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## OUT-OF-HOSPITAL CARDIAC ARREST. DIFFERENTIATED TACTICS FOR PREHOSPITAL RESUSCITATION

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**SUMMARY** This article describes the prehospital resuscitation tactics depending on type of electrical activity in cardiac arrest. Typical tests are given as a tool for assimilating the complex of cardiopulmonary resuscitation in the structure of postgraduate education.

**Keywords:** out-of-hospital cardiac arrest, cardiopulmonary resuscitation, emergency medical service, postgraduate education, education tests

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ALV – artificial lung ventilation

CPR – cardiopulmonary resuscitation

EMS – emergency medical service

VF/PVT – ventricular fibrillation/pulseless ventricular tachycardia

The success of resuscitation with potentially reversible circulatory arrest in the prehospital stage depends on epy clear knowledge of the modern protocols for cardiopulmonary resuscitation (CPR) [1,2], correct delivery of practical skills, and coherence of the work of the ambulance team.

It is possible to single out the following directions for increasing the success of CPR conducted outside a medical organization:

1. *Compliance with the principle of CPR stages*, ideally including not only the calling the ambulance, but also initiation of basic resuscitation measures in the scope of first aid by witnesses of the incident (i.e. trained population and employees of emergency non-medical services) using external automatic defibrillators, particularly under the remote direction of an operator of the EMS station [3, 4]. The subsequent extended resuscitation measures are brought to the place of the call by the EMS team.

2. *Compliance with the principle of adaptability to CPR*. The complex of resuscitation measures can be presented as a technological chain that presupposes the technically accurate and consistent implementation of all the individual stages, including early rational diagnosis of cardiac arrest, immediate commencement of chest compressions, the earliest electrocardiographic monitoring with defibrillation according to indications, ensuring airway patency with respiratory support and vascular access with drug support.

One of the main criteria that determine the tactics of advanced CPR is the type of electrical activity of the heart when circulation stops.

According to the tactics of the resuscitation manual, all types of circulatory arrest can be divided into two groups:

**A. Rhythms subject to electropulse therapy (electrical defibrillation):**

- ventricular fibrillation;
- ventricular tachycardia without pulsation on large arteries.

**B. Rhythms not subject to electropulse therapy (electrical defibrillation):**

- asystole;
- organized electrical activity of the heart (except for ventricular tachyarrhythmia) without pulse (the so-called electromechanical dissociation).

The starting events for the EMS team consisting of 2 people with confirmed clinical death (unconsciousness, lack of breathing, or detection of agonistic breathing such as "gaspings", absence of pulsation in large arteries) are:

- 1) taking measures for the speedy use of an electric defibrillator.

**The presence of a defibrillator in a set of equipment that is initially delivered to the patient, upon arrival for an emergency call, must be mandatory for all types of brigades;**

- 2) the immediate initiation of chest compressions in combination with primary masked artificial lung ventilation (ALV) with a bag valve mask in a ratio of 30:2;

- 3) the management of reversible causes of circulatory arrest upon detection.

**Until the defibrillator is ready to work, and also during its delivery to a patient whose blood circulation stopped suddenly (a reason for a call in the patient's condition without life threatening), it is necessary to continue chest compression and ventilation.**

**When the defibrillator is ready, immediate measures should be taken to determine the electrical activity of the heart with it.**

When using adhesive defibrillator electrodes, fixation on the chest is ensured without interruption of compression by another employee of the EMS team.

After fixing the adhesive electrodes on the patient's chest, the compression is interrupted only for the period of heart rate analysis. When using a defibrillator working in automatic mode, to exclude the effect on the analysis of artifacts and induced rhythm, touching the patient is prohibited throughout the automatic analysis. Further resuscitative tactics are built in accordance with the voice commands of the automatic external defibrillator. When using the defibrillator in manual mode (with both adhesive and manual external electrodes), the employee performs a visual analysis of the heart rhythm for no more than 5 seconds, after which the sequence of actions of the EMS team conducting CPR depends on the type of electrical activity of the heart revealed during the analysis.

#### **A. RHYTHMS SUBJECT TO ELECTROPULSE THERAPY (ELECTRICAL DEFIBRILLATION)**

If ventricular fibrillation or pulseless ventricular tachycardia without pulse (VF/PVT) is detected during the defibrillator set, another employee of the EMS team should continue chest compression.

The first discharge for the biphasic pulse is 150 J as standard (other starting energy values are possible according to the manufacturer's instructions), subsequent discharges for recurrent or refractory fatal ventricular arrhythmia should be increased to the discharge of the maximum pulse energy according to the technical specifications of the specific defibrillator model.

**An employee of the EMS team, who conducts defibrillation, should make sure that there is no physical contact of any of the medical workers or the surrounding people with the patient before discharge!**

Immediately after the discharge, chest compressions should be continued in combination with the ALV for 2 minutes, i.e. the subsequent analysis of the heart rhythm should be performed only 2 minutes after the discharge. If a continuous VF/PVT is detected on the defibrillator monitor, a repeated discharge of maximum energy should be applied, then compression of the chest in combination with the ALV is performed for 2 minutes. During this period, it is necessary to ensure a stable patency of the airways (to intubate trachea or insert a laryngeal tube) and vascular access (intravenous or intraosseous). If the third heart rate analysis is determined, the maximum defibrillator level is applied, then chest compressions in combination with ventilation are continued (with the provision of stable airway patency it is possible to perform mechanical ventilation).

During the next 2 min after the third discharge, 1 mg of Epinephrine and 300 mg of Amiodarone should be administered intravenously or intraosseously.

**The subsequent administration of Adrenaline solution should not be performed earlier than 4-5 minutes after the previous administration.** For a more accurate determination of the time of Adrenaline injection, it should be remembered that the drug is administered "after the cycle" of the heart rhythm analysis.

Additional administration of 150 mg of Amiodarone is necessary after the detection of persistent VF/PVT in the fifth heart rate analysis.

When Epinephrine is injected into the peripheral vein or intraosseally, 20 ml of a 0.9% solution of sodium chloride must be additionally administered or a constant infusion of 0.9% sodium chloride solution should be administered for this purpose.

The number of discharges of the defibrillator is not limited during the whole period of VF/PVT.

*\* According to recommendations for the resuscitation of the European Council for Resuscitation (revision of 2015) [1], when fatal ventricular arrhythmia (VF/PVT) is revealed in a patient connected to a defibrillator monitor who was awake prior to the development of a critical rhythm disturbance, the so-called three-discharge strategy is performed. It implies the possibility of primary defibrillation discharge (without beginning of chest compressions) with subsequent analysis of the heart rate (also without interruption on chest compression and ventilation) and in case of unmanaged arrhythmia with repeated immediate application of a maximum energy discharge (up to 3 times in total). In the absence of the effect of the third discharge, chest compression in combination with mechanical ventilation and subsequent implementation of the standard complex of extended CPR is performed.*

#### **B. RHYTHMS NOT SUBJECT TO ELECTROPULSE THERAPY (ELECTRICAL DEFIBRILLATION)**

If an asystole or electromechanical dissociation is detected, electrical defibrillation is not performed. If these rhythms are detected initially, chest compression in combination with primary masked ventilation using a breathing bag in a ratio of 30:2 for 2 minutes should be initiated immediately. During this period, without ceasing the compression of the chest, it is necessary to check the quality of attaching adhesive electrodes or switching the device from the monitoring mode to the defibrillation mode (using external manual defibrillator electrodes).

**Providing vascular access (intravenous or intraosseous) with this type of electrical activity of the heart is in priority over providing airway patency (intubation of the trachea or installation of a laryngeal tube). 1 mg of Epinephrine should be administered immediately after providing vascular access.**

After every 2 minutes of compression of the chest in combination with the ALV, the cardiac rhythm is re-analyzed on the defibrillator monitor to determine the appearance of a rhythm that is amenable to electrical

defibrillation. In this case, the tactics of conducting CPR changes (see "Rhythms subject to electropulse therapy (electrical defibrillation)") is used.

If rhythms not subject to electrical defibrillation remain unchanged, repeated injections of Epinephrine are possible every 3-5 minutes after previous administration.

After ensuring the stable patency of the airways (intubation of the trachea or installation of the laryngeal tube), it is possible to perform mechanical ventilation with a frequency of 10 per minute. In this case, chest compressions should be carried out continuously with a frequency of 100-120 per minute.

If the next analysis shows an organized rhythm with narrow ventricular complexes, it is reasonable to test an independent pulsation on large arteries within 10 seconds.

In the absence of pulsation, the condition is regarded as electromechanical dissociation and immediate continuation of the CPR complex is necessary.

If spontaneous pulsations on large arteries is detected, CPR should be terminated and preparation for medical evacuation to the hospital begins. If resuscitation (revitalization of the patient) is successful, it is important to perform postresuscitation measures for preventing recurrence of circulatory arrest and improving neurological rehabilitation immediately at the prehospital stage. These include continued respiratory support, correction of hemodynamic disorders and cerebroprotection.

This algorithm of resuscitation, as reflected in the "Algorithms for providing emergency medical care to patients and injured by teams of emergency medical service of Moscow" [5], takes into account the requirements of current international recommendations and is widely used by ambulance teams of A.S. Puchkov Service for Emergency and Urgent Medical Care.

It is also important that the readiness for the exact observance of the technology of the CPR complex is achievable only in the course of permanent training of participants in resuscitation measures, involving simulation techniques [6]. To assimilate the above tactics of resuscitation in the structure of postgraduate education of doctors and paramedics, we present typical test tasks applicable at different stages of knowledge monitoring. In these test tasks, there is one correct answer.

**I. Effective compression of the chest during resuscitation measures are manifested with:**

- 1) the appearance of photoreaction of pupils;
- 2) the carbon dioxide gas at the end of the exhalation, equal to 5 mm Hg, according to the capnography data;
- 3) the increased skin cyanosis;
- 4) the change of ventricular fibrillation to asystole.

**II. When two specialists resuscitate an adult patient, the recommended frequency of artificial inhalations for ventilation of lungs with an automatic respirator through the intubation tube is:**

- 1) 2 per minute;
- 2) 4 per minute;
- 3) 10 per minute;
- 4) 16 per minute.

**III. When resuscitating an adult patient, the electrical activity of the heart after electrical defibrillation is monitored:**

- 1) immediately after the discharge;
- 2) no later than 1 minute of chest compressions and artificial ventilation;
- 3) after 2 minutes of chest compressions and artificial ventilation;
- 4) not earlier than 5 minutes of chest compressions and artificial ventilation.

**IV. When resuscitating an adult patient, the pulse on the carotid arteries is monitored:**

- 1) always, immediately after electrical defibrillation;
- 2) always, after every 2 minutes of chest compressions and artificial ventilation;
- 3) during the entire period of chest compressions;
- 4) after the appearance of an organized cardiac rhythm on the cardiomonitor.

**V. If ventricular fibrillation remains unchanged during resuscitation, an adult patient receives the first dose of Amiodarone:**

- 1) after the first discharge of the electric defibrillator;
- 2) after the second discharge of the electric defibrillator;
- 3) after the third discharge of the electric defibrillator;
- 4) after the fourth digit of the electric defibrillator.

Correct answers: I - 1, II - 3, III - 3, IV - 4, V - 3.

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