METHODS OF DIAGNOSIS AND TREATMENT

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THE IMPLEMENTATION OF AN AUTOMATED DEVICE FOR HUMAN LIMB TEMPERATURE MONITORING AT TREATMENT OF COLD INJURIES

ABSTRACT

The article presents the device for automated temperature monitoring of human limbs. This device, called the «thermometric glove», was developed to be used in the treatment of cold injuries. The thermometric glove registers the surface temperature of the limb at several spots and performs an automatic recording of the readings to the internal memory. Two versions of the prototype devices and the results of approbation and experimental use are given.

Keywords: digital temperature sensor, portable controller, measurement of low temperatures, burn injury.

In the harsh climatic conditions of the Republic of Sakha (Yakutia), when the temperature reaches -60 ° C in winter, the problems associated with frostbite and hypothermia have an undeniable relevance. The greatest number of cold injuries compose those of the limbs. With severe cold injury of the limbs, it is necessary to maintain the condition of slow and gradual warming of frost-bitten tissues by means of natural heat exchange caused by the blood circulation for the maximum possible restoration of tissues. To do this, the injured limb is insulated as good as possible and various means are used to accelerate blood circulation. At the same time, the constant temperature monitoring of the object, namely the tips of the fingers, is of great importance. Such monitoring implies the use of reliable and accurate measuring equipment. Also, measuring the temperature of injured tissues is important for establishing an accurate diagnosis and determining the degree of frostbite, depending on which the method of first aid and medical care is chosen, which is decisive in treatment and determining the outcome of treatment [3]. The positive sides of this method include absolute harmlessness, the possibility of repeated, dynamic studies and the relative simplicity in the interpretation of the results obtained [1, 2]. In particular, a detailed study of the temperature changes in the tissues of the cooled segment makes it possible to diagnose the presence of tissues glaciation. In order to prove the presence of glaciation of tissues, it is necessary to confirm the negative temperatures in the tissues. Temperature control allows you to diagnose not only frostbite, but also diseases such as diabetes, mastopathy, adenoma.

The purpose of our development is the continuous periodic registering of the human fingertips temperature for a certain period of time, which will allow physicians to evaluate the effectiveness of certain techniques used in the treatment of such injuries. Since the patient must be able to move, the device must be autonomous and compact.

Based on the experience gained by NPO Etalon in the development of temperature monitoring systems for soils (Fig. 1), according to the technical requirements of the V.P. Larionov Institute of Physical and Technical Problems of the North it was decided to introduce these technical reserves in the development of the «Thermometric Glove». These technical solutions have made it possible to improve the accuracy and reliability of measurements, simplify the design of the product being developed.

A prototype of the thermometric glove was manufactured (Figure 2) having the following basic characteristics:

Measuring range -50 ... + 100 ° C

Resolution 0.06 ° C

Measurement error 0.1 ° C

The sensors are fixed according to the schematic diagram shown in Figure 3a.

The sensors were installed on the fingertips of the human right hand (Figure 3b), then on the fingers of the left hand. The sensor polling period was set to 60 seconds. (Test date - December 2, 2015 from 11:00 to 14:00.) Using the

Figure 1. Ground monitoring systems.

Figure 2. The model of a thermometric glove.

developed prototype, the pilot operation was performed, during which the first results were obtained (Figure 5). The patient of the Republican Hospital No. 2 with cold injuries of the limbs who already received first aid was chosen as a test patient.

Based on the results of the pilot operation, it was decided to develop a «thermometric glove» for 10 fingers with a device for quick fixing of sensors. The number on the fastener corresponds to the number of the sensor that will be displayed by the device. A general overview is shown in Figure 5. Figure 6 presents a view of the sensor in the fastener.

Approbation of the system was carried out. First, the sensors were fixed to the left hand, which was cooled at -20 ° C for ~ 5 minutes (Figure 7a).

Then the sensors were fixed to the right hand, which was not cooled (Figure 7b). Figure 8 shows a graph after 15 minutes.

CONCLUSIONS

Developed by the Etalon JSC, device for monitoring the temperature of human limbs is important for diagnosing and establishing the degree of cold injury. Also, this device allows one to evaluate and control the effect of various drugs applied to the patient. In the long term, it is necessary to develop a unified methodology for diagnosing the cold injuries, which will be used universally, based on the modified version of this device.

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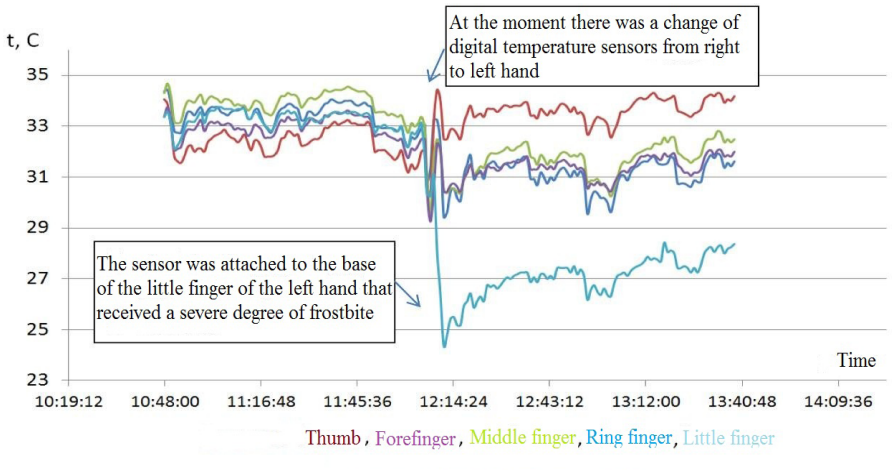


Figure 4. Results of operation.

Figure 5. General overview of the system.

a

b

Figure 3. a - the scheme of fixing the sensors on the hands of a person, b - setting the sensor on the patient.

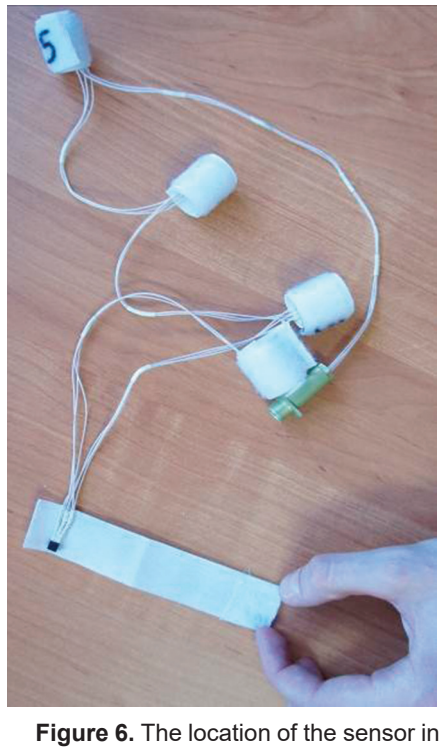
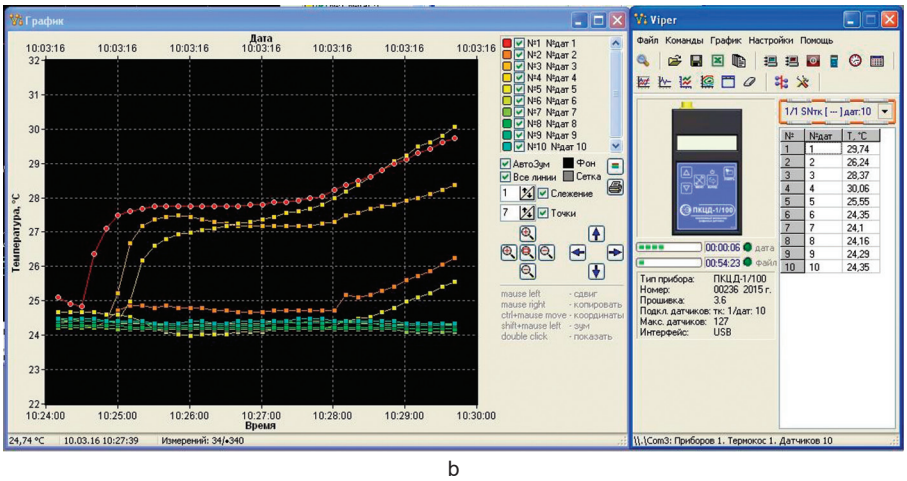


Figure 6. The location of the sensor in the fastener.

a



b

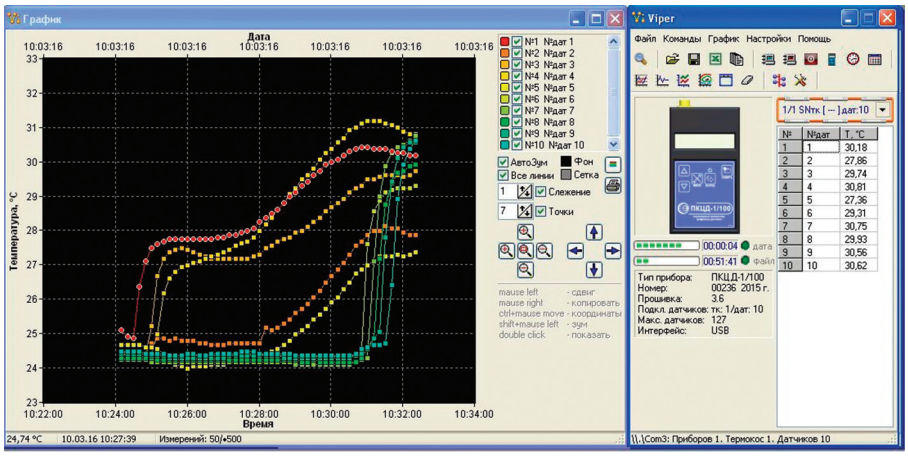


Figure 7. Securing the sensors on the hands: a - on the left hand, b - on the right hand.

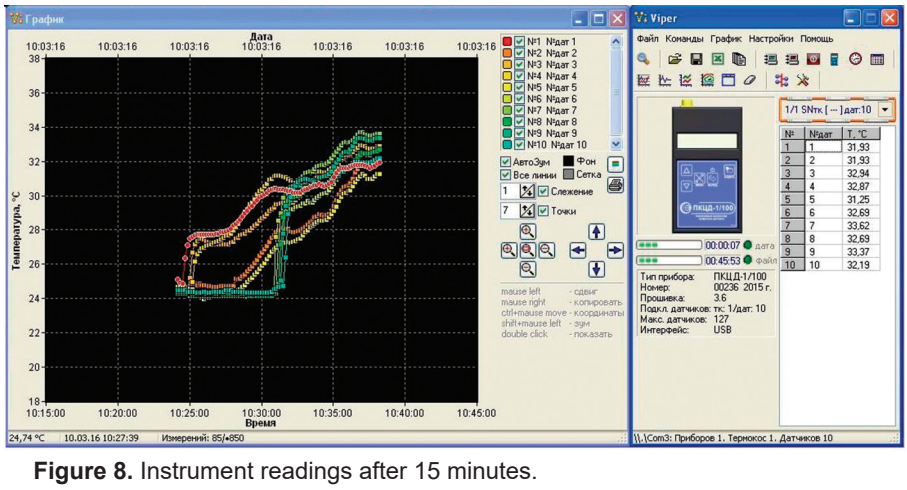


Figure 8. Instrument readings after 15 minutes.

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