Magnetothermia Utilization in the Curing of Malignancies.
Part 1

P. P. Loshitskiy* and N. A. Nikolov**
National Technical University of Ukraine "Kyiv Polytechnic Institute", Kyiv, Ukraine
*ORCID: 0000-0003-2349-0092, e-mail: pepel@phbme.kpi.ua
**ORCID: 0000-0001-8716-6254, e-mail: nikolka_uakr.net
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Abstract—The article presents the main features of magnetothermia influence on biological objects including the characteristics of magnetic antenna near-field, the changes of blood flow and of diffusion, which are caused by the temperature and by the magnetic field.

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1. INTRODUCTION

Hyperthermia, which consists in local or general increase of human body temperature to 42 °C and above, is one of the first “physical” techniques of cancer curing. This approach has been improving up to the present time, however, in consequence of its poor tolerance by patients, it is rarely used separately. The techniques of chemotherapy and radiotherapy, which possess their peculiar strengths and weaknesses, are more widely used. The main disadvantages of these approaches are the damage of the healthy cells besides of the cancer ones, sharp intoxication increase of organism on the whole.

At the present time, the new combined curing techniques, which, on one hand, reduce medicamental burden, and, on the other hand, practically do not affect the curative effect, are being developed. These techniques include the combination of a moderate hyperthermia with a chemotherapy [1].

This approach can be implemented, for example, using a device “Magniterm” providing induction heating of patient’s body by an alternating magnetic field with 27.12 MHz frequency and power up to 200 W (50–120 W in practice). Inductor–applicator is a magnetic loop with a single coil having 25 cm diameter, which is located at 2–3 cm distance from the surface of patient’s body. In particular, doxorubicine is used as a medicament [2].

Inductive nature of field generation leads to a formation of apparent magnetic component, whose energy is slightly transformed into heat in biological tissues. Temperature increase in the case of a device “Magniterm” utilization for experimental tumors of animals (rats, mice) did not exceed 1.5 °C. Dimensions of tumors reached 5 cm in diameter. Irradiation was carried out using a loop coil with 5 cm diameter during 15–30 minutes at 75 W integrated radiation power. Under the clinical conditions during irradiation of metra tumors the endocavitary temperature does not rise more than 0.5 °C. At the same time, the therapeutic effects are sufficiently evident.

Taking into account a number of experimental investigations [1, 3] one may speak of a nonthermal nature of interaction of an external electromagnetic field with tumor cells or of an influence of a moderately high temperature on the entire system. On the other hand, based on theoretical suppositions [4, 5], it has been suggested to generate spatially-inhomogeneous electromagnetic field for the irradiation of malignant tumors. Experimental investigations have confirmed the expediency of moderate electromagnetic hyperthermia utilization with spatially-inhomogeneous field for the curing of malignant tumors.

However, the interaction mechanisms of the field with biological tissues remain controversial, despite the accumulation of experimental data [1]. Thus, for experimental investigations the spatial inhomogeneity of the electromagnetic field is achieved by coil curving of the loop applicator and by configuring it into the profile shape of the circular arc. In this case, one can hardly say that field intensity drops are increasing at the cellular level, not to mention at the molecular one.

Along with a variety of interaction mechanisms of magnetic fields with biological systems [6, 7], including malignant tumors, the most important effect is the alteration of hemodynamics of the irradiated tissues, which leads to an increase in the effective perfusion of the tumor, to its oxygenation, facilitates the