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# MEDICAL SIMULATION IN EMERGENCY MEDICINE: CPR TRAINING



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МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ
КАФЕДРА КАРДИОЛОГИИ И ВНУТРЕННИХ БОЛЕЗНЕЙ

**Д. С. ГЕРАСИМЁНОК**

# ИСПОЛЬЗОВАНИЕ СИМУЛЯЦИОННОЙ ТЕХНОЛОГИИ В НЕОТЛОЖНОЙ МЕДИЦИНЕ: СЕРДЕЧНО-ЛЕГОЧНАЯ РЕАНИМАЦИЯ

# MEDICAL SIMULATION IN EMERGENCY MEDICINE: CPR TRAINING

Учебно-методическое пособие



Минск БГМУ 2020

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Содержит описание алгоритма оказания базовых и расширенных реанимационных мероприятий с использованием симуляционного оборудования при различных клинических условиях возникновения терминального состояния: асистолия, электромеханическая диссоциация, фибрилляция желудочков.

Предназначено для студентов 6-го курса медицинского факультета иностранных учащихся, обучающихся на английском языке.

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## GENERAL INFORMATION

The aim of teaching and learning the topic "Medical simulation in emergency medicine: CPR training" is to provide the students with the knowledge about emergency treatment of critical disorders of cardiovascular system.

The tasks of studying the topic are to develop the students' academic competences, based on the ability to self-search educational and information resources, as well as acquire and understand the knowledge of:

– the basic concepts (principles) of cardiopulmonary resuscitation;

– the causes and mechanisms of acute disorders of cardiovascular system;

– the risk factors of sudden cardiac death etc.

The tasks of teaching the discipline include the formation of students' social, personal and professional competences, based on the knowledge and application of:

– the skills of first aid, contributing to the formation of clinical thinking according to medical ethics and deontology rules;

– the methods of carrying out of cardiopulmonary resuscitation.

Teaching and successful learning of the topic "Medical simulation in emergency medicine: CPR training" is carried out on the basis of the knowledge and skills previously acquired by the students in the following disciplines:

– Internal Diseases, Cardiology, Electrophysiology etc.

**As a result of studying the** topic "Medical simulation in emergency medicine: CPR training" **the student should know:**

– the basic concepts (principles) of cardiopulmonary resuscitation;

– the causes and mechanisms of clinical death;

**be able to:**

– carry out of cardio-pulmonary resuscitation;

– determine of patient condition;

**skill:**

– the methods of mouth to mouth lung ventilation, Bag-valve-mask (BVM) ventilation, chest compression;

– the skills of indicated the pulse, to check the airway, check blood pressure;

– performing Direct current cardioversion and Defibrillation.

**Equipment for practical training:**

– SB50015U CPR Manikin "Virtual simulator for cardiopulmonary resuscitation" (SMART STAT Basic);

– ZOLL M Series defibrillator,

– self-inflating bag, anesthetic face mask, oropharyngeal airway.

# INTRODUCTION

According to the World Health Organization, sudden cardiac death (SCD) is an unexpected death that occurs within 1 hour from symptom onset in witnessed circumstances or within 24 hours from last observed alive and without symptoms in unwitnessed circumstances. Sudden cardiac arrest (SCA) is distinct from SCD, which by definition is a fatal event. SCA is defined as circulatory collapse with cessation of cardiac function that is reversed by cardiopulmonary resuscitation or defibrillation. SCD occurs when a triggering factor serves as the catalyst in an anatomic or electrophysiological substrate, either genetically determined or acquired, resulting in the final common pathway of ventricular fibrillation (VF) or ventricular tachycardia (VT) degenerating into VF and resultant hemodynamic collapse with cessation of cardiac mechanical activity. It is not uncommon for asystole or pulseless electric activity to follow VF. On the other hand, asystole or pulseless electric activity is often the primary event responsible for out-of-hospital SCD. Polymorphic VT or torsades de pointes may be observed in patients with genetically inherited long QT syndrome (LQTS) or drug-induced long QT. A broad spectrum of cardiac and non-cardiac causes, both congenital and acquired, have been implicated in causing SCA. It appears that structural cardiac disease accounts for 60–95 % of the causes of SCA and mainly includes hypertrophic cardiomyopathy, arrythmogenic right ventricular dysplasia and congenital coronary artery anomalies in the under-35-year-old group, and coronary artery disease in the over-35-year-old group, all of which induce ventricular fibrillation as the main presenting rhythm in SCA.

**Immediate CPR and early defibrillation is crucial for treating sudden cardiac arrest!** Defibrillation within 3–5 mins of collapse can produce survival rates as high as 50–70 %. Each minute of delay to defibrillation reduces the probability of survival to discharge by 10–12 %. The links in the chain work better together: when CPR is provided, the decline in survival is more gradual and averages 3–4 % per minute delay to defibrillation.

# CARDIOPULMONARY RESUSCITATION

Cardiopulmonary resuscitation (CPR) is a lifesaving procedure that maintains circulation in patients with sudden cardiac arrest until cardiac function can be restored. Sudden cardiac arrest presents with unconsciousness, apnea, and pulselessness. There are two protocols for CPR: Basic Life Support (BLS) for lay rescuers and professionals alike and Advanced Cardiac Life Support (ACLS) for medical professionals. BLS includes checking the patient’s responsiveness, calling for help, performing chest compressions and rescue breaths, and, if available, the use of an automated external defibrillator (AED).

Advanced Cardiac Life Support includes additional procedures performed by medical professionals, such as drug therapy (especially epinephrine), securing the airways (e.g., endotracheal intubation), and finding and treating reversible causes of cardiac arrest.

## BASIC LIFE SUPPORT

BLS is the foundation for saving lives after cardiac arrest. Fundamental aspects of adult BLS include immediate recognition of sudden cardiac arrest and activation of the emergency response system, early CPR, and rapid defibrillation with an automated external defibrillator (AED). More data are available showing that high-quality CPR improves survival from cardiac arrest, including:

– Ensuring chest compressions of adequate rate (100–120 per min);
– Ensuring chest compressions of adequate depth (5 cm);
– Allowing full chest recoil between compressions;
– Minimizing interruptions in chest compressions;
– Avoiding excessive ventilation.

Basic Life Support Sequence:

1. Ensure scene safety.
2. Check for response (if unresponsive).
3. Shout for nearby help/activate the resuscitation team; can activate the resuscitation team at this time or after checking breathing and pulse.
4. Check for no breathing or only gasping and check pulse (ideally simultaneously for healthcare professionals). Activation and retrieval of the AED/emergency equipment by either the lone healthcare provider or by the second person sent by the rescuer must occur no later than immediately after the check for no normal breathing and no pulse identifies cardiac arrest.
5. Immediately begin CPR, and use the AED/ defibrillator when available.
6. When the second rescuer arrives, provide 2-person CPR and use AED/defibrillator.

## BLS/AED DETAILED SEQUENCE OF STEPS

1. SAFETY. Make sure you, the patient and any bystanders are safe.
2. RESPONSE. Check the patient for a response. Gently shake their shoulders and ask loudly: “Are you all right?” (Fig. 1).

If they respond, leave them in the position in which you find them, provided there is no further danger; try to find out what is wrong with the person and get help if needed; reassess them regularly. **Stop the BLS algorithm!**

If the patient is unresponsive the rescuer should call for help. Activate the emergency response system (for in-hospital cardiac arrest). If you are alone, retrieve an automated external defibrillator if there is one within a 60-second walking distance! Send someone to get it if others are available. **Continue an algorithm!**

*Figure 1.* Check the patient for a response

3. AIRWAY. Open the airway with any of two maneuvers. Turn the patient onto their back.

**Head tilt chin lift.** Place your hand on their forehead and gently tilt their head back; with your fingertips under the point of the patient's chin, lift the chin to open the airway (Fig. 2, *a*).

**Jaw thrust.** Use index and middle fingers to physically push the posterior aspects of the mandible upwards while your thumbs push down on the chin to open the mouth (Fig. 2, *b*).

***a*** ***b***

*Figure 2.* Head tilt chin lift maneuver (*a*), Jaw thrust maneuver (*b*)

4. BREATHING. Once the airway has been opened the rescuer should check for breathing. Look the chest for movements, listening for breath sounds,

and feeling for the exhaled air on the back of the hand for normal breathing for no more than 10 seconds. It is reasonable for experienced healthcare providers to check the carotid pulse simultaneously for a minimum of 5 seconds — but no more than 10 seconds — to determine if there is a pulse present. There is no pulse check for workplace or community rescuers. If there is no breathing, the patient needs CPR — a pulse check wastes time because it's often inaccurate (when attempted by lay providers) and delays the start of compressions. It's important to minimize delay in starting CPR, so take no more than 10 seconds to assess the patient.

When someone is unconscious, all muscles are relaxed. If they are left lying on their back, the tongue, which is attached to the back of the jaw, falls against the back wall of the throat and blocks air from entering the lungs. The patient whose airway is clear who is breathing spontaneously and has carotid pulse should be turned into the recovery position. This prevents the tongue falling back and reduces the risk of inhalation of gastric contents. There is no universally standard recovery position, but any position that secures the patient on his or her side is acceptable provided the following requirements are met (Fig. 3):

– the procedure should minimize the movement of the patient;

– the patient's head, neck, and trunk should be kept in a straight line;

– the position should permit gravity drainage of liquid from the patient's mouth;

– the position should be stable, near a true lateral position, with the head dependent and with no pressure on the chest to impair breathing. The position should be suitable for a patient being carried on a stretcher.

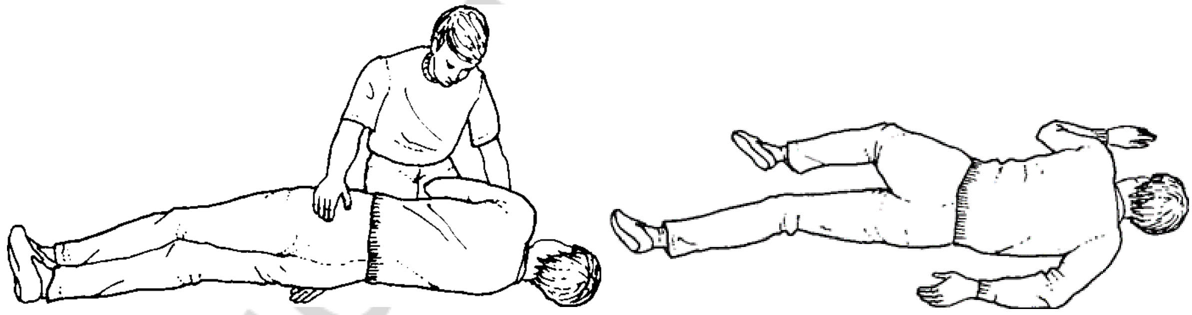


*Figure 3.* Recovery position

**Recovery position sequences:**

– Kneel beside the victim and make sure that both their legs are straight.

– Place the arm nearest to you out at right angles to his body, elbow bent with the hand palm-up.

– Bring the far arm across the chest, and hold the back of the hand against the victim's cheek nearest to you.

– With your other hand, grasp the far leg just above the knee and pull it up, keeping the foot on the ground.

– Keeping their hand pressed against his cheek, pull on the far leg to roll the victim towards you on to their side.

– Adjust the upper leg so that both the hip and knee are bent at right angles.

– Tilt the head back to make sure that the airway remains open.

– If necessary, adjust the hand under the cheek to keep the head tilted and facing downwards to allow liquid material to drain from the mouth.

Then get help if needed, check breathing regularly. **Stop the BLS algorithm!**

If the patient has a pulse but is breathing abnormally, maintain the patient's airway and begin rescue breathing. Administer one breath every 5 to 6 seconds, not exceeding 10 to 12 breaths per minute. Activate the emergency response system if you haven't already done so. All patients in respiratory arrest will develop cardiac arrest if ventilation is delayed. Check the patient's pulse every 2 minutes. **If at any point there is no pulse present go to the step 5.**

In the first few minutes after cardiac arrest, a patient may be barely breathing, or taking infrequent, slow and noisy gasps (abnormal breathing). Do not confuse this with normal breathing. Treat **absence of pulse and breath** or presence of abnormal breathing as a sign of **cardiac arrest**! **Continue an algorithm!**

5. UNRESPONSIVE AND NOT BREATHING NORMALLY. Ask somebody call emergency services if possible otherwise call them yourself or activate the emergency response system (for in-hospital cardiac arrest). Stay with patient when making the call if possible. Activate speaker function on phone to aid communication with dispatcher.

6. SEND FOR AED — send someone to get an AED if available. If you are alone, do not leave the patient and start CPR if you cannot get an automated external defibrillator within a 60-second walking distance.

7. C-A-B SEQUENCE — use the C-A-B sequence to remember the sequence of CPR steps. C-A-B stands for Compression, Airway and Breathing (Fig. 4).

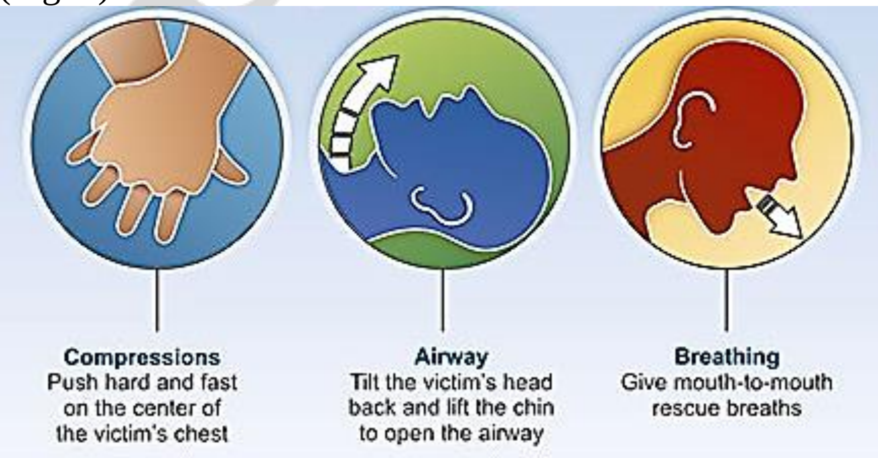



*Figure 4.* C-A-B sequence of CPR

8. CHEST COMPRESSION (CIRCULATION). Start chest compressions.

Sequence:

– Ensure the patient is lying on a firm, flat surface.

– Kneel by the side of the patient.

– Place the heel of one hand in the lower half of the sternum/centre of the chest.

– Place the heel of your other hand on top of the first hand.

– Interlock the fingers of your hands and ensure that pressure is not applied over the patient's ribs.

– Keep your arms straight.

– Do not apply any pressure over the upper abdomen or the bottom end of the bony sternum (breastbone).

– Position your shoulders vertically above the patient's chest and press down.

– Press hard and fast: at a rate of at least 100–120 beats per minute with a depth of 2 inches (approximately 5 centimeters) but not greater than 2.4 inches (approximately 6 centimeters). The song "Staying Alive" is 100 beats per minute.

– After each compression, release all the pressure on the chest. Do not lean on the chest. Take your full weight off the patient's chest while keeping your hands in contact with the chest.

– Minimize interruptions. Interruption to compression reduces blood flow. Delivery of rescue breaths, shocks, ventilations and rhythm analysis lead to pauses in chest compression. Pre-and post-shock pauses of less than 10s. Take no more that 5 seconds to deliver breaths between cycles of 30 compressions.

– Loud counting of the compressions should be encouraged (… 25, 26, 27, 28, 29, 30).

– Perform first 30 compressions.

Chest compressions are the most important part of CPR. Most rescuers do not press hard enough. The earlier compressions are started, and the quality of compressions makes a huge impact on surviving SCA.

***After 30 compressions open the airway again using head tilt and chin lift and give 2 rescue breaths (one second per breath, tidal volume 400–600 mL). Avoid rapid or forceful breaths, and add supplemental oxygen as soon as possible.***

9. GIVE RESCUE BREATHS — open the patients's airway using the head-tilt, chin-lift maneuver. Put your palm on the person's forehead and gently tilt the head back. Then with the other hand, gently lift the chin forward to open the airway. Give the first rescue breath — lasting one second — and watch to see if the chest rises. If it does rise, give the second breath. If the chest doesn't rise, repeat the head-tilt, chin-lift maneuver and then give the second breath. Mouth to mouth, mouth to nose, mouth to mask and Bag-Valve-Mask lung ventilation are all viable methods of rescue breathing.

**Mouth to mouth breathing:**

– Kneel beside the patient's head. Maintain an open airway.

– Take a breath, open your mouth as widely as possible and place it over the person's slightly open mouth. While maintaining an open airway, pinch the nostrils (or seal nostrils with rescuer's cheek) and blow to inflate the person's lungs. Because the hand supporting the head comes forward some head tilt may be lost and the airway may be obstructed. Pulling upwards with the hand on the chin helps to reduce this problem.

– For ***mouth to mouth*** ventilation, it is reasonable to give each breath in a short time (one second) with a volume to achieve chest rise regardless of the cause of cardiac arrest.

– Look for rise of the chest during each inflation. If the chest does not rise, possible causes are:

• obstruction in the airway (tongue or foreign material, or inadequate head tilt, chin lift);

• insufficient air being blown into the lungs;

• inadequate air seal around mouth and or nose.

– If the chest does not rise, ensure correct head tilt, adequate air seal and ventilation. After inflating the lungs, lift your mouth from the person's mouth, turn your head towards their chest and listen and feel for air being exhaled from the mouth and nose.

**Mouth to nose breathing:**

– The mouth to nose method may be used:

• where the rescuer chooses to do so;

• where the person's jaws are tightly clenched;

• when resuscitating infants and small children.

– The technique for mouth to nose is the same as for mouth to mouth except for sealing the airway. Close the mouth with the hand supporting the jaw and push the lips together with the thumb. Take a breath and place your widely opened mouth over the person's nose (or mouth and nose in infants) and blow to inflate the lungs. Lift your mouth from the person's nose. Look for the fall of the chest, and listen and feel for the escape of air from the nose and mouth.

– If the chest does not move, there is an obstruction, an ineffective seal, or insufficient air being blown into the lungs. In mouth-to-nose resuscitation a leak may occur if the rescuer's mouth is not open sufficiently, or if the person's mouth is not sealed adequately. If this problem persists, use mouth-to-mouth resuscitation. If blockage of the nose prevents adequate inflation, the rescuer should use mouth-to-mouth resuscitation.

**Mouth to mask lung ventilation:**

– Mouth to mask resuscitation is a method of rescue breathing which avoids mouth-to-mouth contact by using a resuscitation mask. Rescuers should take appropriate safety precautions when feasible and when resources are available to do so, especially if a person is known to have a serious infection (e.g. HIV, tuberculosis, Hepatitis B virus or SARS).

– Position yourself at the person's head and use both hands to maintain an open airway and to hold the mask in place to maximise the seal. Maintain head tilt and chin lift. Place the narrow end of the mask on the bridge of the nose and apply the mask firmly to the face (Fig. 5).

– Inflate the lungs by blowing through the mouthpiece of the mask with sufficient volume and force to achieve chest movement. Remove your mouth from the mask to allow exhalation.

– Turn your head to listen and feel for the escape of air. If the chest does not rise, recheck head tilt, chin lift and mask seal.

– Failure to maintain head tilt and chin lift is the most common cause of obstruction during resuscitation.

*Figure 5*. Mouth to Mask method of rescue breathing

**Bag-Valve-Mask (BVM) lung ventilation.**

In BVM ventilation, a self-inflating bag (resuscitator bag) is attached to a nonrebreathing valve and then to a face mask that conforms to the soft tissues of the face. The opposite end of the bag is attached to an oxygen source (100 % oxygen) and usually a reservoir bag. The mask is manually held tightly against the face, and squeezing the bag ventilates the patient through the nose and mouth. Unless contraindicated, airway adjuncts such as nasopharyngeal and/or oropharyngeal airways are used during BVM ventilation to assist in creating a patent airway. Positive end expiratory pressure (PEEP) valves should be used if further assistance is needed for oxygenation without contraindications to its use.

– Using one hand, hold the mask, with your thumb and index finger wrapped around the connector stem of the mask. Most operators use their non-dominant hand to grasp the mask, but either hand can be used as long as a good mask seal can be maintained.

– Making sure not to place your hand or the mask on the patient’s eyes, first place the nasal portion of the mask over the nose, and then lower the body over the patient's mouth. The bridge of the nose, the two malar eminences, and the mandibular alveolar ridge must be covered by the mask in order to achieve a proper seal.

– Now extend your middle, ring, and little fingers underneath the patient's mandible, and pull it upward into the mask. This maneuver is similar to that of the head tilt-chin lift technique and further opens the airway.

– While maintaining this upward traction on the mandible, press the mask downward onto the face to attain a tight mask seal. If your hand is large enough, place your little finger behind the mandibular ramus to do a jaw-thrust maneuver to further open the airway.

– Be sure to pull up only on the bony parts of the mandible, because pressure to the soft tissues of the neck or under the chin may obstruct the airway.

– Once a proper seal is achieved, use your other hand to begin ventilation (Fig. 6).

*Figure 6.* Bag-Valve-Mask lung ventilation

10. CONTINUE CPR — ***use a compression-to-ventilation ratio of 30 compressions to 2 breaths.*** Check for return of spontaneous circulation. Healthcare workers who are trained and confident in pulse check should check the pulse after at least five cycles of 30 compressions to two ventilations. Checking of pulse should not take more than ten seconds. If unsure of the presence of a pulse by the end of ten seconds, the rescuer should resume 30 chest compressions to two ventilations.

11. TERMINATING OF RESUSCITATIVE EFFORTS. The Universal Termination of Resuscitation Guidelines suggest that resuscitation should be terminated if, after at least four 2-minute intervals of cardiopulmonary resuscitation, three criteria are met: 1) the arrest was not witnessed by emergency medical services; 2) there has been no return of spontaneous circulation; 3) no shocks were delivered. In general, resuscitation should be continued as long as VF persists. It is generally accepted that ongoing asystole for more than 30 min in the absence of a reversible cause, and with ongoing ALS, constitutes grounds for abandoning further resuscitation attempts.

## AUTOMATED EXTERNAL DEFIBRILLATORS

Automated external defibrillators are safe and effective when used by either laypeople or healthcare professionals (in- or out-of-hospital). Use of an AED by a layperson makes it possible to defibrillate many minutes before professional help arrives.

***Sequence for use of an AED:***

1. Make sure you, the victim, and any bystanders are safe.

2. Follow the Adult BLS sequence:

– if the victim is unresponsive and not breathing normally, send someone for help and to find and bring an AED if available;

– if you are on your own, use your mobile phone to alert the ambulance service — leave the victim only when there is no other option.

3. Start CPR according to the adult BLS sequence. If you are on your own and the AED is in your immediate vicinity, start with applying the AED.

4. As soon as the AED arrives:

– switch on the AED and attach the electrode pads on the victim's bare chest;

– if more than one rescuer is present, CPR should be continued while electrode pads are being attached to the chest;

– follow the spoken/visual directions immediately;

– ensure that nobody is touching the victim while the AED is analysing the rhythm.

5. If a shock is indicated (Fig. 7):

– ensure that nobody is touching the victim;

– push shock button as directed;

– immediately restart CPR 30:2;

– continue as directed by the voice/visual prompts.

*Figure 7*. AED applying

6. If no shock is indicated:

– immediately resume CPR, using a ratio of 30 compressions to 2 rescue breaths;

– continue as directed by the voice/visual prompts.

7. Continue to follow the AED prompts until:

– professional help arrives and takes over;

– the victim starts to wake up: moves, opens eyes and breathes normally;

## ADVANCED CARDIOVASCULAR LIFE SUPPORT

BLS is only a temporary measure to maintain ventilation and circulation. Effective chest compression provides a cardiac output of only 20–30 % of the pre-arrest value, and rescue breathing without supplemental oxygen provides ventilation with an inspired oxygen concentration of only 15 %. Electrical defibrillation is the mainstay of treatment for ventricular fibrillation (VF) and pulseless Ventricular Tachycardia (pVT). The chance of successful defibrillation decreases with time. Therefore high quality CPR and decreasing the time to defibrillation are the first priorities in resuscitation from cardiac arrest. The purpose of BLS is to help maintain myocardial and cerebral oxygenation until ALS personnel and equipment are available:

– effective BLS may increase the likelihood of successful defibrillation;

– effective BLS buys time until reversible causes can be diagnosed and/or treated.

Monitoring CPR quality and resuscitation performance is an important element of Basic and Advanced Life Support and includes:

– effectiveness of compressions (adequacy of depth, rate and minimising hands off periods);

– adequacy of ventilation (avoiding over-ventilation and consequent deleterious effects);

– timing of defibrillation with regard to likelihood of success (as soon as possible and providing compressions before and after).

### SPECIFIC RESUSCITATION DRUGS

**Adrenaline (Epinephrine).** This is a naturally occurring catecholamine with alpha and beta effects. It is administered in cardiac arrest to cause peripheral vasoconstriction via its alpha-adrenergic action (directing available cardiac output to myocardium and brain). It may facilitate defibrillation by improving myocardial blood flow during CPR.

***Indications:***

– Ventricular Fibrillation/pulseless Ventricular Tachycardia after initial counter shocks have failed (after 2nd shock then after every second loop).

– Asystole and electromechanical dissociation (pulseless electrical activity) in initial loop (then every second loop).

***Dosage.*** The initial adult dose is 1 mg (1 mL of 1:1,000 or 10 mL of 1:10,000) and this should be repeated at regular intervals (every 2nd loop) during CPR.

**Amiodarone.** Amiodarone is an antiarrhythmic drug with complex pharmacokinetics and pharmacodynamics. It has effects on sodium, potassium and calcium channels as well as alpha and beta-adrenergic blocking properties.

***Indications:*** VF/pulseless VT (between the third and fourth shock, when refractory to defibrillator shocks and a vasopressor).

***Dosage.*** Initial bolus dose is 300 mg. An additional dose of 150 mg could be considered. This may be followed by an infusion (i.e. 15 mg/kg over 24 hours).

**Lidocaine.** Lidocaine (lignocaine) acts as a sodium channel blocker.

***Indications:*** suggest that lidocaine (lignocaine) may be used as an alternative to amiodarone in patients with refractory VF/pVT.

***Dosage.*** Lidocaine (lignocaine) is given initially as a 1 mg/kg bolus. During resuscitation an additional bolus of 0.5 mg/kg may be considered. It is not recommended to commence a lidocaine (lignocaine) infusion until return of spontaneous circulation.

**Potassium.** Potassium is an electrolyte essential for membrane stability. Low serum potassium, especially in conjunction with digoxin therapy and hypomagnesaemia, may lead to life threatening ventricular arrhythmias.

***Indications:*** persistent VF due to documented or suspected hypokalaemia.

***Dosage.*** A bolus of 5 mmol of potassium chloride is given intravenously.

**Magnesium (magnesium sulfate heptahydrate).** Magnesium is an electrolyte essential for membrane stability. Hypomagnesaemia causes myocardial hyperexcitability particularly in the presence of hypokalaemia and digoxin.

***Indications:***

– Torsade de pointes.

– Cardiac arrest associated with digoxin toxicity.

– VF/pulseless VT (usually administered when refractory to defibrillator shocks and a vasopressor).

– Documented hypokalaemia.

– Documented hypomagnesium.

***Dosage.*** A bolus of 5 mmol of magnesium (magnesium sulfate heptahydrate), which may be repeated once and followed by an infusion of 20 mmol over four hours.

**Sodium Bicarbonate (and other buffers).** Sodium bicarbonate is an alkalising solution, which combines with hydrogen ions to form a weak carbonic acid. This breaks down to produce $CO_2$ and $H_2O$. In most cardiac arrests early efficient CPR and adequate ventilation negate the need for any $NaHCO_3$.

Routine administration of sodium bicarbonate for treatment of in-hospital and out-of hospital cardiac arrest is not recommended.

***Indications:***

– Hyperkalaemia.

– Treatment of documented metabolic acidosis.

– Overdose with tricyclic antidepressants.

– Protracted arrest (greater than 15 mins).

***Dosage:*** 1 mmol/kg, is initially given over 2–3 minutes, then as guided by arterial blood gases.

**Intravenous (IV) route.** Intravenous (IV) drug administration is preferable and IV access is quickly and most easily achieved via a peripheral cannula inserted into a large peripheral vein. If there are no visible peripheral veins, the external jugular vein should be considered. Lower limb veins should be avoided due to impairment of venous return below the diaphragm during cardiac arrest. Intravenous drug administration must be followed by a fluid flush of at least 20-30 mL and external cardiac compression. If a central line is present it should be used. Central access provides more rapid drug delivery but insertion of a new line may be difficult, takes time to establish and has major risks.

**Intraosseous (IO) route.** Intraosseous is the preferred route if intravenous access is not available. Two prospective trials in adults and children and 6 other studies documented that IO access is safe and effective for fluid resuscitation, drug delivery, and laboratory evaluation, and is attainable in all age groups. If IV access cannot be established, intraosseous (IO) delivery of resuscitation drugs will achieve adequate plasma concentrations.1 A number of devices are now available for use in adults.

**Assess rhythm.** As soon as the defibrillator is available, the pads should be placed on the patient’s chest, it should be charged and, the rhythm analyzed. If a rhythm compatible with spontaneous circulation is observed, the defibrillator should be disarmed and the pulse checked.

## “SHOCKABLE” RHYTHM

***Ventricular fibrillation or pulseless ventricular tachycardia:***

– Ventricular fibrillation is asynchronous chaotic ventricular activity that produces no cardiac output.

– Pulseless ventricular tachycardia is a wide complex regular tachycardia associated with no clinically detectable cardiac output.

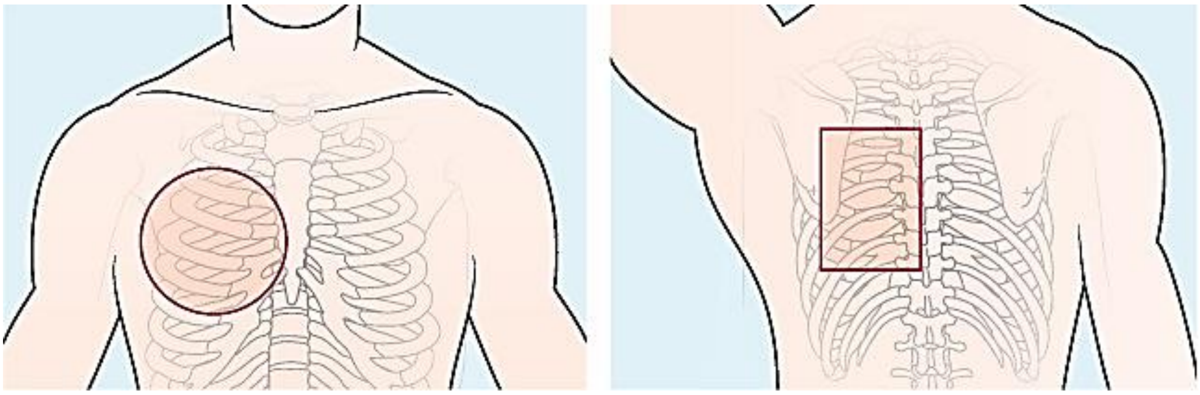
– A defibrillator shock should be administered according to the algorithm.

– Administer a single shock and immediately resume CPR for 2 minutes after delivery of shock. Do not delay recommencing CPR to assess the rhythm.

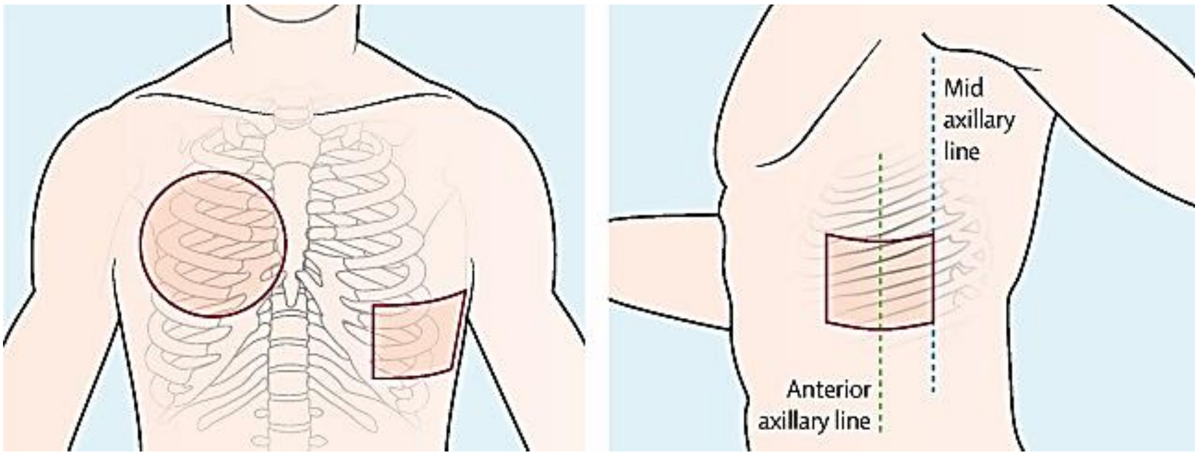
***Defibrillation:***

1. A defibrillation shock is delivered as soon as a defibrillator is available.

2. Paddles or pads are placed on the exposed chest in an anterior-lateral position (Fig. 8, *b*) or an anterior-posterior position (Fig. 8, *a*). It is reasonable to place paddles or pads on the exposed chest in an anterior-lateral position. One paddle or pad is placed on the midaxilliary line over the 6th left intercostal space and the other on the right parasternal area over the 2nd intercostal space.



***a***




***b***

*Figure 8*. Positioning of electrodes

3. In patients with an ICD or a permanent pacemaker the defibrillator pad/paddle is placed on the chest wall ideally at least 8 cm from the generator position.

4. Self-adhesive defibrillation pads are used for defibrillation.

5. Biphasic waveforms are better for defibrillation.

6. For Monophasic waveforms: the initial energy level for adults is set at maximum (usually 360 Joules) for all shocks.

7. For Biphasic waveforms: the default energy level for adults is set at 200J for all shocks. Other energy levels may be used providing there is relevant clinical data for a specific defibrillator that suggests that an alternative energy level provides adequate shock success (e.g. Usually greater than 90 %).

8. If the first shock is not successful and the defibrillator is capable of delivering shocks of higher energy, it is reasonable to increase the energy to the maximum available for subsequent shocks.

9. A single shock strategy is used in patients in cardiac arrest requiring defibrillation for VF or pulseless VT.

***Advanced Life Support Algorithm for "Shockable" cardiac rhythms*** (Fig. 9). Interruptions to CPR decrease the chance of survival from cardiac arrest. While defibrillation is of paramount importance for VF/pVT, a period of well performed CPR immediately after each shock can help maintain myocardial and cerebral viability, and improves the likelihood of subsequent shock success.

During CPR advanced life support interventions are applied and potential causes of arrest sought.

After each defibrillation continue a further 2 minutes of CPR, unless responsiveness or normal breathing become apparent.

If using a defibrillator in manual mode, the defibrillator should be charged during CPR as the end of the 2 minute loop of CPR approaches, to minimise interruptions to CPR and increase the likelihood of shock success.

Rhythm is then reassessed and treatment is directed as necessary. If rhythm assessment results in significant interruption to CPR then a further 2-minute period of CPR is recommended before further shocks are delivered. This is done to obtain the benefits of CPR on VF waveform and increase the likelihood of shock success.

Consideration should be given to administration of a vasopressor in the period of CPR after the second failed defibrillation attempt. Consideration should be given to administration of an antiarrhythmic after the third failed defibrillation attempt. The sequence of escalating advanced life support would then be:

1) attempt defibrillation ensure good CPR;
2) attempt defibrillation add vasopressor (adrenaline 1 mg);
3) attempt defibrillation, add anti-arrhythmic (amiodarone 300 mg).

## "NON-SHOCKABLE" RHYTHM (non VF/pVT)

Asystole is characterised by the absence of any cardiac electrical activity.

Pulseless Electrical Activity (PEA) (sometimes referred to Electromechanical Dissociation [EMD]) is the presence of a coordinated electrical rhythm without a detectable cardiac output.

The prognosis in this group of cardiac rhythms or asystole is much less favorable than with VF/VT.

During CPR advanced life support interventions are applied and potential causes of arrest sought.

Defibrillation is not indicated and the emphasis is on CPR and other ALS interventions (e.g. intravenous access, consideration of advanced airway, drugs and pacing).

***Advanced Life Support Algorithm for “Non-shockable” cardiac rhythms*** (Fig. 9). The following interventions apply to all rhythms and are carried out continuously or during each loop of the algorithm. Each loop comprises 5 sets of 30 compressions (at approximately 100–120 per minute) : 2 breaths, which equates to approximately 2 minutes.

*Other management priorities during CPR:*

– Minimize interruptions to CPR during ALS interventions.

– Administer 100 % oxygen when available.

– Obtain intravenous or intra-osseous access.

– Consider airway adjuncts, but attempts to secure the airway should not interrupt CPR for more than 5 seconds.

– Waveform capnography should be used to confirm airway placement and monitor the adequacy of CPR.

– Adrenaline should be administered every second loop (approximately every 4 minutes).

– Other drugs/electrolytes should be considered depending on the individual circumstances.

## RECOMMENDATION FOR FREQUENCY OF VENTILATION

When ventilating a victim without an advanced airway, ventilation should be continued at a ratio of 30 compressions to 2 ventilations, irrespective of the number of rescuers, until an advanced airway is in place.

After an advanced airway (e.g. tracheal tube, laryngeal mask airway, oesophageal-tracheal Combitube) is placed, ventilate the patient’s lungs with supplementary oxygen to make the chest rise. During CPR for a patient with an advanced airway in place it is reasonable to ventilate the lungs at a rate of 6 to 10 ventilations per minute without pausing during chest compressions to deliver ventilations.

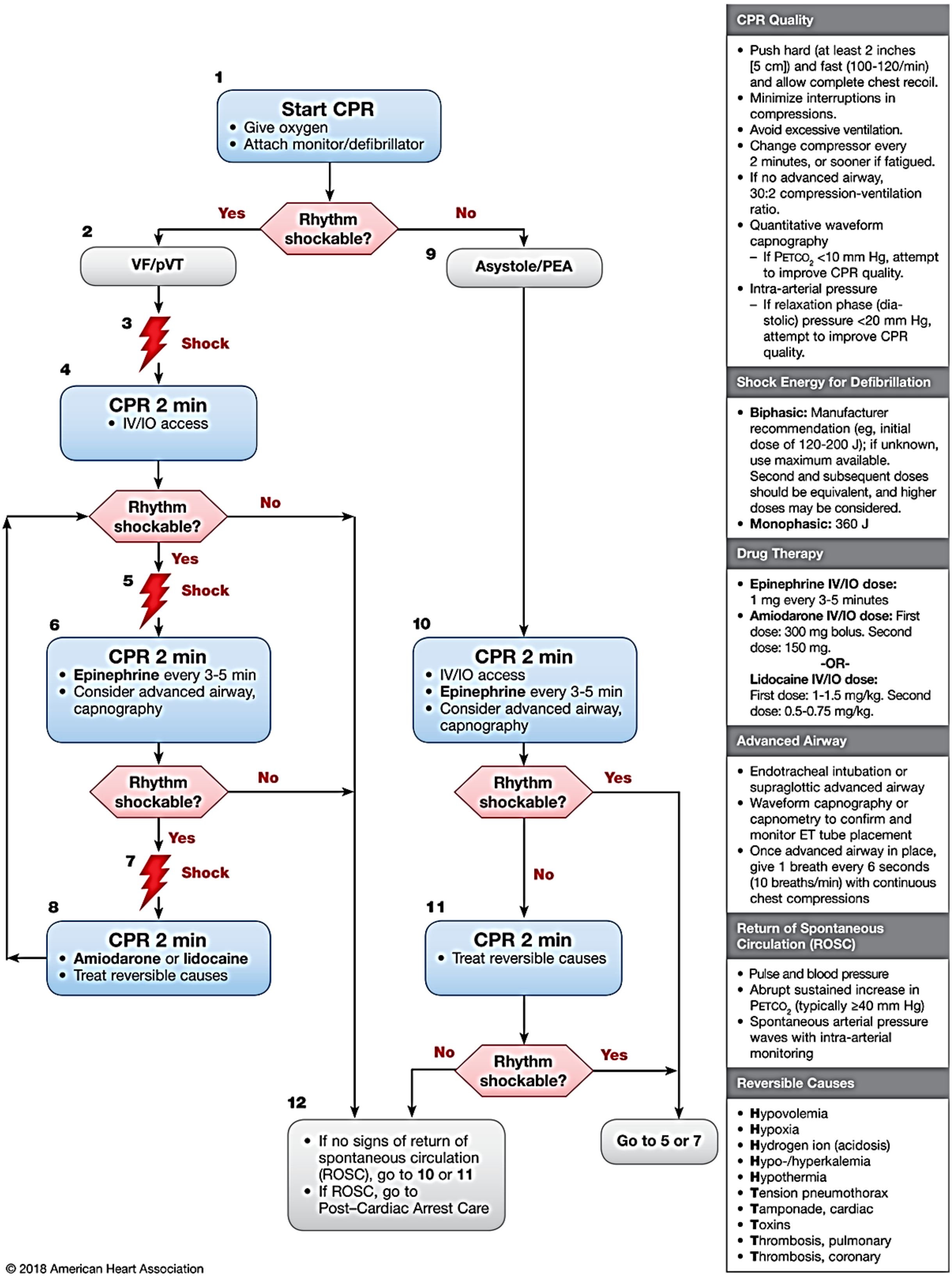





*Figure 9*. Adult Cardiac Arrest Algorithm - 2018 Update

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**Герасимёнок** Дмитрий Станиславович

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