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ORGANIZATION OF OXYGEN THERAPY USING A NASAL MASK AND VENTURA MASK IN SEVERE PATIENTS WITH COVID-19 CORONA VIRUS INFECTION

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Annotation
Oxygen is supplied to the blood by simple diffusion through the alveolo-capillary membrane, along the partial pressure gradient. With an oxygen content of about 21% in the atmospheric air, the partial pressure of oxygen in the atmosphere is about 150 mm Hg, while its content in the blood reaches 100 mm Hg. Oxygen is transported by blood in two forms: dissolved in plasma and bound to hemoglobin. 0.31 ml of O2 is dissolved in 100 ml of blood, which is not enough for tissue oxygenation. Oxygen is mainly transported in combination with hemoglobin in red blood cells: 100 ml of blood is transferred to 200 ml of oxygen. The most important parameter by which one can judge the amount of oxygen associated with hemoglobin is the saturation of hemoglobin with oxygen — SaO2, or saturation. At a partial oxygen pressure of 100 mm Hg, the saturation of hemoglobin with oxygen in arterial blood is about 97%.

Keywords: mitochondria, nasal cannulas, anatomical features

Pulse oximetry, based on differences in the absorption of light by hemoglobin depending on the saturation of hemoglobin with oxygen, became a simple way to assess SaO2 and detect hypoxemia.

When the oxygen content in the blood decreases, the cells of the carotid body of the carotid arteries react first (within milliseconds), which increases lung ventilation and cardiac output. Next, many compensatory mechanisms are included to adapt to hypoxia conditions: changes in lung ventilation, cardiac output, shock volume, hemoglobin concentration, dilation of the systemic micro vascular bed with simultaneous spasm of the pulmonary bed, an increase in the volume of alveoli, spasm of arterioles in the hypoventilation zone in order to redistribute blood to the lung zones with better ventilation.

The progress of molecular biology allows us to understand the relationship between the path physiology of diseases and the cellular response to hypoxia. Different tissues have different oxygen needs; the nerve tissue is the most sensitive. The mechanisms leading

to hypoxia are different: ischemia (reduced blood delivery to the tissue), carbon dioxide poisoning, asphyxia, sleep apnea, severe anemia, altitude sickness, violations of the ratio of ventilation and perfusion. At the same time, the consequences of hypoxia for tissues are the same.

At the cell level, 80% of oxygen is used by mitochondria, 20% by other organelles. At the same time, its partial pressure in the mitochondria is extremely low — 1-3 mm Hg. Oxygen is used as an electron donor at the end of the electron transport chain, in complex IV, Cytochrome-C oxidase, for the synthesis of adenosine triphosphate. In the case of a shortage of oxygen and its electrons, the electronic circuit undergoes compensatory modifications. At the same time, it has been shown that under conditions of cell hypoxia, a direct transfer of electrons into the electronic circuit occurs due to a decrease in the flow of carriers, and thus the number of active forms of oxygen and nitrogen increases, whose free radicals are extremely toxic and lead to cell death.

It should be borne in mind that oxygen therapy is aimed at treating hypoxemia, but not shortness of breath, so the effect in the treatment of shortness of breath in the case of normal oxygen content in the blood should not be expected. In addition, oxygen therapy does not eliminate the cause of hypoxemia. Pulse oximetry should be performed in all patients with shortness of breath or in a serious condition in order to control saturation and timely detection of hypoxemia.

Approximately 14% of patients with a new coronavirus infection have a severe form of the disease, the main criterion for severity is a decrease in blood oxygen saturation, which requires hospitalization and oxygen therapy. About 5% of all patients (and about 25% of those hospitalized) need to stay in the intensive care unit, most often due to the development of an acute respiratory distress syndrome. The mechanisms of hypoxemia development in COVID-19 continue to be studied, one of the main ones is thrombosis in the microcirculatory bed associated with endothelial damage, which leads to blood shunting, the development of alveolar atelectasis. In the case of a stable course of the disease, the target values of SaO2 are more than 90%. In the case of a severe course of the disease, a picture of respiratory failure, shock — the target values of SaO2 are more than 94%. In this case, oxygen therapy through nasal cannulas or a mask is most often not effective enough, high-flow nasal therapy or non-invasive Ventura mask ventilation with positive pressure is preferred. Initiated in a timely manner, these methods can reduce the need for intubation and artificial lung ventilation (ventilator), according to studies and meta-analysis conducted before the COVID-19 pandemic, and high-flow ventilation through cannulas has an advantage compared to conventional oxygen therapy through cannulas and high-pressure ventilation. Given the shortage of ventilators and places in the intensive care unit during the epidemic, it is difficult to overestimate the importance of these methods.

An auxiliary technique used in addition to oxygen therapy is the pron position (lying on your stomach). This method improves oxygenation and outcomes in patients with

moderate to severe respiratory distress syndrome. Presumably, the mechanism is associated with an improvement in the ventilation-perfusion ratio and the opening of the collapsed alveoli in the lower basal parts of the lungs. Both in studies before the epidemic among patients with hypoxemia on spontaneous respiration, and in several studies among patients with a new coronavirus infection who are on oxygen therapy, an improvement in oxygenation and a decrease in the need for intubation when using the pron position was shown. The pron position is well combined with oxygen therapy through cannulas and satisfactorily — through a mask. It is used in patients who may be lying on their stomach for a long time and independently change the position of the body. It is not used in hemo dynamically unstable patients who have recently undergone surgical intervention on the abdominal organs, who have spinal instability. There is currently no convincing data on the effect of the pron position on the long-term outcome in COVID-19.

Taking into account the toxicity of oxygen at a concentration of more than 60%, an air mixture with 40-60% oxygen is used for long-term oxygen therapy. Pure oxygen, when inhaled for more than 30 minutes, has a damaging effect on the mucous membrane of the respiratory tract (tracheitis), in addition, due to a violation of the formation and resistance of the surfactant, adsorption atelectases occur in the alveoli, followed by blood shunting, which does not allow for adequate elimination of hypoxemia. Thus, high concentrations of oxygen are used for a short time in terminal conditions: apnea, hypoxic coma, cardiac arrest, carbon monoxide poisoning.

Oxygen therapy is well tolerated, occasionally there is dryness and irritation of the nasal and pharyngeal mucosa, discomfort can cause restriction of motor activity, difficulties when eating. To reduce the drying effect of the oxygen-air mixture on the mucous membrane of the respiratory tract, the oxygen mixture is moistened by passing through water, and then fed under a pressure of 2-3 atmospheres.

The advantage of masks is their ability to better cope with the leakage of oxygen flow through the mouth. With the help of valves, the exhaled air is brought out, allowing you to maintain the necessary oxygen concentration. When using a standard face mask, the oxygen flow can be up to 15 l/min, which provides a higher concentration (50-60%) compared to cannulas. With high minute ventilation of the lungs, the use of masks, as well as catheters, may be ineffective. The mask is the most common way of delivering oxygen. There are different types of masks:

Ventura valve mask-provides a stable oxygen concentration regardless of the patient's breathing type by using different valves. The achieved oxygen concentration is 24-60%, depending on the type (color) of the nozzle valve used, for which the flow rate is also set depending on the type of nozzle valve. It is often used for COPD, because it allows you to give oxygen strictly in the required concentration, avoiding hypercapnia;

Non-reversible masks (a mask with a retreater). It allows you to achieve the maximum concentration of oxygen in the inhaled mixture, while using a tank-bag that is constantly

filled with a respiratory mixture with oxygen and, thanks to the presence of a valve, works only for inhalation. The mask valves allow you to exhale, but prevent air from entering the mask from the outside. It allows you to reach an oxygen concentration of 85-90% at a flow of 15 l / min, it is not used for long-term oxygen therapy.

Non-invasive ventilation reduces the need for invasive ventilation. It allows avoiding tracheal intubation, thereby minimizing the risk of damage to the upper respiratory tract, avoiding the introduction of sedatives, provides: greater safety and comfort for the patient; preservation of spontaneous breathing; reducing the risk of developing ventilator-associated pneumonia; leaves the possibility of contact with the patient; economically profitable. However, the method is more complex and time-consuming for the doctor, because it is necessary to continuously adapt various parameters to constant changes in the patient's respiratory function. There are also limitations: the inability to use it with a low level of consciousness, anatomical features of the patient; possible damage to the skin of the face with prolonged use of mask ventilation; with inadequate humidification and warming of the gas mixture, damage to the upper respiratory tract mucosa, aerophobia, nausea, heartburn, individual intolerance (claustrophobia) can be observed.

If non-invasive ventilation is ineffective, timely tracheal intubation and invasive (artificial) ventilation of the lungs are necessary. Consideration of this method is beyond the scope of this review.

At home, with a stable course of chronic diseases of the bronchopulmonary system or in a hospital in the absence of access to a central source of medical oxygen (the quality of which is higher), a medical oxygen concentrator can be used for prolonged oxygen therapy. Oxygen cylinders are also used — usually for transporting a patient with hypoxemia by an ambulance team or inside a hospital, the duration of inhalation at the required oxygen concentration of about 40% is limited to about 20 minutes.

Thus, oxygen therapy, despite its more than a century-old history of use, continues to develop actively, taking an important place in the treatment of major cardiovascular and broncho pulmonary diseases. Its importance can hardly be overestimated — it often allows you to save a patient's life, being one of the main methods of treating patients with a new corona virus infection. Various aspects of the use of oxygen are covered in detail in modern recommendations, indications and application algorithms have been developed. At the same time, a number of controversial issues remain; studies are continuing to confirm the effectiveness of oxygen therapy in some cases, demonstrating the uselessness and even negative effects in others. Further study of the use of oxygen, including using the achievements of molecular cell biology, as well as the progress of technologies, thanks to which the development of new devices for oxygen therapy continues, will secure a strong place for oxygen therapy in everyday medical practice.

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