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CHANGES IN QUANTITY OF TOTAL SULFHYDRYL GROUP IN THE BLOOD OF INDIVIDUALS
EXPOSED TO SUPERHIGH-FREQUENCY GENERATORS(Professor E.A. Kolesnik, Col Med
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Investigations revealed that sulfhydryl (SH) groups in the blood perform a catalytic function, they participate in formation of bonds between an enzyme and substrate, in appearance of macromolecular structure of enzymes (Yu.M. Torchinskiy, O.P. Polyanovskiy, 1964, and others), in appearance and conduction of nerve impulses (Kh.S. Koshtoyants, 1951), in implementation of nervous system functions at all levels thereof (K.V. Savich, V.A. Yakovlev, 1957), in energetic processes related to breakdown of adenosine triphosphatase (B.F. Poglazov, et al., 1958), and others. At the same time we know that some occupational factors, and in particular ionizing radiation, heavy metal compounds, arsenic, lead to blocking of SH (E.Ya. Grayevskiy, 1955, 1969; Barron, 1949). In the literature available to us we did not find any data with respect to changes in SH group content in individuals coming in contact with generators of superhigh-frequency (SF) generators.

We studied the SH groups of blood by the method of amperometric titration according to Kol'tgoff and Harris as modified by V.V. Sokolovskiy (1961). It is based on the principle of titrating the hemolysate studied in 0.001 M solution of silver nitrate. The ions of silver that are formed in the course of the chemical reaction are bound to the sulfhydryl groups as follows: $R-SH + Ag^+ \rightarrow R-S-Ag + H^+$. In this case, the quantity of silver used for titration is equivalent to the SH group content.

We surveyed two groups of people: an experimental group (exposed to SF radiation generators) and a control group. The subjects ranged in age

from 20 to 40 years. Tenure of work with such generators ranged from 1 to 10 years. In the experimental group, examination revealed an asthenic state with neurocirculatory dystonia of the hypotensive type, grade I essential hypertension with asthenic state, and other somatic pathology (gastritis, cholecystitis, and polyarthritits).

The average level of total SH groups in the control group of individuals constituted a mean of 920 micromoles per 100 ml of blood; in the specialists of the experimental group with a tenure of 1-2 years the level was 698 micromoles (1.34 times less than in the control group: $t=4.02$, $P>99.9\%$), for those with tenure of 2-10 years it was 768 micromoles (1.19 times less: $t=2.65$, $P=99\%$). Consequently, in individuals working with SF radiation generators we found a decreased level of total SH groups. The fact that the latter present low levels in individuals with brief period of contact with these sources warrants the recommendation that total SH groups be assayed as a test to detect early signs of SF lesion.

We also tested the prophylactic effect of cystamine on individuals who had been in contact with SF radiation generators. This agent was prescribed to both groups of subjects in a dosage of 0.4 to 1.2 grams per day. Total SH group levels were determined before ingestion of cystamine, then 24, 48, and 72 hours after. These investigations revealed that in the control group there was a distinct increase in SH group content by an average of 80-120 micromoles per 100 ml of blood 24 and 48 hours after cystamine (the level was 870 before ingestion of this agent, 990 micromoles after). In those working with SF radiation generators we established the same trend, i.e. within the same intervals of time they showed a visible rise in levels of total SH groups (720 before cystamine and 909 micromoles after). Assay of SH groups 72 hours after cystamine failed to reveal any significant changes, as compared to the preceding days.

We tested the effect of ascorbic acid, which was used instead of cystamine, on another group of individuals who were or were not exposed to SF fields. As a result we found that 24 hours after taking this vitamin (a single dosage of 0.5 gram) there was no change in blood SH groups.

Thus, we observed a distinct inhibition of total SH groups in the blood of individuals coming in contact with SF radiation generators. Assay of these groups can be recommended as a test for the detection of early signs of SF field-induced lesions. Administration of cystamine is indicated for prophylactic purposes.

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THE COMBINED EFFECT OF SUPERHIGH-FREQUENCY FIELDS AND ADVERSE
MICROCLIMATE ON THE ORGANISM

(V.A. Zhuravlev)

There are reports in the literature of considerable functional changes in the organism of people working under the influence of concurrent exposure to SHF (superhigh-frequency) energy and high ambient temperature (A.Ya. Loshak, 1965; Boiteau, 1963, and others). Deichmann (1959) reported sooner death of animals exposed to an intensive SHF when irradiation was combined with high temperature.

The purpose of our study was to determine the effectiveness of the complex effect of microwaves of nonthermal intensities and various microclimate factors encountered under real conditions (N.F. Koshelev, O.N. Karelin, 1966, and others). The investigations were conducted on young female rats weighing 155-160 grams at the start of the experiments. The first experimental group was exposed daily for 1 hour to microwaves in the 10-cm range at a density rate of 5 milliwatts/sq cm, after which they were put in an incubator at an air temperature of 40° and relative humidity of 22-25 percent. Air velocity did not exceed 0.05 meter per second, mean radiant temperature constituted 40.5°. The second group of rats was exposed only to adverse microclimate in the incubator under the above conditions, then was kept in individual cages without irradiation for 1 hour. The control group of animals was not exposed either to SHF irradiation or heat. All other experimental conditions were the same. Total duration of such treatment constituted 60 days; after this the rats were mated with healthy males to observe reproductive function. In the course of the experiment we studied the dynamics of weight, several blood indices, and at the end of the experiment we submitted some internal organs to morphological examination.

Table 1

Nature of factor Характер воздействия		① Эритроциты в млн.	② Гемоглобин в г%	③ Лейкоциты в тыс.	④ Удельный вес в г	⑤ Каталитическое число	⑥ Вязкость крови
СВЧ и нагревание в термостате ⑦	Количество ⑧	5.41	14.8	11385	1.048	4.6	4.3
	t P	2.2 <0.05	2.4 <0.05	0.3 >0.05	0.7 >0.05	9 <0.001	6 <0.001
Нагревание без облучения ⑨	Количество	5.28	15.4	13975	1.052	5.2	4.9
	t P	1.85 >0.05	0.2 >0.05	2 0.05	0.9 >0.05	4.3 <0.001	—
Контрольная группа ⑩		4.86	15.5	11050	1.05	5.8	4.9

Legend:

- | | |
|----------------------------|------------------------------------|
| 1) erythrocytes, millions | 7) SHF and heating in an incubator |
| 2) hemoglobin, grams% | 8) quantity |
| 3) leukocytes, thousands | 9) heating without irradiation |
| 4) specific gravity, grams | 10) control group |
| 5) catalase number | |
| 6) viscosity of blood | |

The experiment revealed that an adverse microclimate led to a considerable elevation of rectal temperature, and it was more marked under the influence of combined factors. Thus, while the temperature remained at the former level after irradiation (30.4-38.6%), after heating in the incubator it rose to 40.1-40.4°. In the second group of rats, after heating rectal temperature was 39.8-40.2°. All of the animals of both experimental groups were removed from the incubator in a listless and moist condition. Their weight did not differ reliably from that of control animals (P>0.05).

We found an increase in number of erythrocytes and hemoglobin in peripheral blood (Table 1) taken from the caudal vein in the first group of rats; in the second group there was a tendency only toward increase in number of erythrocytes, whereas the hemoglobin content did not differ from the control. The leukocyte count, on the contrary, increased in the second group and differed little from control figures under the combined influence of microwaves and heat. There was practically no change in specific gravity of blood in all groups, however, we noted a slight tendency toward decrease thereof with a combination of factors and increase with the thermal factor alone. There was more marked decrease in viscosity of blood under the combined effect of microwaves and high temperature. Probably the minor decrease in specific gravity and marked decrease in viscosity of the blood could be

attributed to the specific influence of the SHF field on the protein-synthesizing systems of the organism. In the opinion of Schliephake (1960), the increase in hemoglobin and decrease in viscosity of the blood are related to impaired liver function with microwave irradiation. Blood catalase activity diminished in both experimental groups, but more distinctly in the first.

In our opinion some interesting findings were made with reference to investigation of reproductive function. Thus, in the control and in the second experimental groups the percentage of females that bore offspring was rather high: 87.5. In the first group it was lower, 50 percent. In this group there were also fewer rats per liter (Table 2).

There is some significance to the ratio between sexes (males and females) among the offspring of animals exposed to deleterious factors. In particular, W.L. Russell (1960) refers to the works of Parks and Hertwig who found a prevalence of males in the offspring of x-irradiated mice. Under ordinary conditions there are more females in rat litters: 54.4-56 percent (P.P. Gambaryan, et al., 1955). According to our data, the ratio between the two sexes was consistent with the usual indices in the control group, and in the experimental group there was prevalence of male offspring.

Examination of internal organs of sacrificed animals revealed more marked changes in the first group of rats. The weight coefficients of the liver and spleen were much lower than in the control, whereas in the second group of animals no significant deviations were demonstrated (Table 3).

Histologically the changes in the myocardium, tissues of the liver, kidneys, and spleen when stained with hematoxylin eosin differed essentially in severity of dystrophy, since deviations of the same type were noted in both experimental groups. However, there were also differences in nature of morphological changes. Thus, under the combined effect of both factors the myocardium more often presented signs of homogenization and fragmentation of muscle fibers with fine subepicardial hemorrhages, whereas in the group exposed only to heat there was prevalence of signs of impaired circulation (plethora, edema of the stroma, etc.). The liver and spleen showed signs of chronic venous plethora, more marked under the combined influence of microwaves and heat. The degree of fatty dystrophy of the liver (sudan-4) was moderate in both experimental groups. There was quite negligible dystrophy of renal tissue.

Analyzing the data obtained it can be stated that the combination of SH field and adverse microclimate leads to marked functional changes in the animal organism, as well as to a greater degree of dystrophic changes in some organs. This is indicated by the increased number of erythrocytes and higher hemoglobin level, marked decrease in catalase activity, and in blood viscosity. Finally, a study of reproductive functions revealed that the number of females that had offspring and the number of offspring per liter were considerably lower in the first group than the second. In spite of a considerable thermal load, the indices of reproductive function in the

Table 2

Nature of Характер воздействия factor	1 Коли- че- ство ро- див- ших самок в %	2 Сред- нее коли- че- ство кры- сят в поме- те	3 Соотно- шение самцов и самок в %
СВЧ и нагрее- вание в тер- мостате 4	50	6.5	53.9:46.1
Нагревание без облучения 5	87.5	8.9	56.4:43.6
Контрольная группа 6	87.5	8.7	44.2:55.8

Legend:

- 1) number of females that delivered offspring (%)
- 2) mean number of rats per litter
- 3) ratio of males to females, %
- 4) SHF and incubator heating
- 5) heating without irradiation
- 6) control group

Table 3

1 Характер воздействия	2 Сердце	3 Печень	4 Селе- зенка	5 Почки
СВЧ и нагрее- вание в тер- мостате 6	0.39 P>0.05	3.0 P<0.05	0.37 P<0.05	0.65 P>0.05
Нагревание без облучения 7	0.45 P>0.05	3.37 P>0.05	0.48 P>0.05	0.69 P>0.05
Контроль- ная груп- па 8	0.41	3.42	0.45	0.72

Legend:

- 1) nature of factors
- 2) heart
- 3) liver
- 4) spleen
- 5) kidneys
- 6) SHF and incubator heating
- 7) heating without irradiation
- 8) control group

second group did not differ from the control, and these results may be attributed to the lack of the specific influence of the SHF field.

Determination of the complex influence on the organism of SHF and adverse microclimate is of practical significance for the prevention of

radiowave lesions and setting standards for exposure to combined factors. On the other hand, the changes in the animal organism which we demonstrated after heating them in an incubator indicate that one should take into consideration the enormous part played by overheating in development of various functional disturbances, and we should take into consideration first of all lowering of air temperature in work rooms and surfaces to optimum levels by means of using effective heat insulation or an air conditioning system.

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