

# Odessa National Medical University

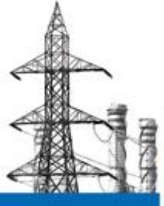
Department of pharmacy organization and  
economics with postgraduate training

## ELECTRICAL SAFETY



# Lesson plan

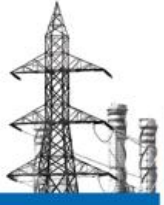
- The effect of electric current on the human body. Electrical injuries. Factors affecting the consequences of electric shock.
- Classification of premises according to the degree of danger electric shock.
- Conditions of injury to a person by electric current.
- Electric shock when touched or when approaching current-carrying parts and when touching non-current-carrying metal elements of electrical installations that are under voltage. Step and touch voltage.



# ELECTRICAL SAFETY -

a system of organizational and technical measures and means that ensure the protection of people from harmful and dangerous effects of electric current, electric arc, electric field and static electricity

(Extract with *GOST 12.1.009-76.SSBT. Electro-safety Terms and definitions*)



## **MAIN REGULATORY DOCUMENTS:**

- Rules for the installation of electrical installations
- NPAOP40.1-1.32-01 Rules for the construction of electrical installations. Electrical equipment of special installations
- Rules for the technical operation of electric power stations, etc networks
- Rules for the technical operation of consumers' electrical installations
- NPAOP40.1-1.01-97 Rules for the safe operation of electrical installations
- NPAOP0.00-1.29-97 Rules for protection against static electricity
- Rules of testing and use of individual means protection
- GOST12.1.019-79 Electrical safety. General requirements and nomenclature of types of protection.
- GOST12.1.030-81 Electrical safety. Protective grounding. Reset

# RULES FOR ARRANGEMENT OF ELECTRICAL INSTALLATIONS

**ELECTRICAL INSTALLATIONS** -these devices intended for:

- generation (production) of electrical energy
- transformation (transformation of one voltage into another)
- switching (on, off, switching)
- transmission of electrical energy over a distance
- conversion of electrical energy into other types of energy



*DISTRIBUTION  
ELECTRICAL INSTALLATION*

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graph TD; A["DISTRIBUTION ELECTRICAL INSTALLATION"] --> B["By voltage:"]; A --> C["By accommodation:"]; A --> D["By degree of risk:"]; B --> B1["- up to 1000 V inclusive"]; B --> B2["- above 1000 V"]; C --> C1["- external"]; C --> C2["- internal"]; D --> D1["- especially dangerous"]; D --> D2["- with increased danger"]; D --> D3["- without increased danger"];
```

*By voltage:*

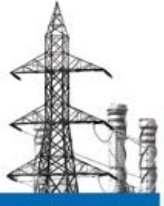
- up to 1000 V inclusive
- above 1000 V

*By accommodation:*

- external
- internal

*By degree of risk:*

- especially dangerous
- with increased danger
- without increased danger



## **THE EFFECT OF ELECTRIC CURRENT ON THE ORGANISM PEOPLE**

- thermal**
- electrolytic**
- biological**
- mechanical**

# THE EFFECT OF ELECTRIC CURRENT ON THE ORGANISM PEOPLE

Thermal action - manifests itself in burns of individual parts of the body, heating of blood vessels, heart, brain and other organs through which the current passes, which leads to functional disorders in them.

Electrolyte physical effect - is characterized by the decomposition of blood and other organic liquids, which causes significant violations of their physical and chemical composition.



## THE EFFECT OF ELECTRIC CURRENT ON THE ORGANISM PEOPLE

Mechanics hon action - manifested by damage (rupture, delamination, etc.) of various tissues of the body as a result of the electrodynamic effect.

Biologists hon action current on living tissue - is manifested by dangerous excitation of cells and tissues of the body, which is accompanied by involuntary convulsive contraction of muscles. Such excitement can lead to significant disturbances and even complete cessation of activity of the respiratory organs and blood circulation.

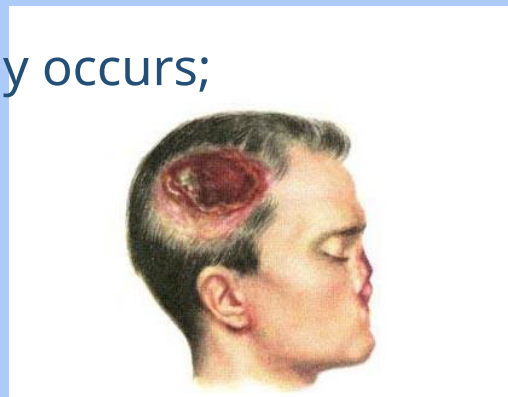
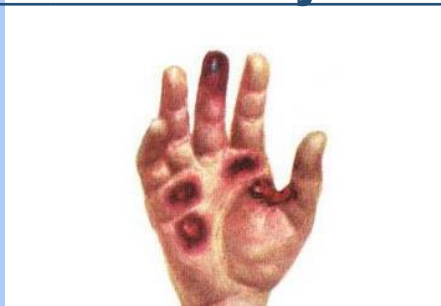
Electric injury is an injury caused by the effect on the human body of an electric current and (or) an electric arc.



## TYPES OF ELECTRICAL INJURIES

According to the consequences, electric injuries are conditionally divided into three types:

-Local electric injuries -local damage to the body occurs;



-General electronic isktrotrauma (electric shocks) -the whole is impressed the body as a result of a violation of the normal functioning of vital organs and systems.



-Mixed electric injuries .

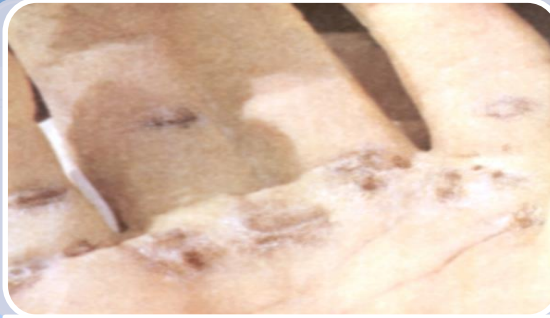
## **TYPES OF ELECTRICAL INJURIES**

### **Local electric injuries:**

- Electrical burns
- Electrical signs (labels)
- Metallization of the skin
- Electroophthalmia
- Mechanical damage



Electroophthalmia



Electric  
signs  
(marks



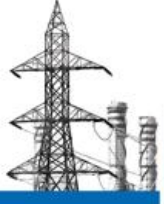
Strumova  
(contact)  
electric shock



Dugova  
electric shock



Metallization  
skin



## TYPES OF ELECTRICAL INJURIES

### **General electrical injuries** or electric shocks:

And - convulsive muscle contractions without loss of consciousness

II - convulsive muscle contractions with loss of consciousness without violation of breathing and blood circulation

III – loss of consciousness with heart failure activity or breathing, or cardiac activity and breathing together

IV – clinical death, i.e. lack of breathing and blood circulation

# FACTORS AFFECTING THE CONSEQUENCES ELECTRIC SHOCK

The nature of the effect of electric current on the body person, and therefore the consequences of the damage, depend on a number of factors, which can be conditionally divided into:

- Electrical factors (amperage, voltage, resistance of the human body, type and frequency of current);
- Non-electric factors (duration effects of the current, the path of the current through the human body, individual characteristics of the person, environmental conditions, etc.).

# DEPENDENCE ELECTRIC SHOCK FROM TENSIONS



$$I = \frac{U}{R}$$

Where: U is the contact voltage

R - the resistance of the human body (1000

Ohm - in unfavorable conditions;

conditions;

50,000 ohms - with favorable conditions)

conditions)

$$I_1 = \frac{42}{1000} = 0.042 \text{ a} = 42 \text{ ma}$$

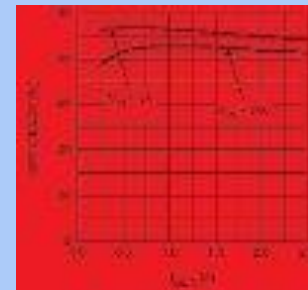
**20÷50 V – non-discharge voltage, injuries of medium severity**

$$I_2 = \frac{42}{50000} = 0.00084 = 0.84$$

up to 5 mA - safe current Resistance

less than 8.4 kΩ - dangerous

$$R_1 = \frac{U}{I} = \frac{42}{0.005} = 8,400 \text{ omg}$$



**Conclusion: a voltage of ~ 42 V is safe at body resistance of a person is more than 8.4 kOhm = 8400 Ohm**



# DEPENDENCE OF CURRENT INJURY ON TENSIONS

$$I_3 = \frac{110}{1000} = 0.110 \text{ A} = 110 \text{ mA}$$

- death at more than 100 mA

$$I_4 = \frac{110}{50000} = 0.0022 \text{ A} = 2.2 \text{ mA}$$

- less than 5 mA - safe

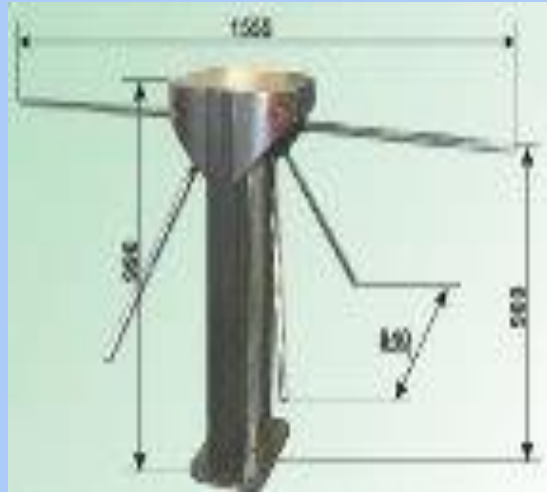
$$R_2 = \frac{110}{0.005} = 22000 = 22 \text{ k}\Omega$$

- Less 22 k $\Omega$  is dangerous

- the current will be more 5 mA

**Conclusion: a voltage of ~ 110 V is safe at body resistance of a person is more than 22 k $\Omega$  = 22000  $\Omega$**

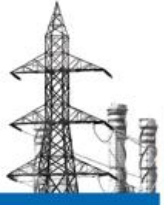
## SAFE VOLTAGE



$$U_1 - I - R - 0.005 - 1000 - 5 V$$

$$U_2 - 0.005 - 50000 - 250 V$$

**Conclusion:** 1) under the most unfavorable conditions, when  $R=1000$  Ohm is a safe voltage of 5 V;  
2) under ideal conditions  $R= 50,000$  Ohm, a voltage of 250 V is safe



## **CLASSIFICATION OF PREMISES ACCORDING TO DANGER ELECTROTRAUMA**

- without increased danger**
- with increased danger**
- especially dangerous**

# FACTORS

Help...

increased  
temperature

increased  
humidity

conductive  
dust

conductive  
floor

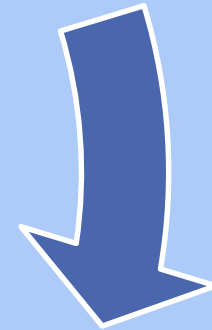
pairs of aggressive environments

placing  
equipment

**RAISED TEMPERATURE > + 35°**

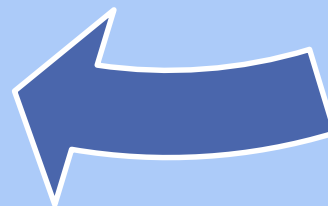
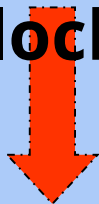
**accelerated  
aging**

**drying out  
isolation**



**short  
locking**

**micro-  
cracks**



## **SHORT CIRCUIT**

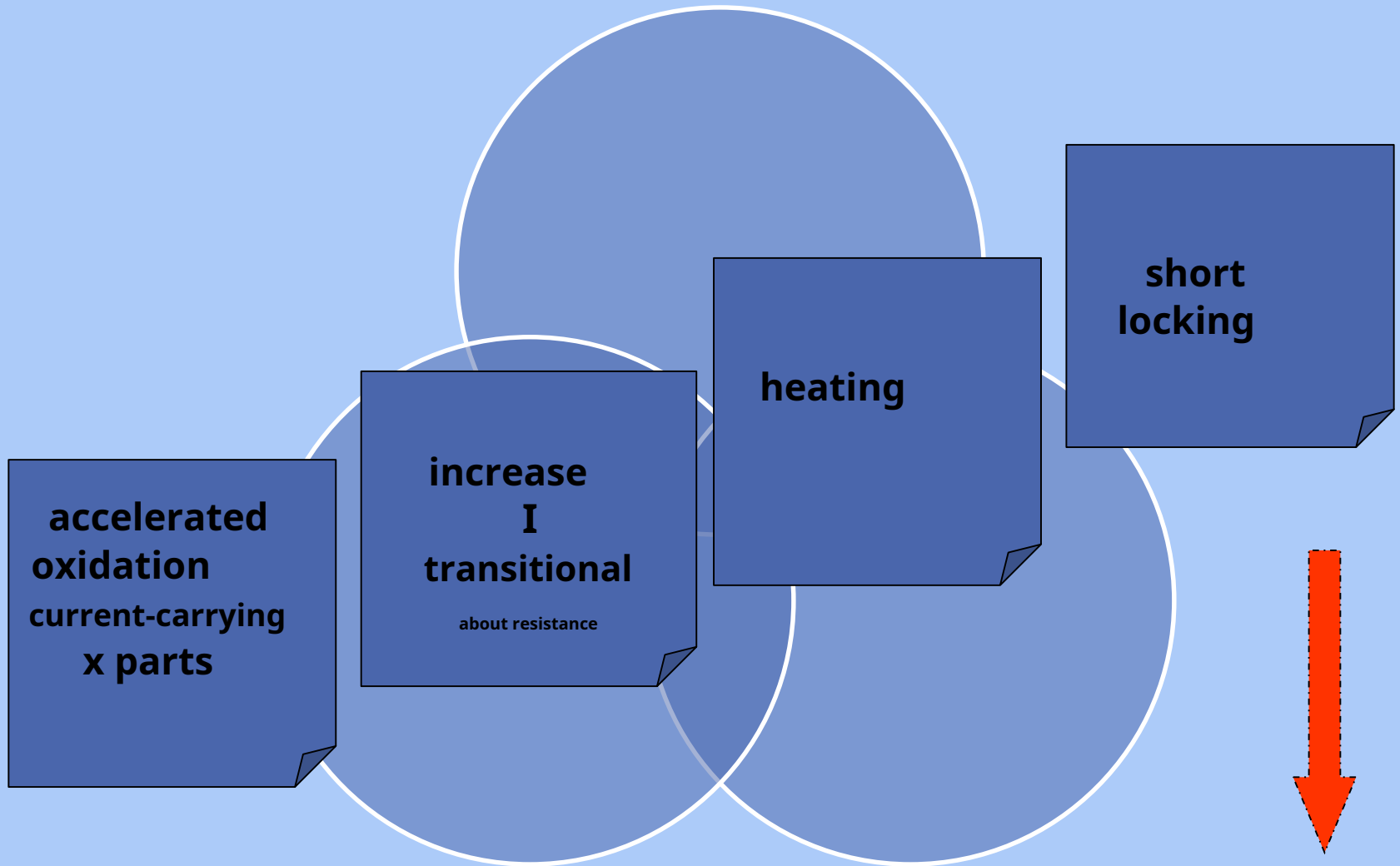
**potential on the hull is  
a danger to personnel**

**opposition**

- **additional supply and exhaust ventilation,  
air conditioners;**
- **reconstruction - replacement of equipment with more  
heat resistant**



# HIGH HUMIDITY > 75%



# SHORT CIRCUIT

**potential on the hull is  
a danger to personnel**

**opposition**

- **additional ventilation, moisture absorbent filters;**
- **more often performing work on cleaning contact connections, tightening bolted ones**  
connections;
- **replacing the equipment with a moisture-proof one (hermetic)**



## **PAIRS OF AGGRESSIVE ENVIRONMENTS**

- accelerated corrosion of insulation;**
- short circuit;**
- electric shock**

# PAIRS OF AGGRESSIVE ENVIRONMENTS

- Acids
- Meadows
- Solvents



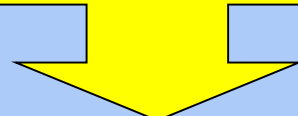
**Fast corrosion isolation**



**The potential for body - danger damage**



**contraindications**



- elimination of the source  
a couple from the room
- changing settings to acid resistant

## PLACING

Simultaneous contact with the grounded structure of buildings and with the body of the installation, which was under the influence of electric voltage, can lead to damage to electric current (way current: "hand-to-hand", "head-hand") through vital human organs - heart and lungs

### Countermeasures

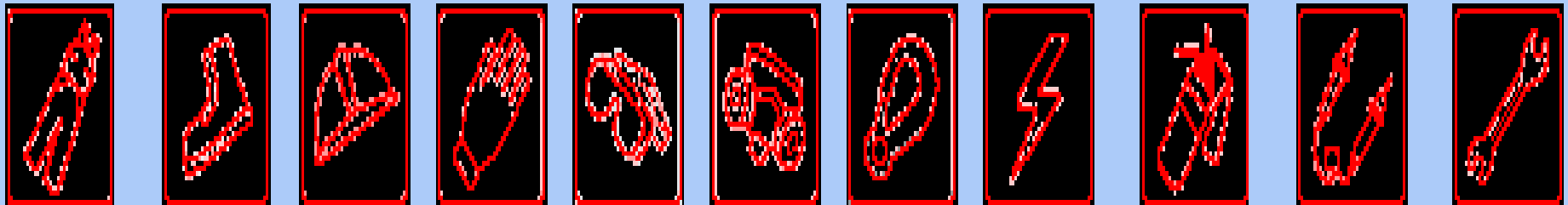
- The distance is not less than 1.5 m
- Screens with insulating materials
- Fencing
- Warning posters
- Additional instruction

## EQUIPMENT



## OTHER ELECTRICAL SAFETY PUE REQUIREMENTS

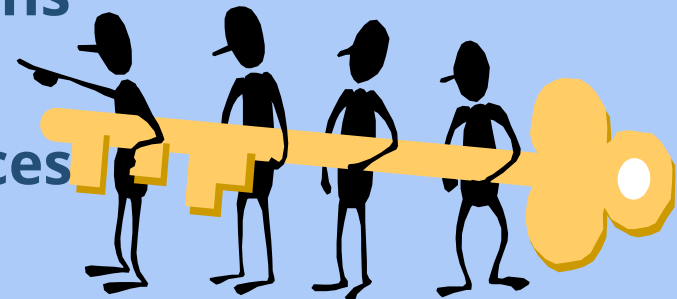
- Impossibility of touching conductive parts
- Use of electrical safety signs
- Presence of an address on the switches
- Protection against mechanical damage
- Protection against surge current and short circuit currents
- Selective protection
- Grounding
- Nullification





## MEANS OF PROTECTION IN ELECTRICAL INSTALLATIONS

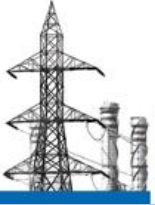
- protective grounding
- nullification
- equalization of potentials
- low voltage
- protective unlocking
- insulation of current lines
- fencing devices
- warning alarm, blocking, safety signs
- means of protection and safety devices





**Earthing -**  
intentionally electric  
connection to earth  
metal conductors  
parts that can  
to be under tension





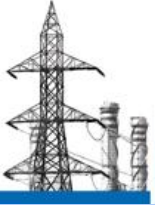
## **Reset -**

**this is an intentional electrical connection  
with a neutral protective conductor  
metal conductive parts that may be  
under voltage (equipment housings, cable  
structures,  
steel pipes, etc.)**



**Protective unlocking -  
fast-acting protection  
that provides automatic  
unlocking  
electrical installations when  
there is a risk of  
electrocution**





## WARNING SIGNS



# RULES OF TECHNICAL OPERATION

necessity  
organizations  
exploitation  
electrical installations

duties  
manager

requirements for  
responsible  
and his deputy

duties  
responsible



security service  
labor and  
requirements for it

attendant  
staff and  
requirements for  
him

categories  
works

species  
works

# SAFE RULES

## ELECTRICAL INSTALLATION

### Duties

- manager
- responsible
- OP services
- staff

### Responsibility

### Categories of works

- without removal U
- **with partial**
- by removing U



# OPERATIONS CONSUMERS

### Requirements to staff

- age
- health
- teaching,  
testing
- admission group

### Activities

- organizational
- technical



## **SYSTEMS OF TOOLS AND MEASURES Z ELECTRICAL SAFETY**

- a system of organizational and technical measures and means**
- a system of technical means and measures**
- a system of electrical protective equipment**

# INDIVIDUAL PROTECTION EQUIPMENT

**Appointment**

**Number**

**Distribution**



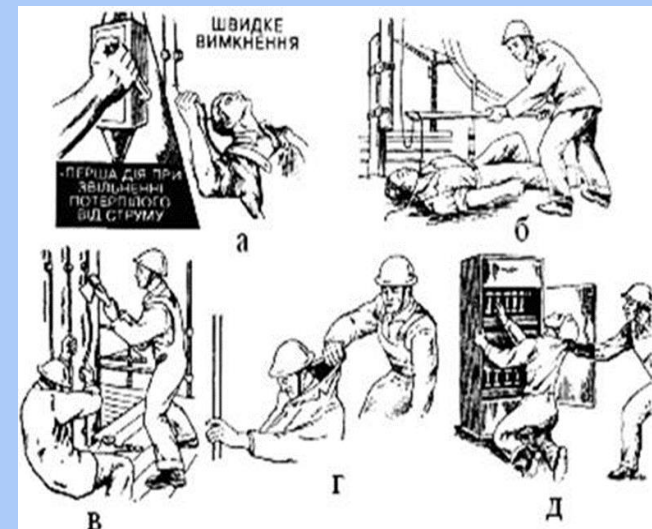
**Trial,  
inscriptions**

**Place  
storage**

**Order  
using**

## PROVISION OF FIRST MEDICAL AID AT SHOCKED BY ELECTRIC CURRENT

- It is forbidden to touch naked parts of the victim's body with bare hands until the electrical circuit is opened.
- As soon as possible, free the victim from the influence of electric current on him. Disconnecting the electricity device from the network with a general circuit breaker.
- If the victim has lost consciousness, the pulse and breathing should be checked first.



## METHODS OF RELIEF FROM TENSION

- DISCONNECTION FROM POWER SUPPLY
- CUTTING THE WIRE
- ARTIFICIAL SHORT CIRCUIT
- WITHDRAWAL FROM THE SOURCE OF VOLTAGE



# PROVISION OF FIRST MEDICAL AID AT SHOCKED BY ELECTRIC CURRENT

- perform rescue sequence (restore passability ways, perform artificial respiration, perform an external heart massage); necessary activities of the victim with urgency in
- support basic vital functions victim before the arrival of a medical worker;
- cause quick medical help or take measures to transport the victim to the nearest medical facility.





# FIRST AID TO THE INJURED

- PUT ON A LEVEL PLACE
- UNDO THE BELT AND COLLAR
- OPEN MOUTH
- PULL OUT THE TONGUE
- TURN YOUR HEAD, PUT A ROLLER UNDER THE NECK
- PERFORM ARTIFICIAL RESPIRATION USING THE "MOUTH-TO-MOUTH" METHOD
- DO INDIRECT MASSAGE OF THE HEART



If breathing and pulse are normal, it is necessary to lay him on his back and turn his head to the side. Measures are taken to bring the victim to consciousness: splash the face with cold water, let them sniff cotton wool soaked in ammonia, etc.

If the victim regained consciousness after fainting, before the arrival of the doctor, you need to provide him with complete rest, put him in a warm room, give him to drink tinctures of valerian (15-20 drops) and hot tea, unbutton clothes that constrict his breath.

It is impossible to leave the victim unattended, to allow him to move.

If breathing is weak and uneven, begin closed heart massage and artificial respiration. Do not stop these measures until the heart and breathing are restored, and if there is no proper effect, then until the doctor arrives.





If there is no breathing and pulse, it should not be considered in any case victim dead. Help should be provided continuously until breathing and pulse are fully restored, regardless of the time during which the victim is in a state of clinical death. Only a doctor's opinion or complete blackout can serve as a basis for stopping resuscitation measures

cooling the body to the temperature of the surrounding air.



**Дякую  
за  
увагу.**

