THERAPEUTIC HYPOTHERMIA FOR PATIENTS AFTER CARDIAC ARREST

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ABSTRACT

The research paper investigates therapeutic hypothermia for patients after cardiac arrest. The paper provides general information about therapeutic hypothermia, its investigation in medicine, mechanism of neuroprotection in case of therapeutic hypothermia use, diseases in case of which therapeutic hypothermia is used as method for treating, the use of therapeutic hypothermia in case of the patients with cardiac arrest, nursing and practical methods of implementation of therapeutic hypothermia. The research paper puts forward and confirms the thesis that therapeutic hypothermia for patients after cardiac arrest is an effective treatment option in preventing neurological damage. Furthermore, it can decrease the mortality.

Keywords: therapeutic hypothermia in cases of cardiac arrest

Therapeutic Hypothermia for Patients after Cardiac Arrest

INTRODUCTION

Cardiac arrest is a serious pathological condition caused by acutely raised lack of blood supply to heart muscle, as well as the development of ischemia and necrosis of this muscle. Currently, about one-third of cardiac arrests that took place in Europe, were fatal. In relation to this, modern medicine uses a lot of means of therapy for patients after a heart arrest. Therapeutic hypothermia has become one of such means.

Therapeutic hypothermia for patients after cardiac arrest is an effective treatment option in preventing neurological damage; it can decrease the mortality rate. To confirm the above thesis, it is necessary to study researches of therapeutic hypothermia and examine its appearance in medicine, general information, neuroprotective mechanism of the organism, impact of hypothermia on different diseases in general and on cardiac arrest in particular.

GENERAL INFORMATION ABOUT THERAPEUTIC HYPOTHERMIA, ITS APPEARANCE IN MEDICINE

A large number of researches about the impact of therapeutic hypothermia provide an opportunity to highlight the history of its occurrence in medicine and general aspects of hypothermia, which should be examined in the first place.

The term of therapeutic hypothermia was first used in ancient Greece.

Hippocrates advised to cover wounded soldiers with ice and snow. However, special applications based on scientific evidences did not exist. The surgeon Baron Larrey Dominique, who was known as a doctor of Napoleon, also noted the impact of cold on the body of the wounded people (Remba, Varon, Rivera, & Sternbach, 2009). He noted that in case of farther position of ill person from the fire in a hospital, the healing process had been more effective.

In 1945, a medical article was published. It mentioned the impact of therapeutic hypothermia on severe head injuries (Skowronski, 2005). Already in 1950, hypothermia was applied during surgery of intracranial aneurysms to create conditions for bloodless surgery (Skowronski, 2005). Most of the first attempts to use therapeutic hypothermia were based on its extreme form that was the maximum reduction in temperature to 20-25 ° C. This reduction in temperature entailed a number of negative side effects. Therefore, in the same period theories about light temperature hypothermia, which reduced the temperature of the patient to 32-34°C, arose. The positive effect of therapeutic hypothermia was shown in the experiments on dogs of doctor Rosomoff. He took advantage of moderate therapeutic hypothermia for dogs with traumatic brain injuries. (Kochanek et al., 2004). In 1980, researchers conducted additional experiments on animals and received evidence that therapeutic hypothermia is neuroprotective in the case of a complete blockade of the blood flow to the brain (Kochanek et al., 2004). In 2002, there were made and published two studies, which were held in public and allowed to disassemble the effect of hypothermia in case of not only trauma of the brain, but also cardiac arrest (Skowronski, 2005). Nolan et al. (2003) believe that therapeutic hypothermia had a positive effect on the patient. Taking into account the data from a study in 2003, the International Liaison Committee on Resuscitation area and the American Heart Association decided to authorize the use of therapeutic hypothermia after cardiac arrest (p. 5).

Therapeutic hypothermia cannot be attributed to comprehensive treatment. This is a medical procedure that affects the human body in order to change its

temperature and thereby reduce the risk of death due to ischemic injury. Ischemic tissue damage is due to a cardiac arrest or embolism during arterial occlusion.

An invasive or non-invasive method can be used for the implementation of therapeutic hypothermia. Invasive method uses the special heat exchange catheter that can be inserted through the femoral vein in the inferior vena cava. Non-invasive method uses water-cooled blankets or special vests and applicators, which are attached to the torso and legs for direct contact with the patient's skin. In such a way the risk of ischemic brain damage can be reduced.

Modern medicine uses 4 types of hypothermia. Therapeutic hypothermia can be elementary, middle, deep and intermediate. Elementary hypothermia includes cooling the patient to 34-32°C for non-surgical intervention. Middle therapeutic hypothermia is applied by cooling the patient to 31-28°C, and is necessary in case of a patient's heart stop during 10 minutes. Middle hypothermia may cause cardiac arrhythmia until ventricular fibrillation. Intermediate degree of hypothermia is applied to decrease body temperature to 27-20°C. It is considered the most dangerous type. Deep hypothermia can be used in case of a patient's heart arrest and heart stop during 60 minutes or more. It is provided through extracorporeal blood cooling to 19-8 ° C in heat exchangers.

Thus, the therapeutic hypothermia therapy is a tool, which includes a decrease in body temperature in order to reduce the risk of death due to ischemic damage in various diseases. The history of the use of this type of therapy also confirms the favorable effect of cooling the body for the healing process.

MECHANISM OF NEUROPROTECTION IN CASE OF THERAPEUTIC HYPOTHERMIA USE

In order to explore the positive effect of therapeutic hypothermia on the body the mechanism of the effect on the human body by lowering the temperature should be considered in detail.

Therapeutic hypothermia is used to force a body to change independently its functions under the influence of cold. First of all, scientists have paid attention to the impact of cold on the exchange at the cellular level, which significantly slows down at low temperatures. Skowronski has shown that the temperature directly affects cellular metabolism. It has been documented that lowering the temperature by 1°C corresponds to the decrease of cellular metabolism by 5-7% (Skowronski, 2005). In the early stages of researches of hypothermia it was hypothesized that the effects of ischemia are reduced by reducing the oxygen demand during the decrease in temperature (Skowronski, 2005). At that moment scientists decreased temperature by a maximum level, because they believed that it would provide an opportunity to reduce mortality from cardiac arrest, brain injuries and other diseases (Skowronski, 2005). It is necessary to outline that even a small drop in temperature helps to achieve greater stability of the cell membrane during oxygen deficiency. Therefore, during an ischemic stroke therapeutic hypothermia helps prevent the flow of unwanted ions. Therapeutic hypothermia reduces not only the production of free radicals, but also the intracranial pressure.

Thus, the mechanism of action of therapeutic hypothermia on the human body primarily includes the effect on cellular metabolism, which considerably slows down, contributing to greater stability of the cell membrane in case of oxygen shortage.

DISEASES IN CASE OF WHICH THERAPEUTIC HYPOTHERMIA IS USED AS METHOD FOR TREATING

In order to understand the positive impact of therapeutic hypothermia on the body, it is necessary to consider those diseases in case of which this type of treatment can be used.

The therapeutic hypothermia can effectively treat a number of diseases. Therapeutic hypothermia is the most used method of treatment in case of encephalopathy in neonates. Its use reduces the risk of mortality and cerebral palsy in children. Also, it is used in the treatment of cardiac arrest. In this case, it makes possible to increase the amount of survivors by 40% (Heaton & Meier, 2002). Therapeutic hypothermia is an effective treatment for ischemic stroke. Studies show the need for therapeutic hypothermia to reduce brain damage. Therapeutic hypothermia is also used to treat brain injuries, as in the case of fever. Thus, the successful use of therapeutic hypothermia for progress in the recovery of a number of diseases confirms its positive effect on the human body. The effect of this type of therapy on the body directly in case of cardiac arrest should be investigated.

THE USE OF THERAPEUTIC HYPOTHERMIA IN CASE OF THE PATIENTS WITH CARDIAC ARREST

Therapeutic hypothermia and its effect on the human body during cardiac arrest have been thoroughly investigated in two studies that are published in the New England Journal of Medicine (Heaton & Meier, 2002). The first publication of that research was made by Australian scientists who have used it in the treatment of cardiac arrest of the first group of people. The second group of people was treated by means of standard therapy after cardiac

arrest. This study has allowed Australian scientists to obtain the following results. In the group that had been treated with therapeutic hypothermia, 49% of patients had a favorable outcome. In the group that was treated with a standard treatment the positive result equaled to 26%. This experiment shows the need for the use of therapeutic hypothermia for positive outcomes after cardiac arrest (Heaton & Meier, 2002).

This statement is also confirmed by the second work published in New England Journal of Medicine (Heaton & Meier, 2002). That study took place over patients who were resuscitated after a certain time period after the collapse. Those patients, who were resuscitated after collapsing during 5-15 minutes, spontaneously renewed their blood circulation in 22 minutes at normothermia. Hypothermia group renewed their blood circulation in 21 minutes. Then, the test group was being cooled to a temperature of about 33°C during one day. This study showed that in case of conventional treatment, only 39% of the subjects achieved a positive result. In the group with therapeutic hypothermia, a positive result was obtained in 55% of the subjects (Heaton & Meier, 2002).

300,000 Americans a year are subjects of cardiac arrest and only 10% of them experienced cardiac arrest till the end and could be discharged from the hospital. Neither improvement in cardiopulmonary resuscitation techniques nor providing of any emergency has raised that figure. However, Mooney et al. (2010) researched that in 2006 in Minneapolis Heart Institute 140 patients with cardiac arrest were being treated (p. 2). The use of therapeutic hypothermia has yielded positive results for 52% of the subjects. These studies demonstrate the need for therapeutic hypothermia to be used on patients with cardiac arrest. During it, in the half of all cases, patients were faced with brain damage that brought irreversible consequences. Therapeutic hypothermia is a relative innovation in medical practice (p. 3).

Therapeutic hypothermia after cardiac arrest has a positive effect on the

health of the patient. But as for using this method of treatment, there is one issue. Application of therapeutic hypothermia tends to reduce metabolism in the body of the patient, because of which more time is needed for diagnosing. The increase in the diagnosing time impacts the process of establishing diagnosis, which should be made in first 72 hours after cardiac arrest.

However, this hypothesis was disproved in Mayo Institute (Fugato et al., 2010). Researchers held a number of studies. These studies have proven that regardless of the use of therapeutic hypothermia, a patient regained consciousness after cardiac arrest within the first 48 hours. Their study also showed that the percentage of survivors after hospitalizing with heart arrest was 47%, 64% of which are patients who received treatment with the therapeutic hypothermia. Studies have proven that the use of therapeutic hypothermia during cardiac arrest reduces not only the blood circulation, but also the exchanges at the cellular level that allows the patient to avoid a number of negative consequences after cardiac arrest. The use of therapeutic hypothermia significantly improves neurological outcome and survival after the cardiac arrest (Fugato et al., 2010).

It should be mentioned that the studies of Skolletta et al. (2012) show that therapeutic hypothermia should be used during cardiac arrest as soon as possible, because it improves the patient's chances for survival.

Therapeutic hypothermia in case of the cardiac arrest as a positive effect on the suppression of the pituitary gland, helps increase the sensitivity of myocytecells to calcium and prevent violations of autoregulation of the coronary vessels, producing a positive effect on myocardial contractility, preventing violation of mitochondrial respiration, and improving the performance of energy production during ischemia. Therapeutic hypothermia reduces intracranial pressure and increases the performance of cerebral blood flow (Heaton & Meier, 2002). The strong decrease in myocardial metabolism was also observed. It was investigated that the decrease in

temperature greatly reduces the arterio-venous difference. Patients were observed with increased activity of adenosine triphosphatase and rise of sensitivity of the myocardium to the influence of adrenaline. In cardiovascular system coronary flow pressure drops and the coronary pressure in coronary sinus and aorta also decreases under the therapeutic hypothermia. Lowering the temperature of the human body makes it possible to change the guilty pathological response of the patient and allows minimizing the risk of side effects on the body from heart arrest.

If cardiac arrest occurred in pregnant women, hypothermia is one of the contraindications during pregnancy, but it should be considered as a possible treatment option for patients. Doctors should also be mindful of the dangers that temperature reduction can bring to the fetus of a pregnant woman (Skowronski, 2005).

In the UK, a large percentage of the population is exposed to heart diseases. According to the research, the number is equal to 20,000 cardiac arrests per year. It is also worth noting that 80% of patients with heart arrest return to normal life. ICU departments in UK hospitals also use therapeutic hypothermia. For patients who are enrolled in a coma for the treatment of cardiac arrest in the intensive care unit, there is a number of auxiliary treatments. In addition to temperature control there are such methods as blood glucose control, ventilation control, optimization of hydrodynamics, and if necessary, early coronary reperfusion.

Nolan et al. (2003) stated that treatment with therapeutic hypothermia was included in the treatment standards of the International Committee on Resuscitation Interactions and the American Heart Association (p. 1). This treatment option has shown positive results on the human body (p. 2). Also it should be mentiond that this treatment has little negative complications on the human body and promotes rapid return of the patient to normal life. This is due to the fact that the reduction in temperature reduces the negative

effect on the cardiac patient's body, thereby reducing the time spent in the clinic. Heaton and Meier (2002) believe that therapeutic hypothermia reduces the possibility of damage of the cerebral cortex, which is one of the most dangerous complications resulting from cardiac arrest. The modern approach to therapeutic hypothermia allows minimizing the risk of side effects (Heaton & Meier, 2002). This is made possible by heat exchangers which reduce the body temperature of the patient by less than 1°C per hour. This avoids the sharp drop in intracranial pressure.

Mechanisms of the positive effect of therapeutic hypothermia in case of cardiac attacks:

- Improvements of the figures of energy production during ischemia,
- Inhibition of apoptosis,
- Increased sensitivity of myocyte cells to calcium,
- Prevention of violations of mitochondrial respiration,
- Prevention of reperfusion injury,
- Prevention of violations of autoregulation of the coronary vessels,
- Improvement of myocardial contractility,
- Inhibition of secretion of such neurotransmitters as glutamate and dopamine in the brain that lead to neuronal damage,
- Prevention of damage to the blood-brain barrier,
- Reduction of intracranial pressure and cerebral blood flow increase

Thus, therapeutic hypothermia for patients after cardiac arrest may be an effective treatment option in preventing neurological damage and even reducing the mortality rate. Therefore, therapeutic methods of implementation should be described.

NURSING, PRACTICAL METHODS OF IMPLEMENTATION OF THERAPEUTIC HYPOTHERMIA.

To expand the understanding of theoretical studies of therapeutic hypothermia and possibilities of practical use of theoretical methods, practical methods of treatment in modern medicine should be investigated and a number of differences between invasive and noninvasive methods should be selected.

Therapeutic hypothermia can be provided to the patient in two different forms: invasive or non-invasive methods. Invasive method includes operating heat exchange via a catheter which is introduced into the femoral vein. Hypothermia carries saline, which is pre-cooled and prepared to the circulation through a pipe or a metal-coated tube. Therapeutic hypothermia passes through lowering the temperature of blood, thereby reducing the temperature of the entire body of the patient. Decrease in the patient's body temperature can be with a sped up by 1,5°C per hour.

Therapeutic hypothermia uses a catheter, which allows keeping the patient's body temperature within 1°C from the desired target. Also, the use of an invasive catheter in hypothermia allows not only cooling the body at a certain rate, but also by means of the physical solution gradually raising its temperature to the required performance. This avoids the sharp drop in intracranial pressure. In therapeutic hypothermia, invasive method has a number of side effects, which include infections, deep vein thrombosis and hemorrhage. It creates a special danger of bleeding because the influence of hypothermia coagulation is reduced. Research work on the catheter has shown that the risk of thrombosis is increased by 33%. It should be mentioned that patients who were with catheter for 4 days or more, increases the risk of deep vein thrombosis at 75%. Heaton and Meier (2002) believe, that this can

be explained by the formation of a blood clot in the deep femoral vein. The danger of this complication is that if the clot of blood is transferred along with the blood into the lungs, it can cause pulmonary embolism and death of the patient (Heaton & Meier, 2002). Invasive method of therapeutic hypothermia is characterized by the fact that it can be carried out only by a doctor, while the non-invasive method is carried out by a nurse.

The implementation of therapeutic hypothermia with a non-invasive method is cooling the body using a blanket or vest, and special applicators on the patient's legs. In order to correct performance of this technique, 70% of the body of the patient should be covered. Unlike invasive method, the cooling body passes only through the direct cooling of the patient's skin. The minimum rate of heat exchanger allows to control the temperature of the patient, reducing it by 0,25°C per hour. This eliminates the possibility of a sudden pressure drop in the brain. A non-invasive method is easier to implement and has a smaller number of side effects, eliminating the need for surgical intervention.

Thus, the study of the treatment of therapeutic hypothermia shows the relative ease of the therapeutic treatment application. Methodology shows that it minimizes the presence of adverse effects. Modern technologies allow avoiding the consequences and confirm the effectiveness of this therapy.

CONCLUSION

Investigations on the role of therapeutic hypothermia in patients after a cardiac attack show that it is a medical procedure that affects the human body in order to change its temperature and thereby reduce the risk of death due to ischemic injury. At the same time, the mechanism of action of therapeutic hypothermia on the human body during a heart attack firstly impacts the

cellular metabolism, which significantly slows down. It contributes to greater stability of the cell membrane at the shortage of oxygen. Research techniques show the relative ease of the therapeutic treatment application. Thus, therapeutic hypothermia for patients after cardiac arrest may be an effective treatment option in preventing neurological damage and even reduce mortality, which confirms the thesis of the research paper.

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