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First Aid Measures

Basics for Students

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Physiology and pathophysiology applied to cardio respiratory and cerebral resuscitation maneuvers

The chemical composition of the air is as follows: Nitrogen – 78-79 %, Oxygen – 20-21 %, Carbon dioxide – 0.03-0.04 %, Inert gases – argon, xenon, neon, ozone, Aerosols – water vapour, organic (pollen, bacteria, fungi) and inorganic dust [13].

During the breathing process, the concentration of these gases changes as follows:

Proportion in inspired air	Proportion in exhaled air
Nitrogen – 78-79 %	Nitrogen – 78-79
Oxygen – 20-21	Oxygen – 16-17
Carbon dioxide – 0.03-0.04%	Carbon dioxide – 3-4%

The oxygenation of blood in the pulmonary capillaries is called pulmonary haematosis. At rest, arterial blood carries 97.5% of the total amount of O2 as HbO2. Because of the bivalent iron it contains, haemoglobin combines very rapidly with O2, each of the four iron atoms of the haem groups can bind one oxygen molecule [14]. At the lung level gas exchange is achieved due to diffusion and partial pressures of O2 and CO2 in the two separate alveolar-capillary membrane media: alveolar air and blood in the pulmonary capillaries. In alveolar air the O2 pressure is much higher (99.7 mmHg) than in venous capillary blood (40 mmHg), so oxygen will pass from alveolar air into blood until it equilibrates with O2 in alveolar air [13]. Carbon dioxide will follow a reverse path, moving from venous blood, where it is at a pressure of 47 mmHg, into alveolar air, where its partial pressure is 40 mmHg. [14]

The partial pressure of oxygen in alveolar air is calculated according to the formula [13],

PAO2 = (Patm – PH2 O) FiO2 – PACO2 / RQ where

Patm is atmospheric pressure at sea level, 760 mmHg, PH2 O is partial pressure of water (vapour) 45 mmHg, FiO2, fraction of inspired oxygen 21%, PACO2, partial pressure of arterial CO2 40%, RQ respiratory coefficient 0.8. This gives an alveolar oxygen pressure of 99.7.

PAO2 = (760 – 47) 0.21 – 40 / 0.8 = 99.7 mm Hg [13]

The exhaled air is actually the air that we introduce into the victim's lungs through external ventilation. Although it has a lower oxygen concentration than atmospheric air, the 16-17% oxygen is sufficient for gas exchange

at alveolar level. According to the above equation, at an oxygen concentration in the inhaled air of 16% we will obtain a PAO2 of 64.7%, sufficient to achieve gas exchange at alveolar level. Although the concentration of carbon dioxide is 100 times higher than in atmospheric air, 3-4% is too low to induce toxic effects. On the contrary, it has a beneficial effect, stimulating through a feed-back effect the respiratory centres in the brain stem, which contains centres regulating vital functions such as cardiovascular and respiratory activity. Respiratory centres receive the information that we are in an environment with too much carbon dioxide, and will try to increase the breathing rate to eliminate the excess carbon dioxide, thus helping the victim's breathing function.

In the case of a cardio respiratory arrest, non-oxygenation of the brain will induce a major dysfunction, namely cerebral hypoxia, severely affecting its functions. Thus, there is a generalized cerebral suffering that will lead to the suffering of the entire body, because the central nervous system is the structure that coordinates absolutely all our activity, conscious or vegetative.

The fundamental, basic functions of the CNS are consciousness and muscle tone, which are coordinated by the brainstem. At the level of the brainstem is the ascending reticular formation with a role in regulating muscle tone in the control of spinal reflexes, balance and posture. The ascending reticular activating system (ARAS) is a well-systematized structure with a role in maintaining brain tone or wakefulness, which is the state of readiness of the entire CNS for any type of brain activity. Through the waking state, the reticulated formation contributes to the realization of reflexes and to the regulation of integration mechanisms related to the relationship with the environment [9].

The information that maintains muscle tone and transmits commands to the muscles to contract or relax is carried out via the neuromuscular junction. The neuromuscular junction consists of 3 entities: the ending of a motor neuron, a muscle cell and a synaptic cleft, which separates the nerve from the muscle [15]. A muscle fibre has a single neuromuscular junction and is innervated by a single nerve. At the neuromuscular junction, the nerve end knob contacts a specialized portion of the muscle fiber, called the end plate [15], with the transmission of the motor impulse taking place from the nerve ending to the plate via a chemical called acetylcholine.

Loss of consciousness will lead to blockage of RAS activity, resulting in loss of muscle tone, leading to the victim falling.

The main risk factors associated with cardio-respiratory arrest are: cardiovascular diseases (hypertension, ischemic heart disease, coronary heart disease), diabetes mellitus, hypercholesterolemia, obesity, low level of physical activity or smoking [16].

Therapeutic maneuver groups in cardio respiratory and cerebral resuscitation (CRCR)

1. Basic life support (BLS)

2. Advanced life support (ALS)

3. Post-resuscitation measures

The chain of survival (Fig. 7), represents a set of interlinked measures that, when correctly executed, can lead to saving the life of the victim in cardio respiratory arrest [16].

I. Rapid recognition of cardiac arrest and early notification of the single emergency service (112)

- is to recognise heart conditions and alert medical services

II. Starting resuscitation as soon as possible

- the earlier CPR is started, the earlier the chances of survival can double or even triple.

III. Early defibrillation

- CPR followed by defibrillation in the first 3-5 minutes after the onset of CPR can increase the survival rate up to 49-75%, with every minute altering the victim's condition.
- Semi-automatic defibrillators (AED – automated external defibrillator) make it possible for people with minimal training to use them. In Bucharest, AEDs can be found at some subway stations, Henri Coandă International Airport, museums, and other public places, and the number of locations is *increasing*.

IV. Post-resuscitation care

- The course of health and recovery is influenced by the quality of post-resuscitation care.

Figure 7. Chain of survival [16]

Specific objectives of cardio-respiratory and cerebral resuscitation

The main objective of CRCR is to ensure that the patient survives intact or with as few irreversible neurological sequelae as possible. Intact survival refers to the fact that the patient should recover to the same intellectual capacity (mainly) as before the cardio-respiratory arrest. In order to achieve this goal we must consider brain survival.

The most important objectives are: Recognition of cardiorespiratory arrest, Prompt response and alarm of the specialized team, Use of correct resuscitation techniques, Knowledge of the cause of the cardio-respiratory arrest (last but not least).

The clinical signs of cardio respiratory arrest can be divided into two main groups [17].

Premonitory

Dyspnea, leading to bradypnea, cardiac arrhythmias (ventricular tachycardia, ventricular fibrillation or ventricular extrasystoles), progressive drop in blood pressure, cyanosis of the skin of the extremities (lips, earlobes, fingertips), dullness of vision.

Characteristic after the onset of cardio-respiratory arrest

Loss of consciousness, absence of carotid pulse, blood pressure can no longer be measured, shortness of breath, onset of mydriasis, pallor followed by cyanosis, muscle hypotonia.

In order to limit the effect of risk factors and decrease the rate of cardio respiratory arrest, prophylactic measures play an important role. These are a set of medical and health actions taken to prevent the onset and spread of diseases. They target risk factors for cardiovascular and respiratory diseases, such as ischaemic coronary heart disease, hypertension, diabetes, smoking and alcohol consumption, obesity and a sedentary lifestyle. Observe clinical signs (a few hours before onset of cardiac arrest): respiratory distress, decreased cardiac output and increased heart rate, hypotension, fatigue, altered consciousness, metabolic imbalances (acidosis).

Prophylactic measures can be primary or secondary. Primary prophylaxis consists mainly in maintaining a healthy lifestyle. Thus we can mention healthy nutrition with the avoidance of exceeding caloric needs, a hypolipidemic diet, normoglucidic, consumption of low cholesterol foods, avoidance of smoking and excessive alcohol consumption, daily exercise, with the main purpose of improving breathing, activation of lipid and carbohydrate metabolism, maintenance of body weight within normal limits, obesity or overweight favoring the risk of developing hypertension, hypertension and cardiovascular diseases [18].

Secondary prophylaxis is represented by regular medical investigations regarding the control of cardiac conditions, DZ, HTA, hypercholesterolemia, anticoagulant and antiplatelet medication in patients with thromboembolic risk, airway aspiration in case various secretions, blood or food debris enter the airway, these should be removed and appropriate maneuvers should be per-formed, putting the patient in the lateral safety position or tracheal intubation or insertion of a nasogastric tube [18].

The role of the nurse in providing post-resuscitation care is extremely important, as the primary goal is to preserve and restore health, relieve suffering and prevent patient complications. Hygiene and care of the resuscitated patient plays a vital role in their survival. Hygiene measures consist of [19]:

- Bed rest:
  - aims to reduce effort and will be maintained throughout the period of hospitalization.

- Body hygiene:
  - the patient's body linen, teguments and mucous membranes. The linen should be made of a soft material that does not irritate the skin and is not too tight, should be kept clean and changed as often as possible.
- The patient's skin should be maintained by daily washing of the entire body surface to avoid the formation of bedsores:
  - Mobilization, bed level, upholstery, anti-scar mattress.
- Mouthwash:
  - remove eye secretions (wiping the eyes with a cotton swab), nasal secretions (and dripping antiseptic and breathing solutions).
- Optimal temperature in the wards should be between 20-22^{0}C, fresh, airy air, preventing patient contact with cold air;
- Furniture as simple as possible, special blankets with optimal mattress, anti-scalding;
- The food will be adapted according to the health condition of each patient, easily digestible;
- Fluids will be administered in small doses to prevent electrolyte imbalance or dehydration.

Cardiorespiratory arrest intervention by CPR

The timing of the intervention plays a vital role in saving the victim. The time between the onset of cardio-respiratory arrest and the moment of intervention is of vital importance. Resuscitation times depend on a number of factors such as the degree of vascularisation of the tissue, haemoglobin concentration in the periphery or the patient's temperature. Hyperthermia shortens resuscitation times while hypothermia prolongs them, while having a protective effect on the neuron (higher chance of success).

In terms of tissue reaction to resuscitation, the nervous tissue is the most sensitive, with the shortest resuscitation times. Within nervous tissue, the most sensitive to hypoxia is the cerebral cortex, layer III, followed by the cerebellar cortex (Purkinje cells), thalamus, hypothalamus and peripheral nerve (least sensitive). The grey matter is more vulnerable than the white