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THE INFLUENCE OF THE LOW TEMPERATURE OF THE FAR NORTH ON THE BODY TEMPERATURE OF PIGS IN THE EXPERIMENT

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Today it can be considered established that the thermal scheme of the human body consists of a "nucleus" comprising the brain, internal organs of the thoracic and abdominal cavities, and a "shell" consisting of skin, subcutaneous base and superficial muscles. We have carried out experimental studies of the temperature of the pig under natural hypothermia under conditions of a full-scale experiment. Graphs of temperature changes in various parts of the body over time are presented. The permission of the bioethical commission of the YSC CMP is available.

Key words: pig, hypothermia, thermometry, low temperatures, cold injury, frostbite.

Introduction. I.M. Sechenov, a Russian physiologist and enlightener, wrote: "An organism without an external environment that supports its existence is impossible; therefore, the environment influencing it must also be included in the scientific definition of an organism. One of the factors of the external world that affects the human body is the low ambient temperature. Russia, by virtue of its geographical location, is the coldest country in the world. Yakutia in Russia is the most extremely cold region. There is almost no summer in the Far North of Russia - nine months of the year are snowstorms. The average temperature of the coldest month is –50 ° C Oymyakon.

The relatively high prevalence of deaths from the effects of cold in Yakutia has long ceased to be a purely forensic problem, now acquiring an important socio-economic component. Serves as a measure of social well-being of our citizens.

In the world medical literature there is no source from which to borrow the epidemiological characteristics of cold death. We in Russia do not have an in-depth analysis of death from exposure to cold. In Yakutia, 180–200 people die every year from exposure to cold, of which 80–90 are in Yakutsk. In the UK, about 300 people die from cold injuries every year. In the United States of America, averages of 754 people die every year. In the Russian Federation, averages of 1241 people die a year. In Moscow, the lowest death toll from cold injury was 48 (1991), the highest death toll was 1261 in (2002). From the analysis it is clear that the idea that the accidental death of people from the action of low temperature is encountered exclusively in the cold season is wrong. It is also not true, the statement that only socially unadapted individuals are victims of the cold. The body temperature of a person at which death occurs, it is not constant, and depends on age, the presence of concomitant diseases and many other factors [1].

The idea of a uniform response of the whole body to thermal stimuli was shaken by I.P. Pavlov in his article on the innervation of the pancreas in 1888, expressing the idea of a difference in a single organism of higher mammals, homotermic and poikilothermic components. He wrote: "It is possible with the right to divide the organs of a warm-blooded animal into two groups: organs with a constant temperature and organs with varying temperature, sometimes descending far below the internal level. There can be no physiological difference between the tissues of the internal cavities, which represent the daily temperature fluctuation at the most 1 degree, and the tissues and organs of the skin, whose temperature can vary with impunity between 10 and 20 degrees or more. Consequently, a warm-blooded animal can be imagined as if consisting of two halves: a warm-blooded animal and a cold-blooded one "[2].

Today it can be considered established that the thermal scheme of the human body consists of a "nucleus" ("homothermal core"), which includes the brain, internal organs of the thoracic and abdominal cavities, and a "shell" ("poikilothermic surface layer") consisting of skin, subcutaneous basement and superficial muscles.

The "deadly" temperature can be different for different people. As a general scheme, you can take the following: a decrease in temperature to 25 ºC is very dangerous; up to 20 ºC - causes almost irreversible consequences; body temperature in the rectum, equal to 17-20 ºC, can be considered absolutely deadly. According to some information, the mortal rate of hypothermia for a person is 22-25 ºC. It is believed that at 24 ºC the body temperature of a person is still possible revival and that death from general cooling becomes inevitable at a temperature of about 20 ºC. According to our data, at a temperature inside the stomach of 27 ºC, a specially hardened swimmer was able to swim across the Bering Strait. A decrease in body temperature is one of the main characteristic signs of a consistent development of cold injury [4].

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Purpose. Investigation of temperature changes in the "core" and "shell" of pigs when receiving hypothermia under conditions of a full-scale experiment.

Materials and research methods. The work was performed in 2019 from January to February on the basis of the faculty of veterinary medicine of the YSAA. We have modeled the conditions for obtaining natural deep hypothermia on animals at temperatures of about – 40 °C.

The experiments were carried out on clinically healthy pigs obtained from the “Khatassky pig complex” at the age of 2-3 months, weighing from 15 to 20 kg. In the first model of a pig, in order to limit the mobility and fixation of animals, neuroplegia was performed at the beginning of the experiment (neuroleptic - Xyla 0.2% 0.5 ml and Droperidol 0.5 ml). Then it was used to simulate the state of alcohol intoxication - ethyl alcohol orally at a dose of 5-6 ml / kg of live weight. The animals were fixed and placed on the street at an ambient temperature of - 40 ° C ... - 43 °C.

Experimental work was carried out in accordance with the ethical standards governing animal experiments, in accordance with the European Convention for the Protection of Vertebrate Animals used for experiments or for other scientific purposes No. 123 of March 18, 1986, Strasbourg, and the order of the Ministry of Health of Russia of 01.04. 2016 № 199n "On approval of the rules of good laboratory practice." The permission of the bioethical commission of the YPC KMP is available.

The following measuring devices were used for this study:

1. To characterize temperature changes, especially muscular, needle thermocouples of chromel-alumel type K were used. The temperature range is from -40 to 200 °C, which are introduced to a depth of 0.5 to 1 cm in the region of five and the wrist of a pig.

2. Rectal thermocouple chromel-alumel type K was used to determine the temperature in the large intestine.

3. External surface temperature thermocouple chromel-alumel type K was used.

For visualization of temperature readings from thermocouples, a precision Tercon signal converter was used as a controller.

The precision signal converter of thermometers of resistance and thermocouple "Tercon" produced by LLC "Termeks" is used for temperature measurements. The device has two input channels on which it measures the resistance of a connected resistance thermometer or EMF of a connected thermocouple, and then calculates the temperature from a given conversion function.

The Tercon-K switchboard supplied with the converter allows you to expand the number of input channels to 16.

Measurement of voltage signals from thermocouples is performed by comparing with the reference voltage built into the device. Measurement of resistance of thermistors is made by the method of comparison with the reference resistance connected in series with the sensor. An integrated analog-to-digital converter converts the comparison result into a digital code. Next, the microprocessor converts the digital code into a temperature value. The result obtained is displayed on a digital scoreboard and sent to a personal computer via the RS-232 interface in the form of a string in which the channel, measured value and unit of measure are sequentially indicated. Complete with the converter the software application for work in the environment of Windows is delivered. The program receives the data sent by the converter via the RS-232 interface to a computer, and outputs the data in the form of graphs and a table.

Results. The figures show the temperature of pigs with hypothermia in the “cooling – warming” cycle. We performed a selective antegrade cerebral perfusion technique using an artificial blood circulation apparatus (AIC) with a perfusion rate of 8 ml / min / body weight with a gradual warming of the perfusate (maintaining a temperature gradient of less than 5 °C). After the sternotomy, aortic cannula was inserted into the aortic root and the venous cannula into the cranial vena cava for perfusion. Heparinization was carried out at the rate of 3 mg / kg. Warming of the perfusate through AIC was performed with maintaining the temperature gradient less than 5 °C [5].

Conclusion. As a result of our experiments, it is possible to establish that the temperature in the “shell” is minus, and the core region is positive. A very characteristic picture of the protection of the "core" from the damaging effects of cold. The decrease in internal temperature depends on the ambient temperature.

Experiments with animals made it possible to establish a number of factors that impede the process of restoring the vital functions of the brain. These include prolonged exposure to low temperatures. Further warming of the heart, did not give the results of warming the brain in a small circle. The impossibility of establishing the time when you can "start" the reverse mechanism for restoring the work of the brain. Research on this issue of "revitalization" will continue. The given

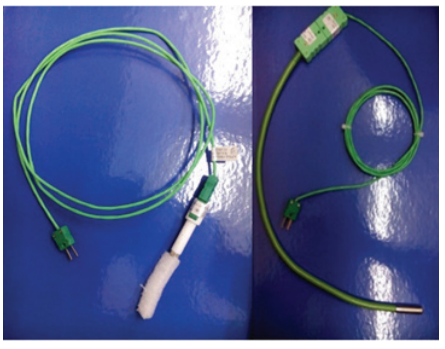

Fig. 1. From left to right: 1. Needle thermocouple to establish intramuscular temperature. 2. Rectal thermocouple to establish temperature in the large intestine

Fig. 2. “Tercon” signal converter

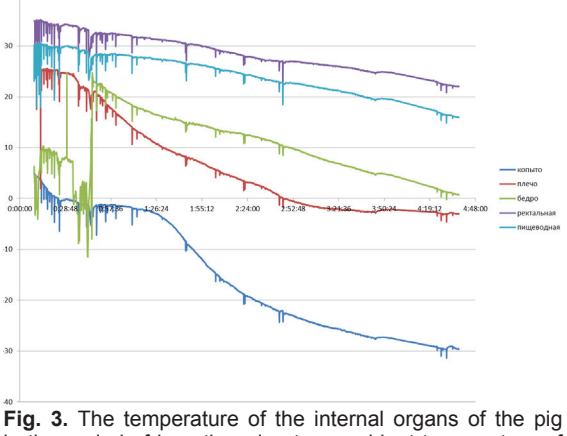

Fig. 3. The temperature of the internal organs of the pig in the period of hypothermia at an ambient temperature of -42 °C.

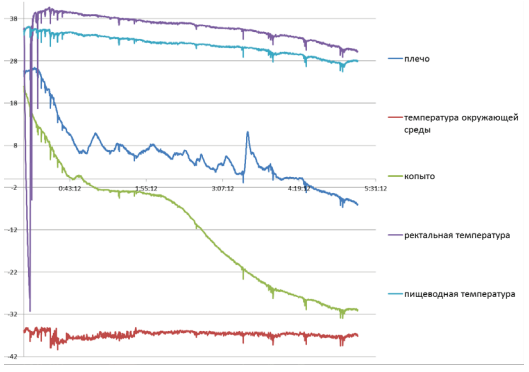

Fig. 4. The temperature of the internal organs of the pig in the period of hypothermia

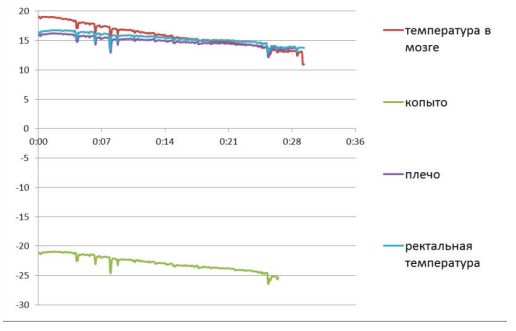

Fig. 6. Monitoring body temperature after cardiac arrest

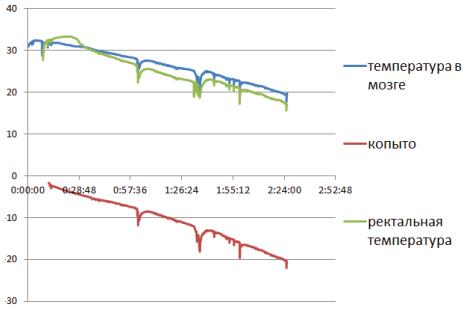

Fig. 5. The temperature of the internal organs of the pig in the period of hypothermia at an ambient temperature of -37 °C

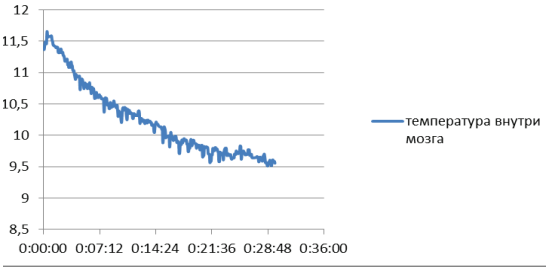

Fig. 7. Measuring the temperature around the pig's brain after bringing the body into a warm room

experimental materials show that the mechanisms of the brain work during cold injury have not yet been elucidated and there are still enormous and complex tasks to further study this problem.

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