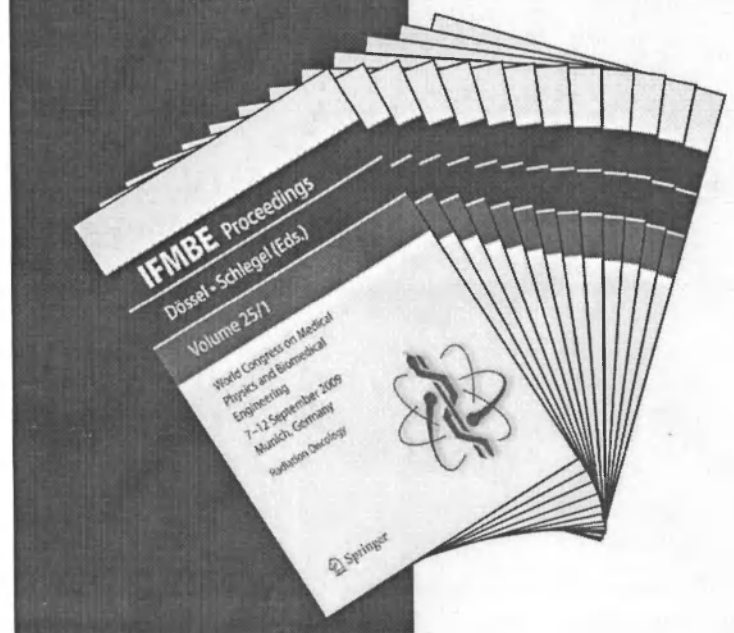
Olaf Dössel • Wolfgang C. Schlegel (Eds.)

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# Influence on Erythropoiesis and Blood Catalase Activity Low Intensity Electromagnetic Millimeter Radiation

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Abstract- **The present study was undertaken to investigate changes of the blood catalase activity and regeneration processes in the circulatory system of rabbits under conditions of bone-marrow deficiency and long-term exposure to low-power extremely high frequency electromagnetic radiation (EHF EMR) at frequency of 50.3 GHz. As it is known, this frequency is resonant for the vibrations of water hexagonal structures[1]. During both whole-body and head area exposure to EHF EMR the animals were placed in front of the center of the conical antenna, at distance of 500 mm and 150 mm from the radiating end of the antenna (far field zone). The spatial peak incident power density (IPD) was measured to be as 0,05 mW/cm$^2$ and spatial peak specific absorption rate (SAR) at the skin surface was calculated to be as 2 W/kg.The results of our experiments show that repeated exposures can cause erythrogenetic activity, prolonged retyculocyte crisis, hemoglobin and erytrocyte content growth, as well as faster retyculocyte maturation. The obtained data demonstrate that living organisms react to low-intensity monochromatic radiation mobilizing their internal resources. Namely, regenerative processes are intensified and compensation mechanisms gain broader capacities. Deficiency of bone marrow in the result of its removal does not significantly affect the erythrogenesis. Irradiation on the rabbits head area increases catalase activity in peripheral blood, maximum of which was registered 20-fold and on the 10-th day after 25-fold influences.The character of changes of the catalase activity does not depend on the changes of total number of erythrocytes.**
**The observed activation of catalase probably, promotes the enhancement of the power antioxidant system of the organism.**

Keywords-**Extremely high frequency electromagnetic radiation, low-intensity millimeter waves, erythrogenesis, bone-marrow deficiency,blood catalase,erythrocytes.**

## I.Introduction

According to literature facts, the millimeter-wave therapy increases the level of immune resistance, influences different stages of pathogenesis, changes enrymatic reaction activity and growth rate, destroys microorganisms [2,3].It has shown that millimeter waves have strong effect on the process and bioelectric activity of neurochemical functions of the brain. Penetrating into the organism this radiation is transformed into information-carrying signals performing guidance and adaptation control or rehabilitation processes in the organism. Different physical factors,affect the organism, in the same way as electromagnetic waves, provoking changes in the functioning of different organs/systems. Erythron plays an essential role in development of such processes, as it actively contributes to the maintenance of functional state of the organism.
This investigation has the aim to study the characteristics of regenerative processes in the circulatory system and blood catalase activity change under the effect of non–thermal(low intensity) and non-ionizing coherent electromagnetic radiation millimeter range.

## II.Methods

Experiments were carried out on rabbits of the same weight, age and sex. The animals underwent 30-day exposure with G4-141 coherent electromagnetic waves generator (Russian made) with frequency of 50.3 GHz, in correspondence with resonance frequency of vibrations of hexagonal structures of water [1]. A whole-body exposure of rubbits to Extremely High Frequency Electromagnetic Radiation (EHF EMR) was conducted in the far-field zone of conical antenna at a distance of 500 mm from the radiating end of the antenna. Incident power density (IPD) value in the plane of exposed object was of 0,05 mW/sm$^2$ . To calculate the SAR, we used dielectric parameters of the skin $\varepsilon' = 14$, $\varepsilon'' = 18$ and skin density $\rho = 1.15$ g/cm$^3$ [2]. Specific absorption rate on the surface of skin of animals back was calculated by the formula [3]

$$SAR = \frac{\sigma_\xi^\xi (1-R) P_0}{n\rho} \qquad (1)$$

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where $\sigma = \varepsilon_0 \varepsilon'' \omega = 50.4$ S/m is the electric conductivity of skin at the frequency of 50,3GHz, $\varepsilon_0 - 8.85 \cdot 10^{-12}$ F/m is the vacuum dielectric constant, $\omega$ is the circular frequency, $\xi = 377\ \Omega$ is the vacuum wave impedance, $P_0$ is the incident power density, $R$=0.5 is the reflection coefficient, $n = 4.2$ is the refractive index of the skin.

Calculated value for the SAR is received about 2W/kg. Animals of the control group were sham-exposed by placing the rubbits into the exposure zone when the generator was turned on but the output power was attenuated to zero. Duration of the exposure and sham-exposure was 60 minutes.

Normally, 24 hours after the bone marrow extraction and on the 5th, 10th, 15th, 20th, 25th, 30th days and 2 weeks after the exposure the following features of erythropoesis were analyzed: the quantity and colorimetric characteristics of erythrocytes, reticulocytes, hemoglobin, maturation rate of reticulocytes, the cellular content of the bone marrow.In order to assess the functional alternations of erythroid branch, the bone marrow index of erythronormoblasts protoplasm maturation has been revealed.

In catalase activity change experiments the animals were exposed under a single, 5-, 10-, 20-,25- and 30-fold radiation. In case of a single radiation the studies were carried out before the radiation effect and on the 5-th, 30-th, 90-th minutes after it. Have been calculated the catalasen umber Cn, represented as quantity (in milliliter) of decomposition hydrogen peroxide - $H_2O_2$ in 30 minutes, the absolute number of erythrocytes in blood periphery, catalase index Ci – the ratio of Cn to the numbers of erythrocytes in 1 $mm^3$ of blood (in millions). In multiple radiation the studies of the mentioned characteristic values were carried out before the radiation effect and after it on the 5-th minute

## III. Results and discussion

Hypochrome changes of erythrocyte and hemoglobin amounts were observed without irradiation during 24 hours after the bone marrow withdrawal. As compared to the starting point, the amount of erythrocytes had fallen by 13.5%, hemoglobin by 21.33% (Fig 1). Thus the color index changed to value 0. 68. The latter was accompanied by increase in relative and absolute quantities of reticulocytes , as well as their maturation rate (Fig.2). On the 5th day of irradiation, normochrome decrease of erythrocytes and hemoglobin content was observed. Reticulocytosis and high level of their maturation rate were the same in the mentioned period. In the phase of marrow extraction, the amount of myelocaryocites and erythroid branch cells was low. The myelocaryocites level is 95300 $\pm$ 3115 and erythroid branch cells 38.0 ± 1.2 in normally. On the 5th day of irradiation they were respectively 68000 ± 2045 ($p < 0{,}001$) and 27,0 ± 0,678 ($p < 0{,}001$). However, the marrow index of erythronormoblasts protoplasm maturation remained unchanged (0. 6). On the 10th day of the experiment, moderate increase of erythrocytes and hemoglobin amount has been observed (5% and 9% correspondingly). On mentioned time the increase of cells, not containing hemoglobin proerythroblasts and erythroblasts was seen in marrow, which confirms the acceleration of proliferative processes. On the 15th day the growth of erythrocyte and hemoglobin quantities continued. The quantity of reticulocytes and their maturation rate were high. On the 20th day of studies the erythrocyte and hemoglobin quantities were within the limits of physiological vibration 94.48%, 94.28%. As compared to the 15th day, the absolute and relative amounts of reticulocytes had decreased, but still were on the high level compared to the starting point. The observed variations in the peripheral red-blood indices are likely to be related with intensification of marrow proliferative and maturatoin processes. This fact is confirmed by high activity of erythroid cells in the extracted marrow domain and the growth of hemoglobin-containing normoblasts quantity.

During 25 to 30 days after exposure the quantities of erythrocytes and hemoglobin have not undergone any essential changes compared to the 20th day . The absolute and relative amounts of reticulocytes on the 30th day varied within the limits of starting point. In 2 weeks after stopping the irradiation, all parameters of erythropoiesis have returned to the initial values. It should be noted that the marrow index of cytoplasm maturation of erythronormoblasts have not changed during the whole investigation period.

Catalase activity change investigations have shown that on the 5-th minute after single low intensity EMR influence Cn and Ci have an increase and absolute number of erythrocytes in peripheral blood decreased .A gradual decrease of the Cn level up to the norm was registered during the following 30, 60, and 90 minutes. Analogical changes were registered for the Ci characteristic values, but for the all mentioned periods of time it was on the relatively higher level. The catalase activity and the absolute number of erythrocytes were not changed synchronously. The carried out investigations on blood catalase have shown that on the 5-th minute after single low intensity EMR influence Cn and Ci have an increase and absolute number of erythrocytes in peripheral blood decreased .A gradual decrease of the Cn level up to the norm was registered during the following 30, 60, and 90 minutes. Analogical

changes were registered for the Ci characteristic values, but for the all mentioned periods of time it was on the relatively higher level. The catalase activity and the absolute number of erythrocytes were not changed synchronously. After 5-fold radiation effect the character and value of the changes of Cn, Ci and the total erythrocyte number were analogical to the changes compared to a single radiation effect. After 10- and 20- fold radiation effect an increase of the catalyze activity was observed (Fig.3).

## IV. Conclusions

The results obtained show that, after removal of the marrow, repeated application of millimeter electromagnetic radiation activates the erythropoiesis, enhances the long-lasting reticulocyte maturation process, increases the erythrocytes and hemoglobin content. Stability of erythrocytes and hemoglobin quantities during 20 to 30 days after extraction and irradiation of marrow, strong intensification of reticulocyte maturation process, as well as the acceleration of proliferative branch erythroids and maturation processes allow us to conclude that multiple exposure of living organism to coherent electromagnetic millimeter radiation mobilizes its preservation power. The latter tends to enhance the regenerative processes and broaden the capacities of compensational mechanisms, as a result of which the removal of marrow does not seriously affect erythropoiesis. Our obtained results agree on the literature, according to which in case of combined action of millimeter range electromagnetic radiation and anti-tumor preparations the impairment of hemopoietic system decreases significantly and stimulates the proliferative activity of stem cells of marrow, as compared with isolated effect of the mentioned drugs.

The data obtained prove that in single, 5-, 10-, 20-fold and on the 10-th day after 25-, 30-fold radiation effect of 60-minute-duration of EM radiation on the rabbits' head the increase of catalase activity in peripheral blood was observed, maximum of which was registered in 20-fold and on the 10-th day after 25-fold influence (Fig.3). The character of changes of the catalase activity do not depend on the changes of total number of erythrocytes. The observed in our experiments activation of the peroxisomatic catalase enzyme , probably, promotes the enhancement of the power antioxidant system of the organism.

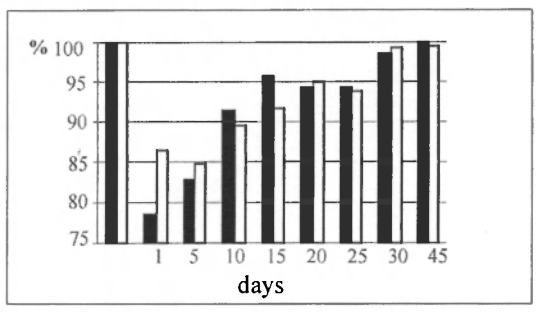


Figure 1: The change by percent amount of erythrocytes in 1 ml blood (white) and amount of hemoglobin (gram/%)(black) under influence of electromagnetic radiation (EMR)

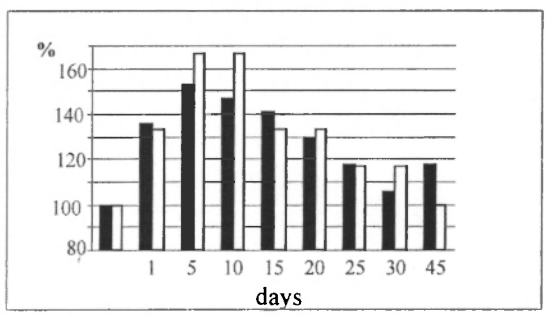


Figure 2: The change by percent relative amount of retuculocytes ( ‰ ) (black) and the rapidity of retuculocytes ripening in an hour (white) under influence of electromagnetic radiation (EMR)

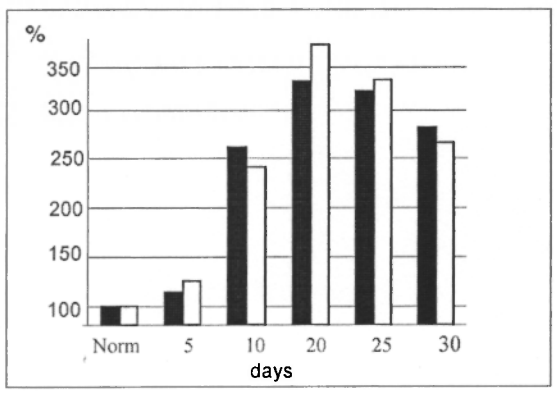


Figure 3: The change by percent catalase number Cn (black) and catalase index Ci (white) in the blood under influence of electromagnetic radiation (EMR)