New approaches to assessing the biological effect of modern wireless communication devices based on Bluetooth technology on a user

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Interest in the problem of assessing the risk to human health of electromagnetic radiation in the radio frequency range (EMR RF) covers an ever wider layer of society, which is explained by the rapidly expanding spheres of their application and the steadily increasing levels of exposure of the population in industrial and domestic conditions. The consequence of this is the need for further study of the features of the influence on the human body of new sources of EMR, in order to improve hygienic standards based on the accumulated world experience in solving this problem and modern views on the mechanisms of the biological action of this factor.

Despite the fact that the main contribution to the substantiation of the hygienic EMP standards is made by experimental studies, which is associated with the nonspecific nature of functional and pathological disorders that arise in humans under the influence of radio waves, the role of hygienic research in assessing the nature of the EMP effect of new sources and new generation modes is extremely high. since it is hygienic research that aims to determine the intensity and time parameters of the influencing factor [1].

At present, special attention of researchers is paid to the potential risk to humans of new sources of EMR in the RF range. The greatest attention is paid to EMP from mobile phones, as the radiation source closest to the human head. At the same time, Bluetooth technology, which has appeared in recent years, is becoming more widespread. In a number of countries, at present, the main task of dosimetry of communication facilities based on Bluetooth technology is electromagnetic compatibility, primarily for medical equipment [2], since Bluetooth technology operates in the same frequency range as most medical devices (ISM band). The power level of Bluetooth devices is divided into three classes: class 1 - 100 mW, class 2 - 2.5 mW and class 3 - 1 mW.

Using the Bluetooth protocol, the recorded physiological parameters of a person are transmitted, such as ECG, EEG, etc. [3-5]. Currently, there is no correct data on the harmful effects of Bluetooth radios due to low radiation power and

insensitive methods for determining the biological effect of RF EMR, however, a number of researchers point to the negative effect of Bluetooth EMR on children [6].

Currently, there are no fast adequate methods for assessing the effect of EMR on a person in the world. The fastest and most accurate determination of the absorbed energy is experimental dosimetry using phantoms and the specific absorption rate (SAR) [7, 8]. Therefore, there is an urgent need to develop a quick and sufficiently sensitive method for assessing the effect of EMR on a person.

Segmental bioelectronic functional diagnostics, based on the assessment of changes in the electrical parameters of biological active zones on the human skin when carrying out a standardized electric current load of physiological quantities, makes it possible to carry out integral express diagnostics of a person's condition. [11] This method, implemented in the equipment produced by the Center for Intelligent Medical Systems "IMEDIS", makes it possible to identify changes in the state of human health associated not only with the occurrence and development of diseases, but also with the impact of factors of the labor process (high psycho-emotional stress, stress, and the action of harmful physical factors [9]. According to a number of researchers, this method has a higher sensitivity compared to traditional methods for assessing the functional state of the human body. This allows the use of segmental bioelectronic

functional diagnostics to assess the biological effect under the action of EMR, even of low intensity.

We have carried out a series of studies to measure the levels of EMR generated by the Bluetooth radio module near the head and body of a person. Measurements of the levels of energy flux densities (PES) were carried out using an IPM-101M electromagnetic radiation meter with an E02 antenna. PES levels were measured at a distance of 0.05; 0.1; 0.2; 0.3; 0.4; 0.5; 0.6 and 1 m from the source. 10 measurements were taken at each point. PES levels were measured at a SonyEricsson HBH-610 Hands-Free mobile communication device, a Billionton computer adapter (Class 1), a Nokia 6270 cell phone and an HP iPAQ h2210 PDA in standby (paired devices), receiving and transmitting (data and voice).

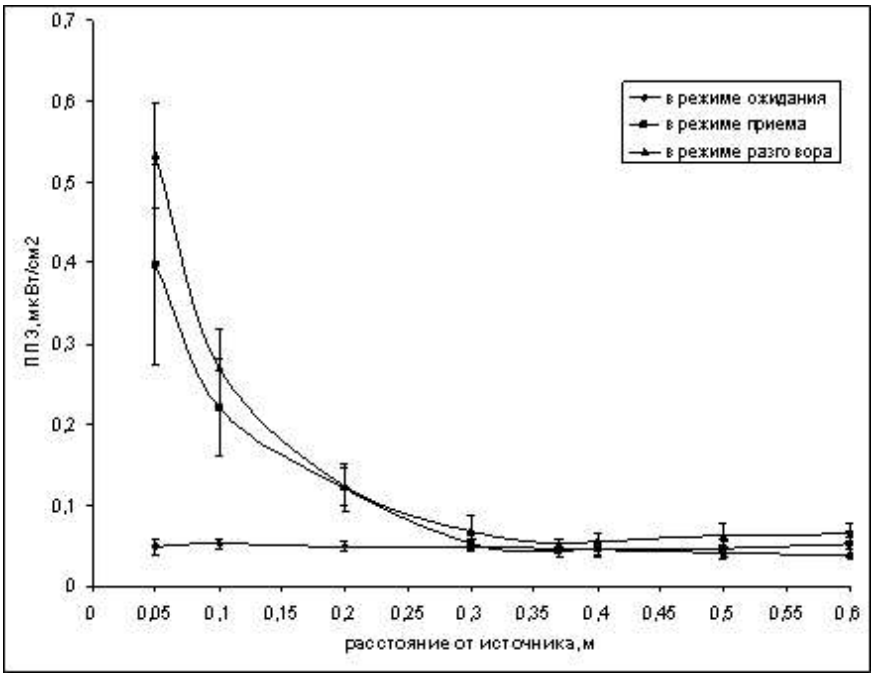
Despite the fact that the registered levels of EMR were rather low, the “Hands-Free” device can have the greatest potential impact on a person, because the person is in direct contact with the transceiver device, and the user's head is exposed to the greatest extent.

In addition to experimental dosimetry, a study was made of the biological effect of EMR generated by a SonyEricsson Hands-Free mobile communication device (model HBH-610). Healthy volunteers were selected for the study - men aged 18–20 years. All volunteers were divided into 5 groups, 10 people in each: two groups were exposed to EMR in standby mode, 2 - in talk mode, and one group - control. The study was carried out in the morning (10-11 hours). Registration of biological effects when working with the Blutooth radio module was carried out by the method of segmental bioelectronic functional diagnostics before and after exposure. In the course of segmental express diagnostics, 3 measuring cycles were carried out on 7 pairs of leads at a constant electric current of negative and positive polarity.

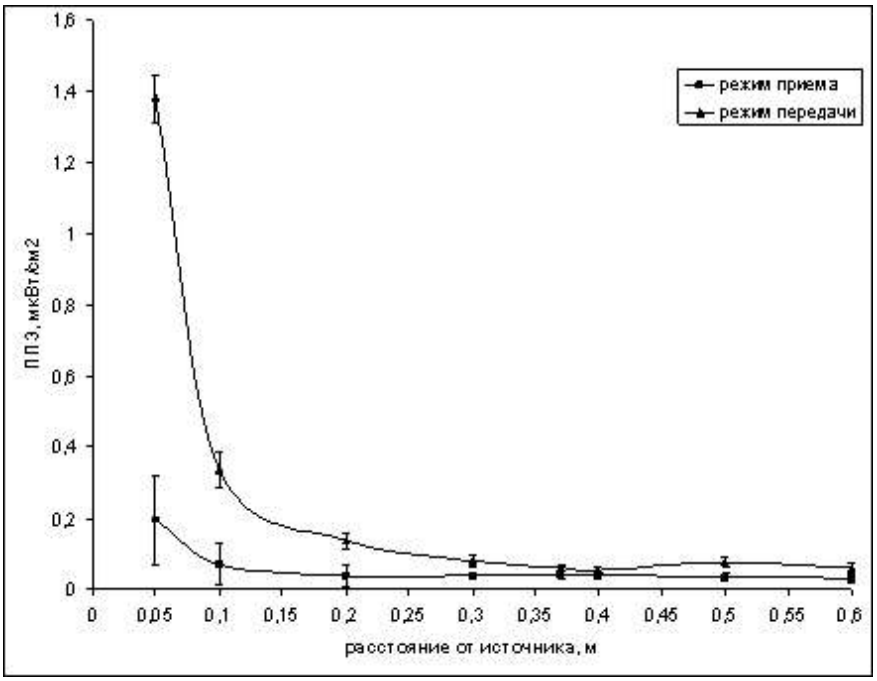
For preliminary analysis, the following leads were selected: left hand - left forehead, left forehead - right forehead, right forehead - right hand, as corresponding to the organs closest to the source of electromagnetic radiation.

As part of experimental dosimetry, it was found that the maximum recorded PES levels at a distance of 0.05 m from the speaker of the "Hands-Free" earphone in the talk mode reach 0.38 μW / cm^2 (rice. one). At

this marked a decrease in the PES values to 0.08 μW / cm2 at a distance of 20 cm regardless of synchronous or asynchronous data transmission. The rest of the Bluetooth devices, despite the higher radiation levels (Fig. 2), do not pose any harm to users, because the PES levels generated by them are lower or the radiation source is located at a distance of more than 0.5 m from the user and the recorded levels do not exceed 0.04 μW / cm2.



Rice. one.PES levels of "Heands-Free" SonyEricsson HBH-610 in standby, receive and receive-transmit modes



Rice. 2.PES levels of the computer radio module Bluetooth Billiton in the modes of receiving and transmitting data

Thus, it was revealed that the maximum PES levels created by

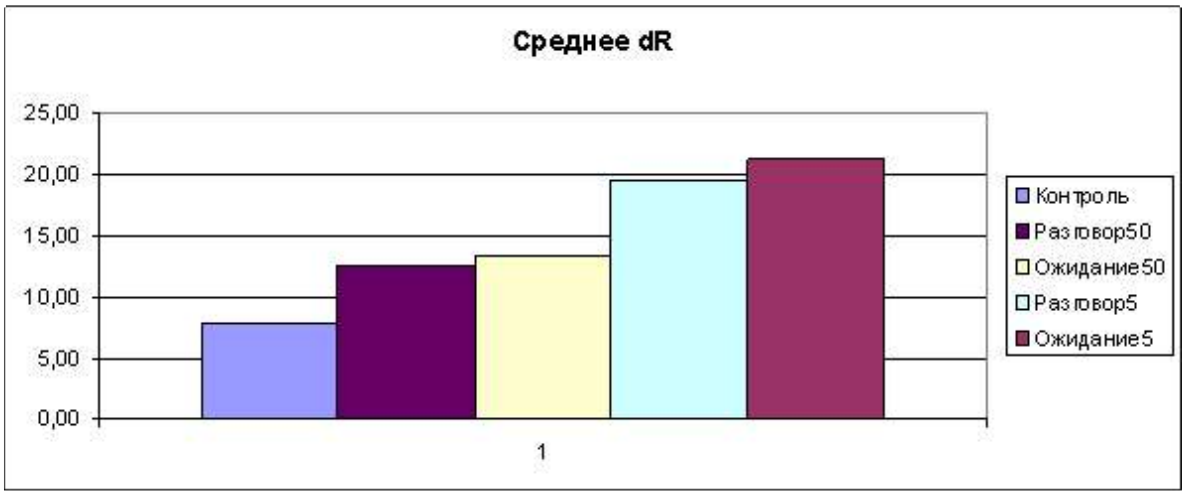
wireless headset, which is located closest to the human body, are 0.38 μW / cm2.

The initial analysis of the data obtained showed a strong scatter in the results of measurements of the absolute amplitudes of AA on the leads. For the subsequent analysis, we will use the average value of all amplitudes along the leads - MA. It is obvious that the effect of the radiation under consideration on the organism is individual, however, it is possible to reveal general patterns by examining changes in the regulation of the organism before and after exposure. Regulation - the body's response to stress - can be assessed by the totality of the MA differences of measurement cycles I, II, and III.

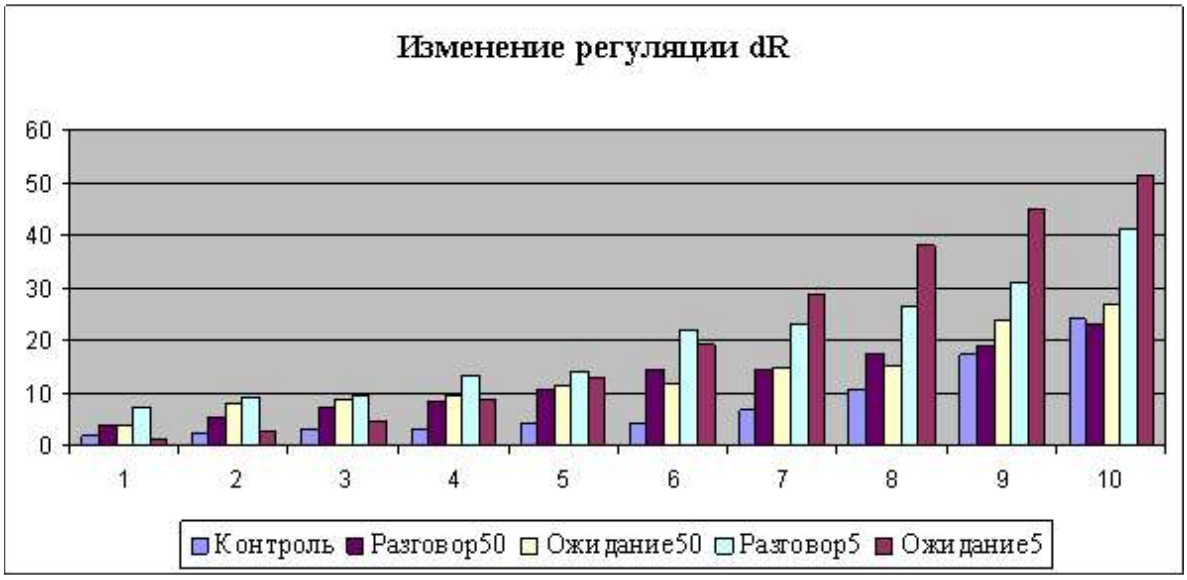
$$RI = MAII - MAI$$
$$RII = MAIII - MAII$$

The pairwise difference between the corresponding values of RI and RII before (e) and after (n) exposure characterizes the change in regulation. The summation of these differences in modulus gives the dR characteristic, independent of the type of regulation (increase, decrease or irregular change in MA in cycles).

$$dR = | RIп - RIд | + | RIIп - RIIд |$$



Rice. 3.Diagram of the distribution of the average value of regulation in the experimental and control groups



Rice. 4.Average value of regulation for all subjects, sorted by the rise

Analysis of the data obtained allows us to make a preliminary conclusion about the possibility of recording the effect of the wireless headset on the human body. At the same time, in the considered sample of subjects, the greatest change in the body's response during segmental measurements was revealed when the device was exposed to the standby mode for 5 minutes.

As noted above, all levels generated by wireless devices based on Bluetooth technology do not exceed the RF EMP remote control for the population, therefore, the recorded EMP levels can be considered insignificant. However, when assessing the general condition of a person, rather clear dependences of the influence of EMR are highlighted when working with a “Hands-Free” device.

The method of segmental express diagnostics makes it possible to approach an individual assessment of the degree of risk for each person when working with low-power sources of EMR.

Obviously, when talking on a cell phone without using a wireless headset, the biological effects will be more pronounced, and, therefore, the use of a headset, although somewhat reduces the dose load, does not completely eliminate it. It can be assumed that the effect of low-intensity pulsed-modulated radiation on the human body has an information load and can subsequently lead to long-term biological effects, which are superimposed by many other factors, which does not allow determining the effect of EMR. It is the sensitive and objective technique of segmental diagnostics that solves these problems, and the established approaches to assessing the results can give researchers the necessary tool in determining the biological effect of EMR on a person, which previously seemed difficult and subjective.

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