

ABSTRACT

Litovchenko O.L. **Peculiarities in the formation of biological effects under the influence of electromagnetic radiation in conditions of experimental cold stress.** Qualification scholarly paper: a manuscript.

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The subject of the thesis is the study of biological reactions formation in the whole organism of rats under the combined influence of low frequency electromagnetic radiation (EMR) and low temperature in the dynamics of physiological, morphological changes, reactivity of the immune system, redox system balance, lipid and mineral metabolism in the laboratory experiment; with a subsequent statistical-diagnosing neuro-phase DNFS system, fuzzy clustering method to determine the dominant factor in the formation of corresponding biological effects in the body on the combined influence of factors, as well as a hybrid system for assessing the informativeness of biological indices, for processing indices when determining biological effects.

It was determined that under the influence of moderately low temperature (4°C) over 30 days, 4 hours a day, there was a restructuring of functional systems, which was manifested by stimulation of body weight gain in rats and a decrease in the CNS ability to summation of subthreshold impulses (SSI). The results of body temperature measurements before and after exposure indicated a moderate decrease in temperature by 0.5°C on average. It is demonstrated that the reduced temperature leads to the initiation of free radical processes in terms of diene conjugates (DC) and malondialdehyde (MDA), which causes a gradual weakening of antioxidant protection (AOP) by the following criteria: reduction of SH-groups, catalase activity and superoxide dismutase (SOD). Changes in lipid metabolism were characterized by atherogenic effects due to increased levels of low-density lipoprotein (LDL), very low-density lipoprotein (VLDL) and decreased levels of high-density lipoprotein (HDL). The increase in serum triglycerides and

cholesterol led to an increase in the atherogenic index in general. Elevated serum glucose levels in rats were maintained throughout the study. An imbalance in the trace element composition (decrease in calcium, phosphorus and increase in magnesium concentrations) of blood serum reveals a disorder of energy metabolism.

The effect of low temperature on the body of rats resulted in the activation of phagocytosis in the middle of the experiment by increasing the phagocytic activity of the stimulated and spontaneous HCT test; the latter had the opposite effect at the end of the study. The ability to form extracellular traps by neutrophils (NETs) was suppressed throughout most of the study, but the opposite effect was found on the 30th day. As for the humoral link of the immune system, an increase in the concentration of effective C4 molecules of the complement component was determined. The content of IgM and IgG immunoglobulins changed nonlinearly, but on the 30th day of the experiment, an increase in their levels was revealed.

This group of observations is characterized by moderate dyscirculatory liver disorders in the form of uneven vascular blood supply and the development of stasis in the microcirculatory tract, changes in the granularity of the hepatocyte cytoplasm, the presence of polyploid cells, increased Kupffer cells, reduction of glycogen content in the cytoplasm of hepatocytes. In response to the influence of moderately low temperature, reactive hyperplasia of the white pulp of the spleen developed.

It was proved for the first time that 4 hours of exposure to EMF (70 kHz, 600 V / m) for 30 days causes the formation of biological effects similar to those under the influence of low temperature according to the criteria of biochemical, immunological, morphological changes. However, there were differences in quantitative characteristics and in the ratio between the studied indices. It is proved that under the conditions of 30-day exposure to EMR, in the serum of rats, there is a gradual increase in the processes of lipid peroxidation, the level of which increased by the 30th day. As for AOS, compensatory increase in catalase activity was revealed at the beginning of the experiment, but after the 15th day, the catalase

activity, concentration of SH-groups were reduced until the end of the experiment. Studies of lipoprotein composition have shown that the effect of EMR leads to a disorder of lipid metabolism in the direction of atherogenic effects by the following indices: increased concentrations of cholesterol, LDL, VLDL, triglycerides and atherogenicity index. EMR also causes the mobilization of carbohydrates, as indicated by the increased concentration of glucose and changes in the balance in the trace element composition of blood serum, in particular, a decrease in the concentrations of calcium and phosphorus in the second half of the experiment.

It was proved for the first time that, under the conditions of 30-day exposure to EMR (70 kHz, 600 V / m), phase changes in cellular and humoral immunity were the most significant, which was manifested by activation of oxygen-dependent phagocytosis in the first half of the experiment by spontaneous HCT test, as well as the activity of neutrophils on the 15th day by all studied parameters (spontaneous HCT, stimulated HCT, phagocytosis). On day 30, cellular immunity was suppressed by phagocytosis activity, which was compensated by the ability of neutrophils to form extracellular traps after their death. Humoral immunity was characterized by suppression of C4 and Ig component of class M in the first half of the study, with subsequent compensatory growth of C4, C5 and IgM components. The action of EMR provokes a decrease in Ig class G until the end of the observation.

Examination of the internal organs revealed uneven plethora of blood vessels in the liver, and the average number of Kupffer cells located along the sinusoid was reduced. In the spleen, there was a moderate hyperplasia of the white pulp and an increase in the reactive center of the follicle.

For the first time in a laboratory experiment, the features of the exposure to EMF associated with low temperature were studied, according to physiological, biochemical, immunological and morphological criteria. The obtained results showed that under the conditions of the combined influence of factors, the biological effects were slightly modified in comparison with the isolated influence

of both electromagnetic radiation and reduced temperature. The following biological effects should be considered peculiarities of the combined influence of factors: pronounced influence on the functional state of the CNS in terms of SSI, increased intensification of peroxidation processes with a simultaneous decrease in antioxidant protection by reducing SH-group concentration, catalase activity; enhancement of lipid metabolism with dyslipoproteinemia phenomena, which was manifested by an increase in triglycerides, cholesterol and its fractions (LDL and VLDL), with a simultaneous decrease in the content of high-density lipoprotein (HDL). The used method of cluster analysis (Fuzzy-c-means) based on artificial intelligence allowed to determine the share of contribution of each of the studied factors to biochemical processes in the body, it proved that low temperature had the greatest impact (63%); the share of exposure for EMR was 37%.

The manifestations of biological effects concerning the immune system were the following indices: decrease in the ability of neutrophils to phagocytosis at different stages of the experiment, imbalance of the complement system activation (decrease in C4 concentration) against the background of increased IgM and IgG synthesis. Determining the intensity of the influence of factors allowed us to say that the share of the contribution to the functioning of the immune system for low temperature was 53%, and for EMR 47%.

Signs of hepatocyte discomplexation and dystrophic changes of liver cells were found in a significant part of the observations. The average number of Kupffer cells in the group of combined factors was reduced. In the spleen, there was a moderate hyperplasia of the white plp and the effects of additivity by indices of density of the T-zone of the follicle and its reactive center, as well as a synergistic decrease in the volume of white plp with a simultaneous increase in volume of red one. EMR had a greater effect (81%) on immunocompetent cells in the internal organs, compared with the action of low temperature (19%).

It is proved that, under the conditions of simultaneous combined exposure to EMR and low temperature, the biological effects that were characteristic for low temperature are preserved. Thus, the leading factor in the combined effect was the

reduced temperature, which added 60% to the overall biological effect throughout the study, against the effect of EMR, for which the contribution rate was only 40%.

It was determined that an increase in the concentration of DC with a simultaneous decrease in the concentration of SH groups, an increase in VLDL and inhibition of oxygen-dependent neutrophil metabolism by the HCT test were the leading indices in the formation of biological effects.

Key words: combined action of factors, electromagnetic radiation, low temperature, biological effects, immunological state, antioxidant status, lipid metabolism, mineral metabolism, Fuzzy C-Means, adaptation mechanisms, rats.