 inches)	At least 1/3 AP diameter, about 4 cm (1.5 inches)
Chest wall recoil	Allow complete recoil between compressions. HCPs rotate compressors every 2 minutes.		
Compression interruption	Minimize interruptions in chest compressions Attempt to limit interruptions to <10 seconds		
Airway	Head tilt – chin lift (HCP suspected trauma : jaw thrust)		
Compressions - to - ventilation ratio (until advanced airway placed)	30:2 1 or 2 rescuers	30:2 single rescuer	
		15:2 2 HCP rescuers	
Ventilations: when rescuer untrained or trained and not proficient	compressions only		
Ventilations with advanced airway (HCP)	1 breath every 6-8 seconds (8-10 breaths per 1 min) Asynchronous with compressions About 1 second per breath. Visible chest rise		
Defibrillation	Attach and use AED as soon as available. Minimize interruptions in chest compressions before and after shock; resume CPR beginning with compressions immediately after each shock.		

### III. Cardiopulmonary resuscitation (CPR) and the principles of postresuscitation in Ukraine (Usenko L.V. and others, 2011)

#### I. Basic Life Support – BLS

##### A. Restoring airway.

Gold standard for airway management is a “triple Safar” and an intubation. In case of cardiac arrest, an intubation should be performed in a period from 113 to 146 seconds, and in 25% of cases - more than 3 minutes without chest compressions. Alternatives for intubation (that are more reliable) are: a) the use of laryngeal mask

airway (there is an increased risk of aspiration, to reduce it you need a pause for chest compressions. During mechanical ventilation you should select laryngeal mask and have basic skills to use;

b) use of two-way air Combitube, which provides a clear airway, even if the tube is in the esophagus or the trachea.

**B. Artificial ventilation.** During mechanical ventilation "mouth to mouth" each breath should be taken at 1 second (not force), you should watch a movement of the chest: the air should not get into the stomach, and the respiratory volume should be 400-600 ml (6-7 ml / kg). Respiratory rate is 10 per 1 min to prevent hyperventilation during CPR, which leads to increasing of intrathoracic pressure, decreases venous flow to the heart and a decrease in cardiac output, it is connected with poor survivability of injured.

**C. Artificial maintenance of circulation.** If you see the beginning of ventricular fibrillation / ventricular tachycardia (VF / VT) in the monitor, the pulse is absent, defibrillation is not possible, during the first 10 seconds after cardiac arrest make precordial strike. Sometimes when VF / VT strike is not used, it is often ineffective and may even lead to asystole.

**Chest compressions.** Proper implementation of the compression maintains the systolic pressure (SP) at 60-80 mm Hg, while diastolic pressure rarely exceeds 40 mm Hg, that causes low levels of the brain circulation (30-60% of normal) and coronary circulation (5-20% of normal). Successive pause for mechanical ventilation "mouth to mouth" further reduces coronary perfusion pressure. In particular, an additional chest compressions lead to the restoration of cerebral and coronary perfusion, the ratio of compressions to breath is 30:2. If laryngeal mask or Combitube was introduced, the compression rates for one or for two rescuers is 30:2 and should be performed with a pause for ventilation (risk of aspiration). If intubation was conducted, frequency of chest compressions is 100 per 1 min, ventilation is 10 per 1 min. When you use the Ambu bag, you should give 1 breath each 5 seconds without waiting for mechanical ventilation (chest compressions performed simultaneously with ventilation, increases coronary perfusion pressure).

## **II. Advanced Life Support - ALS. Route of drug administration.**

According to the recommendations of the ERC 2010 drugs do not introduce in endotracheal way. Studies have shown that the introduction of endotracheal epinephrine should be increased from 3 to 10 times to achieve the effect, resulting in hypotension and reducing coronary perfusion, as well as the endotracheal insertion of fluids impairs gas exchange. Therefore there are two main ways:

a) intravenous - in the central (subclavian and jugular) veins to ensure delivery of drugs into the central circulation or peripheral veins. Drugs were dissolved in 20 ml of salt (physiological) solution;

b) intraosseous - introduction of fluids to the shoulder or the tibia, providing the drugs concentration in plasma, and time is equal to intravenous introduction. The method is simple and accessible.

### **Pharmacological providing resuscitation:**

**1. Adrenaline.** If the injured has pulseless electrical activity ( asystole) - adrenaline is injected 1 mg intravenously every 3-5 minutes. When pulse is absent in case of ventricular fibrillation / ventricular tachycardia, you should inject 1 mg of

adrenaline after the third ineffective discharge of electrical defibrillation, and then every 3-5 minutes intravenously, that is before every second defibrillation.

**2. Amiodarone** - antiarrhythmic drug for ventricular fibrillation / pulseless ventricular tachycardia you should inject after three ineffective discharge 300 mg in 20 ml of salt solution or 5% glucose. If it is necessary- inject 150 mg. After restoring circulation 900 mg amiodarone is drip injecting in 24 hours to prevent refrillation.

**3. Lidocaine** - inject (if not amiodarone) 100 mg (1-1.5 mg / kg) intravenous or bolus of 50 mg (a total dose no more than 3 mg / kg in 1 hour).

**4. Sodium bicarbonate** (baking soda). It is not recommended for CPR, as increases intracellular acidosis, negative impacts on the ischemic myocardium, brain blood circulation, reduces oxygen delivery to the tissues.

You should inject soda in cardiac arrest in combination with hyperkalemia.

**5. Calcium chloride** - inject 10 ml of 10% solution intravenously if it is hyperkalemia, hypocalcemia.

Atropine during CPR is no longer applicable.

#### **Defibrillation:**

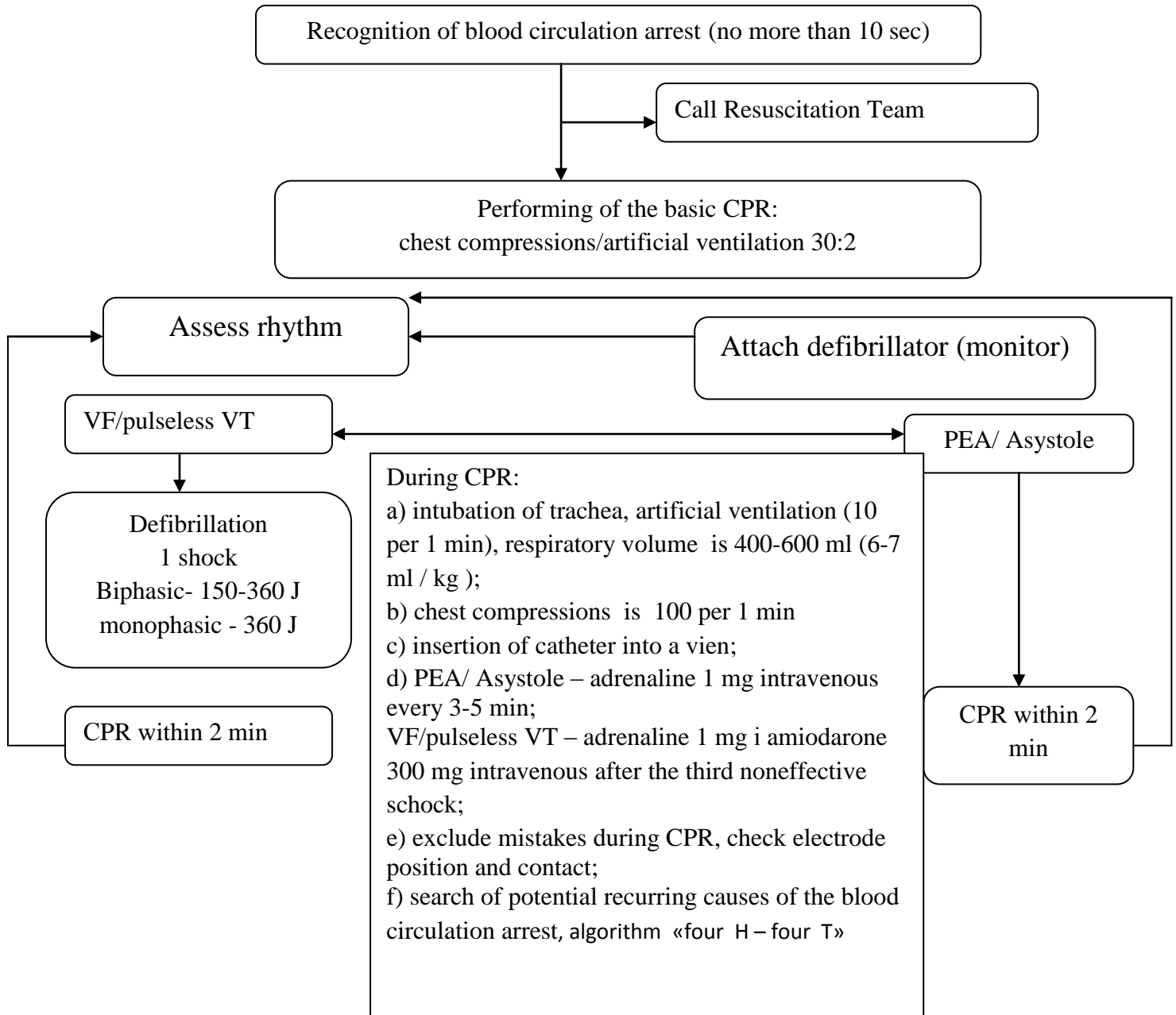
Proper position of the right electrode is on parasternal line below the collarbone, the second is on the mid-axillary line on the left in the projection of the cardiac apex. Apply electrodes with pressure force up to 8 kg with compulsory use pads soaked hypertonic solution or gel.

Do not use dry electrodes, because they reduce efficiency and can cause skin burns. When using a biphasic defibrillator (energy should be 150 J), for the repeated discharge energy should be up to 360 joules.



## Algorithm of Cardiopulmonary resuscitation (CPR)

(Usenko L.V., Tsarev A.V., Kobelyatskii Y.Y., 2011)



### Algorithm «four H – four T»

Hypoxia

Hypovolaemia

Hyper/hypokalaemia/metabolic disorders

Hypothermia

Tension pneumothorax

Tamponade (cardiac)

Thrombosis (coronary or pulmonary)

Toxic overdose

## The Protocol of the initial injured's examination ABC

(Order of the Ministry of Public Health of Ukraine "Protocols of the care, specialty" Medical emergencies" № 24 from 17.01.05.)

