Approaches to modeling electromagnetic fields in biomedical research

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One of the most important components in assessing the nature of the influence of electromagnetic fields (EMF) is to determine the amount of electromagnetic energy absorbed in the human body - dosimetry. Attention to theoretical EMF dosimetry is paid mainly in foreign studies, while in domestic studies it remains clearly insufficient.

Theoretical dosimetry uses analytical approaches and numerical methods to study the effects of EMF on models that simulate various biological objects (humans and laboratory animals). In order to obtain more accurate data on the magnitude and nature of the spatial distribution of the absorbed EMF energy in the irradiated objects, their models are used, consisting of many blocks (cells). In theoretical dosimetry, for each unit with specified electrical parameters (, and)

typical for, for example, muscle, adipose, bone and other types of tissues, Maxwell's equations are solved, for E- and H-vectors of an EMF or electromagnetic wave of a certain frequency, intensity and polarization. When the number of blocks in the model is exceeded more than 10^4 the method of finite differences in the time domain (FDDT) is used in the calculations, the English abbreviation of this method is FDTD (Finite-Difference Time-Domain). An important feature of theoretical dosimetry methods is the ability to obtain results that cannot be measured experimentally due to methodological or technical difficulties.

Among the currently available programs in which the mathematical apparatus of the KPVO is implemented for solving Maxwell's equations, the closest for dosimetry problems in biomedical research is the SEMCAD X program (Simulation Platform for Electromagnetic Compatibility Antenna Design and Dosimetry), Schmid & Partner Engineering AG, Switzerland.

In mathematical (numerical) modeling, it becomes necessary to take into account the geometric dimensions and structure of the irradiated object (block or cellular models). The block approach allows you to create models with a high degree of detail, based on the data of computed and magnetic resonance imaging. Thanks to this method, a detailed description of not only a biological object, but also the entire study is possible. All this imposes certain difficulties on the computing power, tk. with a detailed model, the calculation time can take more than a few days. However, the data obtained will make it possible to assess the correctness of the research and develop recommendations for eliminating possible experimental errors.

Currently, various numerical models of humans (man, woman, child) and laboratory animals (rats, mice, etc.) have been developed,

which can be applied quite flexibly within the framework of calculations in the design of biomedical research.

Theoretical dosimetry is a way to obtain predictive values that are extremely necessary for solving the problems of the therapeutic effect of EMF. Therefore, the use of theoretical approaches to EMF dosimetry in biomedical research can be the first step in setting up any experiment aimed at obtaining a specific therapeutic effect.

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