

**How to Act After Accidents Caused by Electrical Current – Course:  
Basic Skills and Knowledge of Electrical Engineering. Trainees'  
Handbook of Lessons**



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# How to Act After Accidents Caused by Electrical Current – Course: Basic Skills and Knowledge of Electrical Engineering. Trainees' Handbook of Lessons

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## Introduction

The present material is meant for the training for jobs in the field of electric engineering.

It comprises the description of activities and auxiliary means required after accidents caused by electric current.

The required methods are described in self-contained sections. The required knowledge and skills are explained in each section in the order of the necessary sequence of activities. Illustrations are included to support the text of the individual sections.

In order to intensify the process of learning, questions are included for the trainee to check his knowledge.

## 1. Effects of Electric Current on Human Organism

### *Irritating effect*

– If an electric current flows through the human body, the entire sensitive muscular system becomes cramped.

– For the degree of injury caused by electric current two factors are decisive:

- The intensity of current
- The duration of current flow through the body.

– From the equation  $I = U/R$  it is to be seen that the current intensity depends on the following values:

- Intensity of the voltage affecting a person;
- Resistance of the parts of the human body through which the current flows.

Influence of the current intensity on the sensations with alternating current with 50 Hz supposing a current path hand-body-feet.

Current	Sensations
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intensity I in mA	
3.5	Current just perceptible on the palms (absolute threshold).
5	Prickling sensation in the whole hand as if it went to sleep.
8	Pressure in the forearm.
10	First sensations at the soles of the feet.
11.5	Slight cramping of the wrist, moving of the hand is difficult, pressure on the heels.
12.5	Prickling in the upper arm, severe cramping of the entire arm, especially of the wrist.
14.5	Strong prickling along the arm to the armpit, forearm almost numb up to the elbow, letting loose "still" possible.
15.8	Pressure in ankles and heels, thumb of the hand completely cramped.
18	Letting loose only possible "with greatest effort".
20	Shooting pain in the wrist-joint and elbow.
	"Letting loose no more possible!"
	"Danger of life!"
more than 40	"Absolute danger of life! Death may occur."

– For the protection of man, the highest permissible contact voltage is:

- for alternating current voltage 50 V,
- for direct current voltage 120 V.

– The body resistance is varying and different with each person.

– The resistance of the body is, to a far extent, determined by the resistance of the skin.

- Dry skin offers a resistance of some kilohms.
- Sweaty skin has a resistance of a few ohms only.

*Approximate figures of the body resistance*

Current path	Resistance
Hand–body–hand	approx. 1300 ohms
Hand–body–feet	approx. 1000 ohms
Hands–body–feet	approx. 650 ohms
Foot–foot	approx. 1300 ohms

What is the intensity of a current flowing through a person, if the current path is hand–feet and the applied voltage 220 V?

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What conclusions have to be drawn from this current intensity?

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- The most dangerous irritating effect of the three–phase current is the "ventricular fibrillation". This can occur if the current flows during the T–spike of the electrocardiogram.

The frequency of the three–phase current disturbs the heart rhythm so that it comes to the ventricular fibrillation. This means that the heart works at 400 to 1000 contractions per minute and no blood is pumped through the body.

Why is each minute of first aid decisive in the case of an accident caused by electric current?

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#### *Thermal effect*

- By the electric arc, i.e. the thermal effect of the electric current, clothes may catch fire and the skin be burned.

Fire with burning people must only be smothered with the help of insulating material, such as 'blankets or clothes. Do never extinguish the fire by water!

## **2. Rescue of Injured People out of Electric Plants below 1 kV**

### *Rescue measures*

- Breaking of the fault–current circuit by
  - switching off the light or machine switch
  - pulling the plug out of the socket
  - removing the fuses
  - creating a short circuit, for example with the help of tools which have an insulated handle
- Rescue of the injured person
  - rendering of first aid

### *Measures to protect the rescuer*

- Insulating his position by
  - wood chairs, wood tables, wood ladders
  - repeatedly folded newspapers, books
  - rubber or plastic mats
  - glass panes
- Insulating the position of the injured person by putting underneath
  - rubber or plastic mats
  - dry wooden plates
  - fabric reinforced laminate plates
- Removing the injured person out of the fault circuit by the rescuer by
  - his insulated hands (working gloves, dry clothes)
  - a dry plank or wooden bar
  - insulated cables or plastic ropes

Why must the rescuer never touch the injured person with bare hands?

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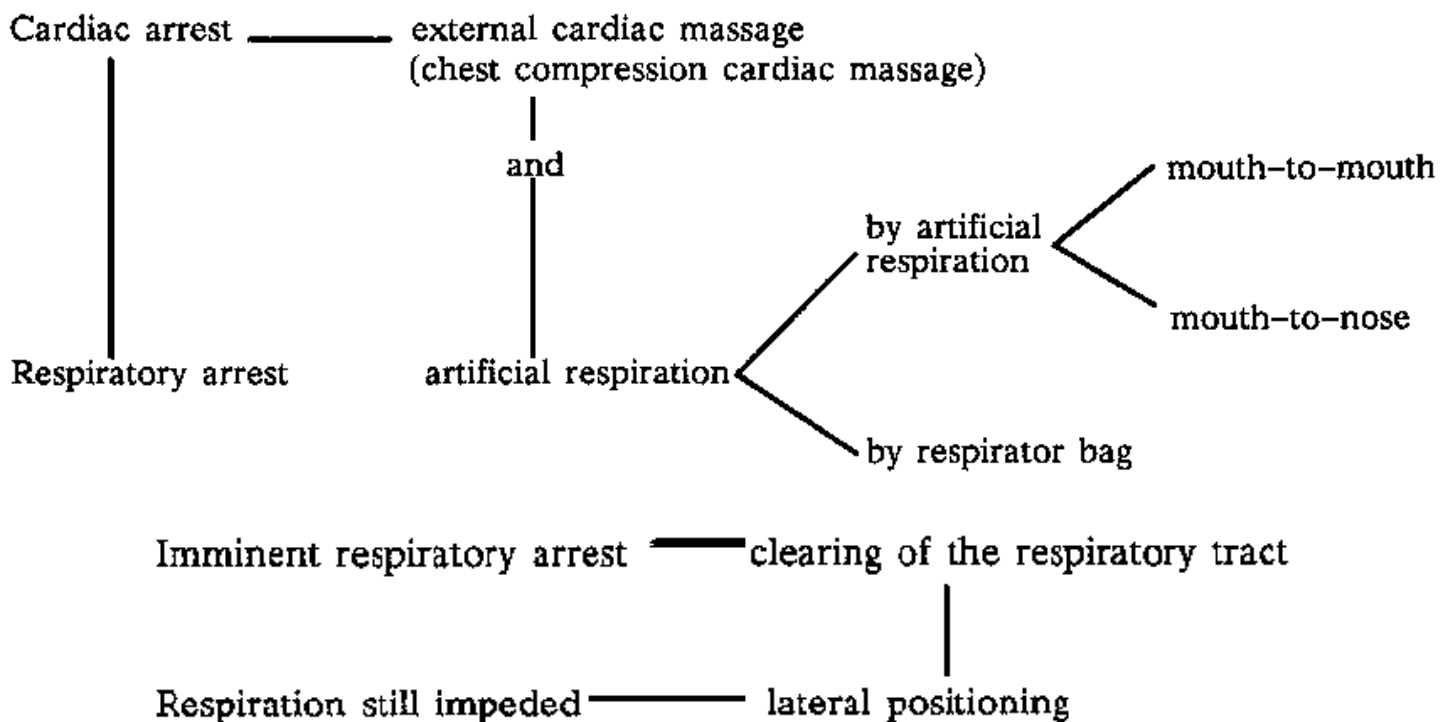
### 3. Immediate Measures after an Accident Caused by Electric Current

The health defect and the life of the injured person depend to a high degree on the correct rescue work.

*First aid measures* – Rescue and bedding of the injured person

- Artificial respiration in the case of respiratory paralysis
- Cardiac massage in the case of cardiac arrest
- Alkalinization
- First wound treatment
- Calling medical help

*Measures in the case of unconsciousness (survey)*



*Measures in a state of consciousness*

- Let the injured person drink an alkalinized solution.  
(Sodium hydrogencarbonate drinking ampoule or two table-spoonfuls of bicarbonate of soda in 1 l water.)
- Only then treatment of secondary wounds, such as immobilization of fractures etc..

*Do not*

- give the injured person any medicine!
- Do not pour any fluids down an injured person's throat! (Danger of suffocation).
- Do not touch open wounds with hands.
- Do not remove foreign bodies that have penetrated the body.

Reanimation must be continued until clear signs of returning life are visible or a medical doctor orders to stop the measures.

What information should an information board of first aid give?



Every person who had an accident caused by electric current has to be considered as seriously injured. Such person must not be left alone!

### 3.1. Measures Taken if the Injured Person is Conscious

It has to be supposed that the injured person has just been rescued.

- Prevent hypothermia by putting blankets underneath and on the person.
- Administration of an alkalinized solution.

(Before giving the injured person the alkalinized solution, the rescuer must try it in order to avoid that the injured person gets a cauterization. Inform the medical staff about the alkalinization.)

- Treatment of wounds and secondary injuries. (Only first aid.)
- Examination of the pulse and respiration, especially during the first 30 minutes.
- Calling a second rescuer.
- Calling medical help.
- Preparation of transportation of the injured person to further medical treatment.

What has to be considered with the treatment of wounds and secondary injuries?

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### 3.2. Measures Taken if the Injured Person is Unconscious but Respiration is Regular

Also here it is supposed that the injured person has just been rescued.

*Brief examination of the injured person to find out the extent of the injuries.*

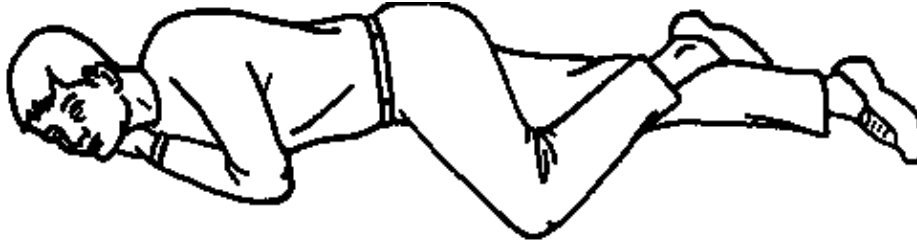
- Examination of heart action
- Examination of the pulse
- Opening of too tight clothes which might obstruct the respiration
- Recognition of further signs of life

- Rosy skin
- Pupillary light reflex
- Mucosa visibly blood-supplied

- Stating of further injuries

- Burns of the skins
- Arterial bleedings
- Bone fractures

*Bedding the injured person in coma position*



**Figure 1 – Coma position (right side)**

If the injured person is wounded on the right side of his body, he is put in coma position on his left side.

The coma position prevents the squeezing of the respiratory tract and enables the flowing off of blood, phlegm and vomit through the mouth.

*Further measures*

- Constant examination of respiration and heart action
- Supply of fresh air
- Treatment of arterial bleedings
- Calling of medical help
- Preparation of the transportation of the injured person to further medical treatment

**3.3. Measures Taken if the Injured Person is Unconscious and Has Stopped Breathing**

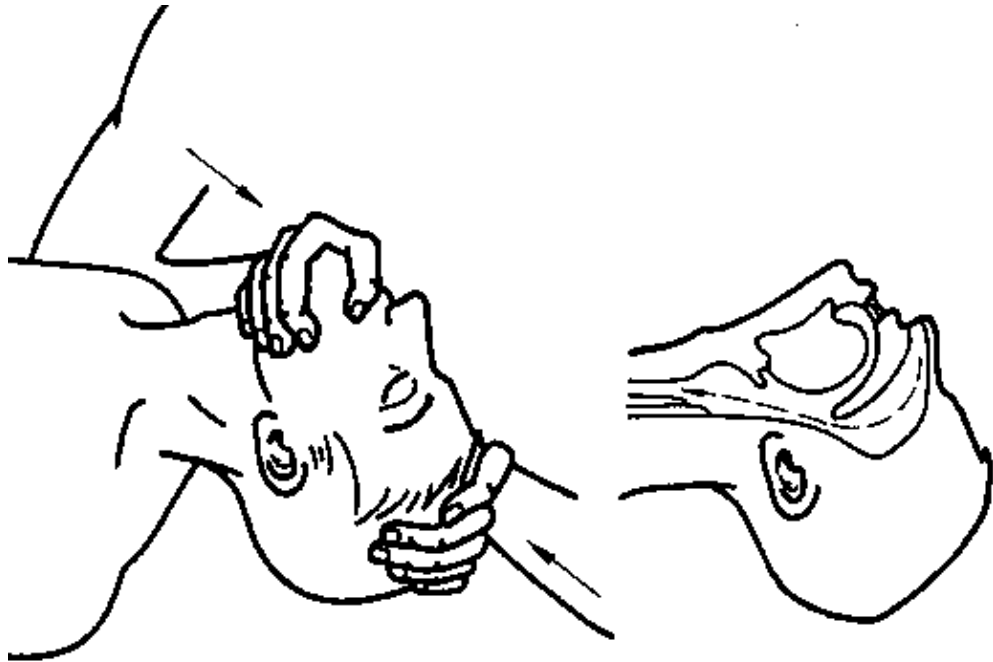
If the respiration stops, there is acute danger of life!

(5 minutes after the respiration has stopped, at the latest, it comes to incurable cerebral damages.)

Artificial respiration must be started immediately after the injured person is rescued.

*Preparatory measures*

- Open the mouth of the injured person by hands.
  - Kneel down above the head of the injured person.
  - Put both your thumbs on the lower jaw of the injured person, left and right thumbs pointing to the tip of the chin.
  - Get hold of the lower jaw with the fingers of both hands.
  - Press the lower jaw downwards thumbs and fingers acting as a lever.
- Opening the mouth of the injured person with the mouth opener.
  - Kneel down on the right side of the injured person.
  - Press the thumb of your left hand between the lips of the injured person thus exposing the row of teeth.
  - Open the clenched jaws with the help of the mouth opener.
- Cleaning of the oral cavity.
- Overstretching the head in order to make the upper respirator tract accessible.
  - Put one hand on the forehead of the injured person and – without force – pull his head back.
  - By the other hand raise the lower jaw.



**Figure 2 – Overstretching of the head**

If after the overstretching of the head respiration does not start visibly and audibly, artificial respiration must be started immediately!

*Carrying out of the artificial respiration*

Why is a person who has lost consciousness in danger of suffocation?

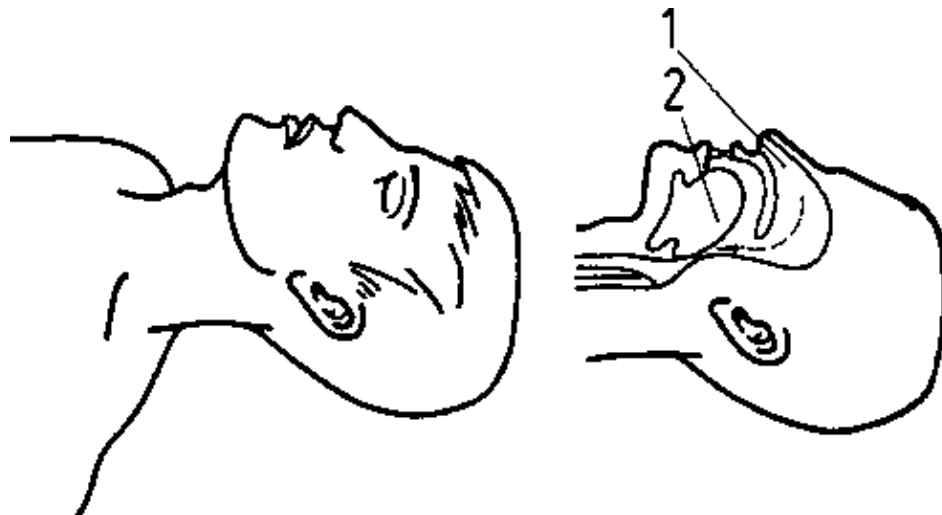
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**Figure 3 – Danger of suffocation in a state of unconsciousness – 1 Respiration tract, 2 Tongue**

#### **4. Giving Artificial Respiration to Injured People**

The chance of surviving of an injured person decreases with passing time. Approximately 5 minutes after breathing has stopped, there is only a chance of 15 %.

Each second is valuable and fast and efficient help decides about life and death of the injured person. Artificial respiration has priority over any other measure!

## 4.1. Artificial Respiration

### *Principle of artificial respiration*

- Breathing in

By breathing the rescuer's breath into the lungs of the injured person, this person is supplied with the required oxygen.

- Breathing out The injured person breathes out spontaneously due to the natural flexibility of the chest.

On principle, artificial respiration is started by breathing in.

- The breath of the rescuer which is breathed into the injured person contains still 16 to 17 percentage by volume of oxygen.

- For sufficient respiration, 15 to 20 moderate breaths per minute given by the rescuer are required.

- Artificial respiration has to be continued until the injured person starts breathing or a medical doctor orders to stop the measure.

### *Advantages of artificial respiration compared with other methods:*

- In order to give artificial respiration, the rescuer must keep the respiratory tracts of the injured person free.
- The success of the artificial respiration can be seen from the movements of the chest of the injured person and can be observed by the rescuer.
- Only little energy is required for giving artificial respiration, so that this measure can be continued by one rescuer for a long time.

No method of artificial respiration is allowed to be practised at a person for the purpose of exercise. Her, a dummy has to be used.

### *Signs of returning life*

- Twitching of the corners of the injured person's mouth
- Movement of the throat or fingers
- Returning of the normal colour of the skin
- Spontaneous independent breathing

### *Mistakes with artificial respiration*

- The head of the injured person is not enough overstretched or the rescuer breathes his breath too violently into the lungs of the injured person.

By this the introitus of the oesophagus is pushed open, the stomach of the injured person is pumped up by the rescuer's breath, whereas too little breath reaches the lungs. (This situation is recognized by the fact that the chest of the injured person does not expand and rise.)

- The rescuer himself, during artificial respiration, feels dizzy or everything goes "black" before his eyes. (In this case, stop breathing for a moment and then breathe calmly for a few seconds.)

- The rescuer has aesthetic or hygienic objections.

Clean the face of the injured person.

Cover the face of the injured person with a clean handkerchief or cellulose wadding.

### **Mouth-to-nose respiration**

- Kneel down by the side of the injured person.
- Bend the head of the person back.

(Most important precondition of successful respiration!)

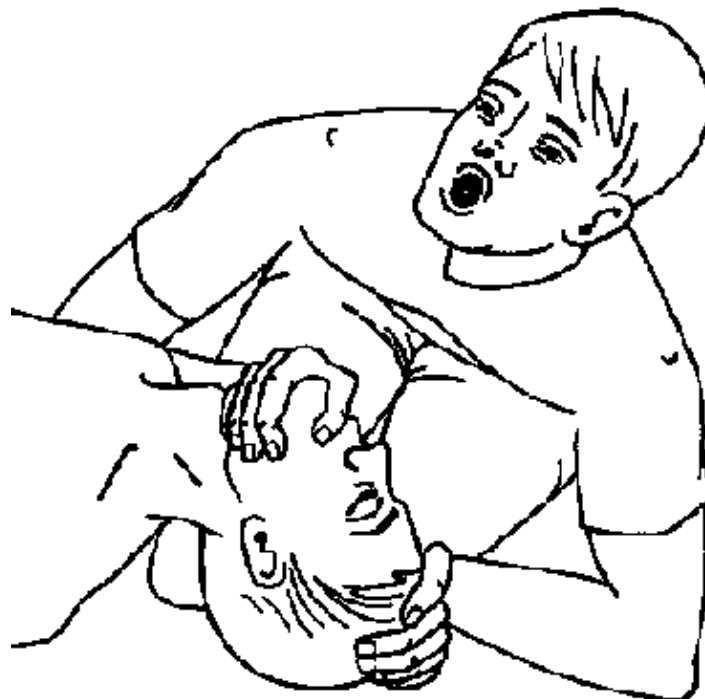
– Breathe in deeply, firmly enclose the nose of the injured person by your mouth and breathe out into his lungs.

(In doing so, keep the mouth of the injured person closed.)



**Figure 4** – Mouth-to-mouth respiration (breathing in)

– After this, the rescuer turns his face towards the body of the injured person in order to watch if the chest of the injured person slumps as a sign of breathing out. In doing so, the rescuer again breathes in deeply.



**Figure 5** – Mouth-to-nose respiration (breathing out)

– This action is repeated according to the rhythm of the rescuer's own respiration 15 to 20 times per minute

**Mouth-to-mouth respiration**

This method should be used only if the respiratory tract of the nose is blocked.

- Kneel down by the side of the injured person.
- Put the head of the injured person in the most favourable position for artificial breathing by bending it back.
- Get hold of the chin of the injured person and move the lower jaw till the mouth opens.
- By the other hand get hold of the forehead of the person in such a way, that the nose of the injured person can be held by thumb and fingers.
- Breathe into the lungs of the injured person with your lips wide open. Pay attention to the rising of the injured person's chest.
- Remove from the injured person and watch his breathing out. Pay attention to the noise of breathing out.
- Repeat the action according to the rhythm of your own respiration 15 to 20 times per minute.

Why must the head of the injured person be overstretched backwards?

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### **Artificial respiration by breathing apparatus**

For this purpose,

- mouth breathing apparatus and
- mouth masks

are used.

They are universally applicable and can also be used during transportation of the injured person.

- Put the apparatus on the injured person's face.
- Operate the apparatus.
- Watch respiration after each breath.
- Stop artificial respiration when the injured person begins to breathe independently.

In case of emergency, do not search for a breathing apparatus but start mouth-to-nose or mouth-to-mouth respiration immediately.

### **4.2. Manual Methods of Respiration**

Manual methods are applied only if artificial respiration of mouth-to-nose or mouth-to-mouth ' respiration is impossible due to extensive injuries of the face.

*Principle of manual respiration methods*

- Breathing out

By squeezing the chest and thus the lungs, the respiratory air is forced out of the lungs and a negative pressure is created.

- Breathing in

With relieving external pressure, the chest, as a result of its flexibility, returns to its original position, the lungs expand and surrounding air is aspirated.

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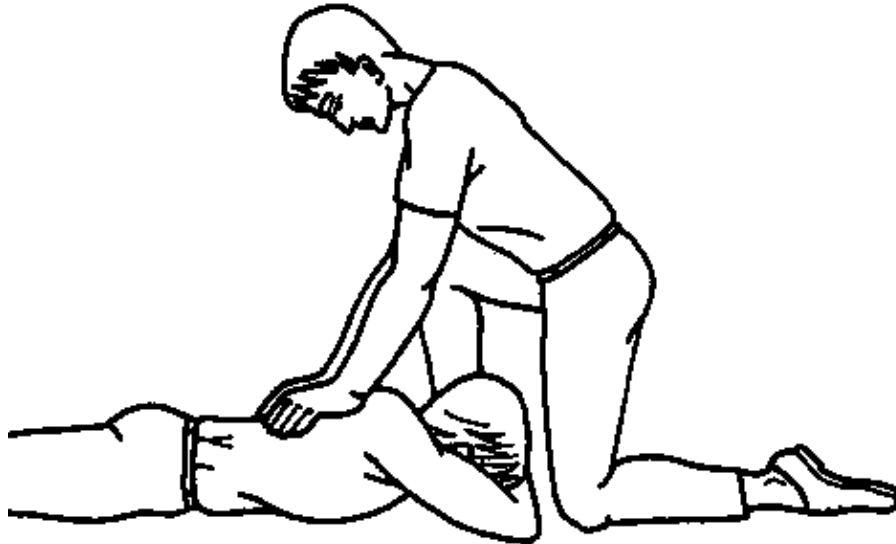
With the manual methods, begin with breathing out.  
In order to avoid rib and breastbone fractures, the chest must be pressed down only moderately!

#### *Mistakes with the manual methods*

- The breathing phases are not deep enough.
- The breathing rhythm is not observed.
- The movements of the arms are anatomically wrong.
- The respiration movements are not carried out evenly.

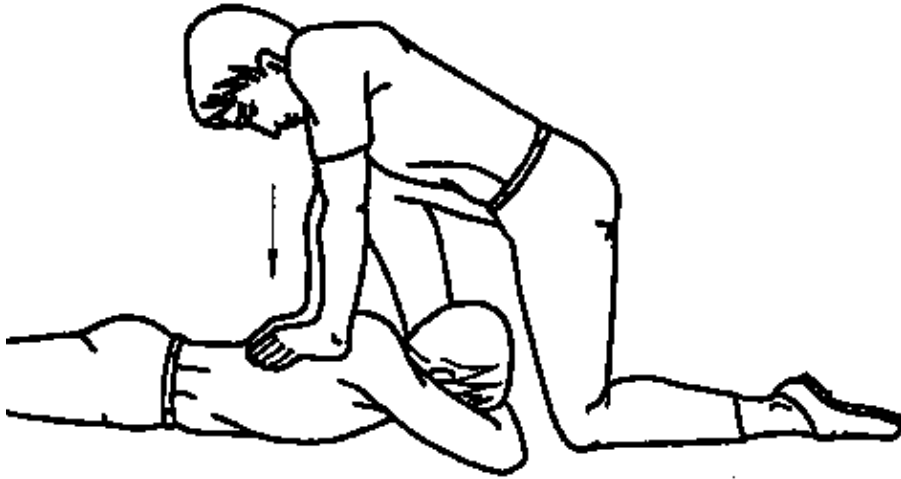
#### **Method in prone position**

- Put the injured person in prone position.
- Bend the arms of the injured person and put them down on the floor.
- Turn the head of the injured person carefully to the side and put it on his bent arms.
- Make the respiratory tracts of the injured person accessible.
- Kneel down on one knee by the head of the injured person.
- Put your hands flat on the back of the injured person just above the waist your thumbs paralleling the injured person's spinal column.



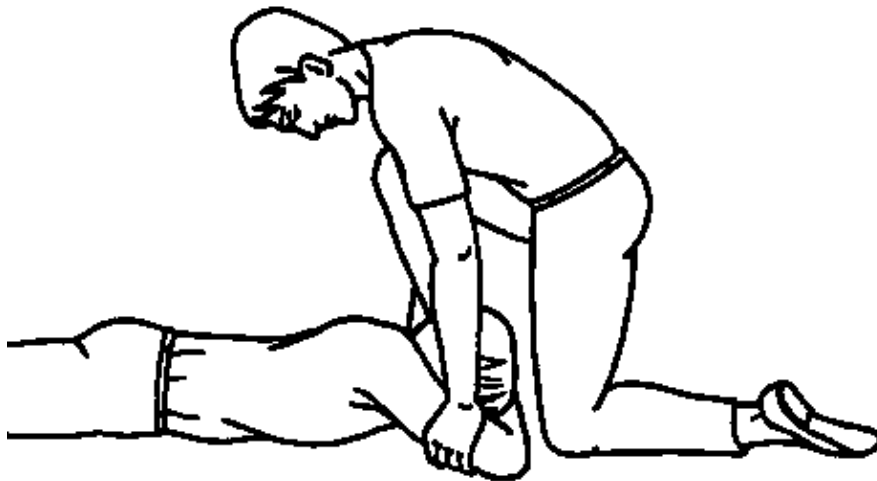
**Figure 6** – Correct position before manual respiration

- Begin with breathing out your body shifting slightly forward and thus exercising a moderate pressure. (This way, the chest of the injured person is pressed against the floor and the lungs are squeezed together with the chest. The breathing air can escape through the respiratory tracts of the injured person.)

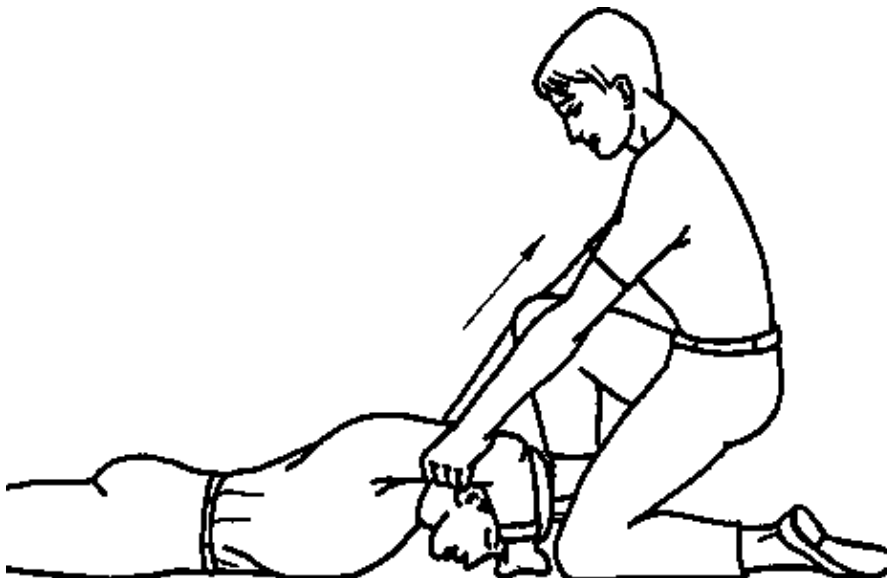


**Figure 7** – Manual respiration (breathing out)

- For breathing in, pressure must be relieved suddenly by taking the hands of the injured person's back.
- Get hold of the upper arms of the injured person and lift them slightly. (This enables that the lungs and chest of the injured person expand and the surrounding air flows into the lungs.)



**Bild 8** – Letting go of the chest



**Bild 9** – Manual respiration (breathing in)

- This action must be repeated 12 to 16 times a minute.



## Method in dorsal position

The method in dorsal position should be used only if no other respiration method is mastered.

It is the most awkward and least effective of all methods of artificial respiration.

- Put the injured person in flat dorsal position.
- Place a bundle of rolled up clothings or a folded blanket under the shoulder blades of the injured person.
- Clean the external air ways from foreign bodies.
- With the help of a handkerchief or a mull bandage, pull the tongue of the injured person out of his mouth and tie it up on the chin.
- Carefully turn the head of the injured person to the side.
- Kneel down behind the head of the injured person. (Your face towards the injured person.)
- Hold the arms of the injured person right above the elbows and put his arms next to each other on his chest.
- For breathing out, the rescuer shifts his body forward, this way exercising pressure on the chest of the injured person. (By this, the chest of the injured person is squeezed and the air pressed out of his lungs.)
- For breathing in, both arms of the injured person are moved in the widest possible circular movement sideways over his head to the floor. (The chest and the lungs of the injured person expand and air can be drawn in.)
- Then hold the forearms of the injured person right below his elbows and move his chest. In doing so, press the chest down.
- Repeat this action 12 to 16 times per minute.

Why should manual respiration be applied only in exceptional cases?

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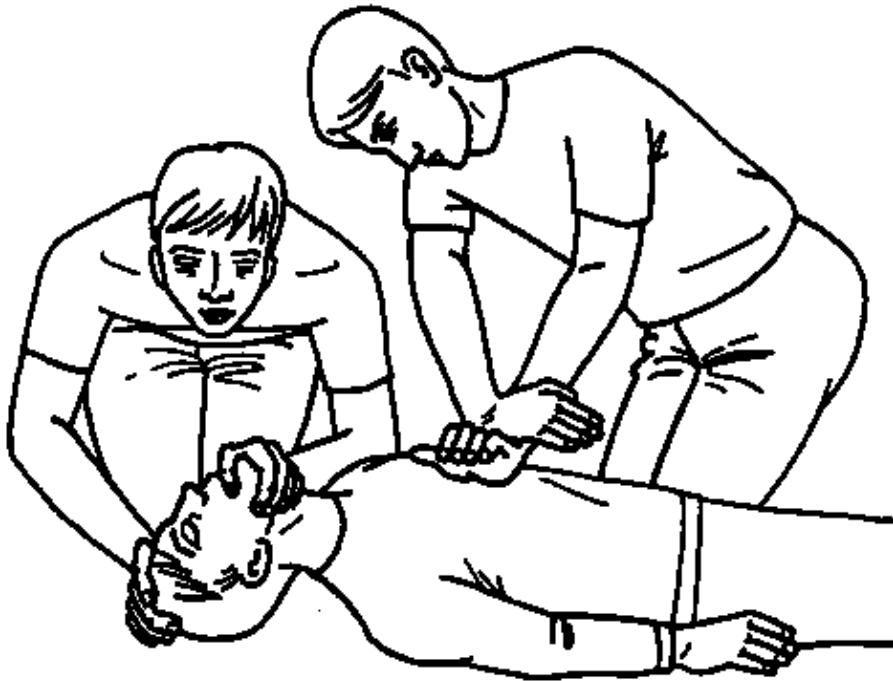
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## 5. Measures Taken in the Case of Circulatory Arrest

In the case of circulatory arrest there is utmost danger of life!

In any circumstances, even if one rescuer is alone with the injured person, rescue measures have to be started! Call for help!

With unconsciousness, missing pulse beat, respiratory arrest, wide pupils that show no reaction carry out cardiac massage in addition to artificial respiration – if possible simultaneously by a second person.

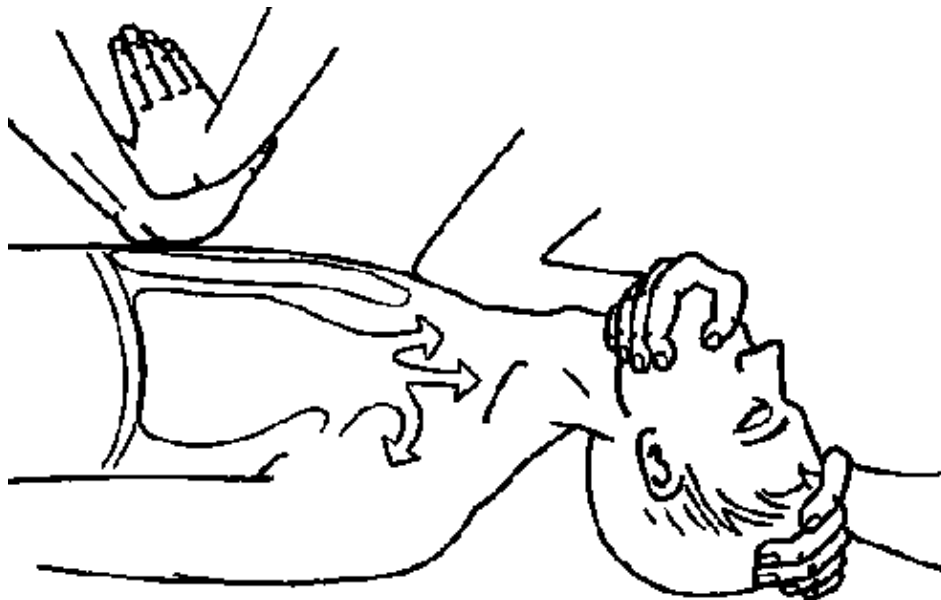


**Figure 10** – Cardiac massage with simultaneous mouth-to-nose respiration

Do not practise first aid for circulatory arrest by a person for exercising purpose. It must be applied only in case of emergency. Exercises are made with the help of a dummy. (On living people all required measures are only indicated.)

*Principle of cardiac massage*

– Using the weight of the body of the rescuer, the heart sac of the injured person is pressed together and his blood forced into the main artery. A pumping effect is created.



**Figure 11** – Principle of cardiac massage

– By relieving the pressure suddenly, chest and heart can reexpand.

A suction effect at the heart is created and the blood can flow towards the heart.

– By rhythmical squeezing and letting go (approximately 60 strokes a minute) blood circulation is forced. (If this is carried out correctly, a blood pressure of up to 40 % of the normal blood pressure is achieved.)

*Carrying out of the cardiac massage*

Before beginning with the cardiac massage, 10 artificial breaths have to be given in natural breathing rhythm. If after 10 artificial breaths no pulse beat is to be noted, cardiac massage has to be started.

- Bed the injured person on a hard pad.
- Kneel down by the side of the injured person.
- Put your left hand on the chest of the injured person. The wrist should lie on the lower end of the injured person's breast bone.
- Put your right hand on your left wrist.
- Press the breast bone of the injured person 3 to 4 cm towards his spinal column rhythmically approximately 60 to 80 times per minute.

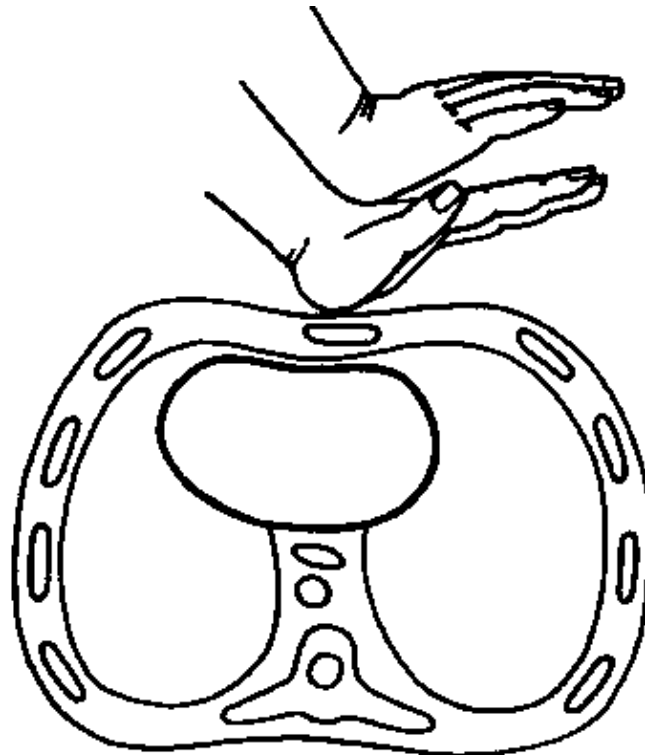


Figure 12 – Cardiac massage

**Attention!**

With too strong pressure, there is the risk of rib and breast bone fractures.

Cardiac massage has to be combined with artificial respiration at the ratio 4:1. This means that 12 strokes of cardiac massage are followed by 3 artificial breaths.

Continue the cardiac massage till independent heart action starts or if the doctor orders to stop the measure.

Further measure to stimulate heart beating are allowed to be taken only by the medical doctor.

*Mistakes with cardiac massage*

- Hands are not put in the correct place on the breast bone.
- The ratio of cardiac massage and artificial respiration is wrong.
- Pressure on the breast bone is too strong.

Why must the rescuer never stop resuscitation measures on his own?

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## 6. Hints for the Transportation of Injured People

The health condition of the injured person is perhaps essentially influenced by the right transportation.

- People who had an accident caused by electric current must be transported in lying position.
- The injured person must be able to be transported. (Blood circulation and respiration must be functioning.) There must be not signs of critical injuries.
- If medical staff is present, the question of transportation is decided by them.
- The hospital to which the injured person is going to be transported has to be informed of the kind of accident, kind of injuries and the first aid measures taken so far.
- With low temperature, the injured person must be covered with blankets.
- Make sure that the injured person cannot fall down during transportation.

Why must injured people be carried by at least two rescuers?

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Why must the medical staff be informed of the first aid measures that have been taken?

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