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EFFECTS OF NON-IONIZING ELECTROMAGNETIC RADIATION

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EFFECTS OF NON-IONIZING ELECTROMAGNETIC RADIATION

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HYGIENIC ESTIMATION OF INTENSITY OF IRRADIATION OF INDIVIDUALS WORKING IN HIGH AND ULTRAHIGH FREQUENCY INSTALLATIONS

Kazan' KAZANSKIY MEDITSINSKIY ZHURNAL in Russian No 6, 1975 pp 60-61

[Article by Ye. B. Reznikov, Docent N. Kh. Amirov, R. A. Ablyazov and Docent I. V. Chudnovskaya (Kazan])]

[Text] In the last few years there has been considerable improvement of working conditions for individuals dealing with sources of radio-frequency radiation as a result of broad use of protective measures that help lower the intensity of irradiation. However, even low intensities, in the case of prolonged and regular exposure, are not indifferent to the human body. This is why the problem of preventing the effects of high frequency electromagnetic fields on the human body continues to be a pressing one.

The main sources of ultrahigh frequency [UHF] radiation are working capacitors between the place of which plastics are heated and welded. It is particularly difficult to shield the capacitors when plastic goods of large dimensions are treated.

There may also be other environmental factors that are deleterious from the standpoint of hygiene, in addition to high frequency and UHF electromagnetic fields when equipment is in operation: high temperature, increased concentration of carbon monoxide and certain other chemicals.

Our studies revealed that industrial high frequency and UHF installations present a hazard to health if the electromagnetic field has a high voltage at the work stations and indoors. The main cause of these problems is the lack or inadequacy of shielding the radiation sources. Shielding the generator as a whole or of different high frequency elements in blocks constitutes an effective measure for protecting workers from the effects of the electromagnetic field of high frequency installations. In dielectric heating devices one must shield the plates of the working capacitor and energy input feeders.

These measures make it possible to lower the voltage of high frequency and UHF electromagnetic fields at the work stations and, accordingly, to eliminate them from the workroom.

10,657
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EFFECTS OF SUPERHIGH FREQUENCY FIELDS ON NEUROPSYCHIC FUNCTIONS OF MAN

Kazan' KAZANSKIY MEDITSINSKIY ZHURNAL in Russian No 6, 1975 pp 73-74

[Article by T. N. Orlova and I. V. Chubnovskaya, submitted 23 January 1975]

[Text] Abstract: It was found that individuals who are in prolonged contact with a SHF [superhigh frequency] field, along with asthenovegetative disturbances, also develop signs of the encephalopathic syndrome in some cases.

We were concerned with the effects of prolonged exposure to relatively low voltages of SHF on the mental and somatic state of man. We studied 365 men working with SHF field generators in the decimeter and centimeter wave bands.

Only one-third (32%) of those examined had no complaints; a lack of changes in the internal organs was established in only 12.6%.

We found symptoms of vegetovascular disorders of the hypertensive and hypotensive type in 72 subjects. We often observed generalized and local hyperhidrosis, "marbling" and cyanosis of the distal parts of the limbs and pathological dermatographia. Impaired thermoregulation was found in some patients. In 20 cases there was persistent subfebrile temperature and most of them were not aware of having an elevated temperature, and numerous thorough clinical examinations failed to demonstrate foci of infection. Electrothermometry of symmetrical points on the body performed on 51 patients chronically exposed to SHF fields revealed thermoasymmetry in 44 cases (from 0.8 to 1° in 12 cases, to 2° in 27 and over 2° in 5). Four patients also presented a markedly low foot temperature (to 22.3°).

Four patients complained of episodes of palpitation with headache, sharp temperature elevation, profuse perspiration, sensation of pain in the region of the heart and a sense of fear. The attacks we observed lasted from a few minutes to 2 hours.

We found marked asthenic symptoms in 21 cases. The patients complained of irritability, tearfulness, fatigability, a desire to sleep in the daytime, lack of interest in distractions, family affairs or in their favorite leisure time occupations. Some patients stopped attending classes at a night institute because their memory had worsened, they found it difficult to assimilate the material, they suffered from headaches that developed with mental tension. Unpleasant "rush of blood" to the head and a feeling of fever were reported by 17 of these patients. Dynamic arterial pressure monitoring enabled us to demonstrate neurocirculatory dystonia of the hypertensive or hypotensive type. As a rule, all of these patients retained fitness for work and reluctantly agreed to a hospital work-up; after a brief rest their morbid signs disappeared.

Some individuals who coped well with their work presented psychopathological symptoms: hypnagogic and simple visual and auditory hallucinations in 5 cases; paresthesia, cenesthiopathic, vestibular and psychosensory disorders in 6; obsessive symptoms in 5. They all maintained that these disorders had appeared only in the last 2-3 years; previously they did not present overly concern about their health, indecisiveness and other psychasthenic personality features. The obsessiveness was expressed in the form of thanatophobia, claustrophobia, acrophobia, obsessive recollection of events and conversations in the distant past. For a long time, some patients could not get rid of alarming thoughts about their work and about petty offenses. Nine people reported frequent and groundless appearance of anxiety, diminished affect or "complete apathy towards everything."

We took into consideration factors that were involved in onset of neuropsychic disorders. There was a history of brain concussion as a result of household trauma in 4 cases; their neurological status revealed signs of traumatic encephalopathy. Alcohol abuse was noted in 3 people.

The data obtained warrant the assumption that neuropsychic disorders in individuals who are in prolonged contact with SHF fields are not limited to the asthenovegetative disorders and symptoms of vegetovascular dystonia described in the literature. In a number of cases, to these symptoms are added signs of the encephalopathic syndrome with its inherent opticovestibular, cenesthiopathic and psychosensory disturbances, as well as hypnagogic hallucinations. Detection and consideration of these symptoms are mandatory for more accurate evaluation of the severity of illness, fitness for work and choice of treatment. The role of additional deleterious factors (in particular, alcohol abuse, organic brain lesions) requires further investigation as it relates to development of the clinical signs of diseases related to man's prolonged exposure to SHF fields.

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LIPID METABOLISM INDICES IN WORKERS WHO ARE IN CONTACT WITH SUPERHIGH FREQUENCY WAVES

Kazan' KAZANSKIY MEDITSINSKIY ZHURNAL in Russian No 6, 1975 pp 74-76

[Article by Yu. A. Vorob'yev, submitted 18 November 1974]

[Text] Abstract: A study of cholesterol, β-lipoproteins, total lipids, phospholipids and phospholipids/cholesterol coefficient of workers who come in contact with low intensities of SHF [superhigh frequency] fields in the centimeter and decimeter bands revealed that the first three lipid indices were high, with the opposite changes in phospholipid level and phospholipids/cholesterol coefficient. It was established that there is a correlation between disturbances of lipid metabolism and increase in age, work tenure and nature of neurocirculatory disorders. It is assumed that electromagnetic waves of low intensities could be involved in development of atherosclerosis.

We studied some of the indices of lipid metabolism in a group of men (194 people) whose work involved regular exposure to SHF electromagnetic waves in the centimeter and decimeter bands (the intensity did not essentially exceed the maximum permissible level). Total cholesterol was assayed (by the method of Mrskos-Tovarek) in all 194 men; phospholipids (according to Silversmith-Davis) and β-lipoproteins (according to Burshteyn-Samayl as modified by M. Ledvin) were assayed in 116 and total lipids (Kunkel test) were assayed in 142.

All of the subjects were divided into 3 groups according to age: there were 62 men 20-29 years of age, 94--30-39 years, 38--40-49 years old; they were divided into 4 groups according to work tenure: 63 men--1-4 years, 63--5-9 years, 45--10-14 years and 23 had worked for over 15 years.

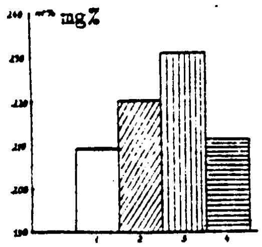
As a control, the same indices were studied in 58 men of the same age who worked under comparable conditions but who had never been exposed to SHF fields (see Table).

As can be seen in this table, in the control group, with age there is a distinct increase in cholesterol, phospholipid and β-lipoprotein content; this is not in

Lipid content (mg%) in blood serum of people exposed to SHF fields

Index	Age (years)								
	20—29 лет			30—39 лет			40—49 лет		
	C	M	P	C	M	P	C	M	P
n	20	62		25	94		13	38	
Cholesterol	202.3 ± 2.6	213.4 ±3.8	< 0.02	209.8 ±3.0	224.6 ±3.7	< 0.01	215.2 ±4.0	234.4 ±6.4	< 0.01
n	20	39		26	51		13	28	
Phospholipids	215.0 ± 2.7	217.4 ±3.9	> 0.2	223.8 ±1.5	213.3 ±4.0	< 0.02	227.3 ±2.2	214.5 ±5.4	< 0.05
Phospholipids / Cholesterol	1.06 ±0.01	0.99 ±0.02	< 0.01	1.04 ±0.01	0.96 ±0.02	< 0.001	1.06 ±0.02	0.93 ±0.03	< 0.001
n	20	38		25	49		13	29	
β- lipoproteins	521 ± 10.9	550 ±11.2	> 0.1	529 ±7.0	567 ±15.9	< 0.05	550 ±11.3	613 ±16.9	< 0.02
n	20	47		25	66		13	29	
Kunkel' test, cloudiness units	23.6 ± 0.6	25.6 ±0.56	< 0.02	24.6 ±0.8	26.6 ±0.52	< 0.05	24.9 ±0.53	27.1 ±0.80	< 0.05

Key:
C) control
M) main group



Mean blood serum cholesterol level in workers who are in contact with SHF fields, as function of arterial pressure level
1) control
2) individuals with normal AP
3) individuals with high AP
4) individuals with low AP

contradiction with the data in the literature. We arrived at the same conclusions with regard to cholesterol, β-lipoprotein and total lipids when we examined those working in an SHF field.

It was interesting to compare the biochemical indices of healthy individuals and those exposed to SHF fields according to age groups. In all 3 age groups, the cholesterol level was reliably higher than in healthy individuals of the same age ($P_1<0.02$, $P_2<0.01$, $P_3<0.01$). Similar changes were found when we tested total lipids ($P_1<0.02$, $P_2<0.05$, $P_3<0.05$).

There was no appreciable difference between individuals up to 30 years of age and the control with regard to β-lipoprotein levels. Among those over 30 years of age (2d and 3d group) blood serum β-lipoprotein levels were reliably higher than in the control ($P_2<0.05$, $P_3<0.02$). Other changes were observed when we assayed phospholipids and the phospholipids/cholesterol coefficient. In the control group, we observed a reliable increase in phospholipids with age. There was a substantial difference between the 1st and 3d age groups ($P<0.01$). The phospholipids/cholesterol ratio does not change with age.

When we compared phospholipid levels in those who come in contact with SHF fields and the control, lowering of these indices was demonstrated in the 2d and 3d age groups ($P_2<0.02$, $P_3<0.05$). Because of hypercholesterolemia and moderate decline of phospholipid content, the coefficient of their correlation was found to be lower in all age groups than in the control ($P_1<0.01$, $P_2<0.001$, $P_3<0.001$). These data are indicative of impaired stability of colloid state of cholesterol in blood, which is typical for those suffering from atherosclerosis and essential hypertension.

A study of the indices as function of work tenure revealed a tendency toward gradual increase in cholesterol. Thus, the cholesterol content constituted 214.4±3.6 mg% in the group of individuals with work tenure of up to 5 years, 218.0±4.1 mg% up to 10 years, 231.6±5.3 mg% up to 15 years and 242.8±7.6 mg% with tenure of over 15 years. The difference between the 1st and 4th tenure groups is statistically reliable ($P<0.01$).

To rule out the influence of age in these tenure groups, we selected 67 men 30-35 years of age and compared their indices to the data obtained for individuals of the same age (16 people) in the control group. This comparison revealed a very distinct influence of SHF electromagnetic fields on cholesterol metabolism. Thus, cholesterol constituted 222.3±5.1 mg% ($P<0.02$) for individuals with work tenure of 6 to 10 years, 227.9±7.3 mg% ($P<0.02$) in those with tenure of more than 15 years, whereas in the control group the figure was 209.4±2.0 mg%.

We also investigated the effect of arterial pressure [AP] level on some indices of lipid metabolism (see Figure).

It was established that the quantity of β-lipoproteins is higher among patients with neurocirculatory dystonia of the hypertensive type than in the control ($P<0.01$).

Our data indicate that there are disturbances of lipid metabolism among people working in contact with SHF fields. According to most indices, these disturbances are observed in individuals with work tenure of over 5 years and at over 30 years of age.

In view of the fact that such changes in lipid metabolism are involved in development of arterial hypertension, we can agree completely with V. P. Medvedev (1972) who considers essential hypertension, occurring with prolonged exposure to SHF fields, to be the consequence of the effects of this factor.

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10,657
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UDC: 612.822.3

ON THE NATURE OF CHANGES IN BACKGROUND AND EVOKED RHYTHMS OF RABBIT BRAIN BIOPOTENTIALS UNDER THE INFLUENCE OF STRONG STATIC MAGNETIC FIELDS

Moscow ZHURNAL VYSSHEY NERVNOY DEYATEL'NOSTI in Russian Vol 26, No 2, 1976 pp 403-410

[Article by N. P. Smirnova and L. D. Klimovskaya, Moscow, submitted 26 May 75]

[Text] The research of Soviet authors has made a large contribution to the study of nervous system reactions to strong magnetic fields. We refer primarily to the works of Yu. A. Kholodov et al. [1-5]. An extremely important fact established in these works is that the central nervous system (CNS) is sensitive to the effects of a static [steady] magnetic field (SMF). The authors observed an increased number of spindles and slow high-amplitude waves on electrograms of different parts of the brain and, in some cases, appearance of convulsive discharges after brief (1-3 minutes) exposure of the rabbit's head to SMF ranging from 200 to 1,000 H [oersted]. Use of automatic analysis enabled them to demonstrate increased intensity of faster rhythms and of overall voltage of the EEG, along with intensification of slow activity. In these experiments, primarily the effects of turning SMF on and off were considered, while the latter effect was equated to that of a mild stimulus.

It is felt that the problem of effects of SMF on CNS functions is incompletely solved without studying the distinctions of total effects of strong SMF, with prolonged exposure and assessing the sequelae of such effects after the animal is removed from the magnetic field.

In this work, we studied the changes in overall bioelectric activity and the reaction of adopting the rhythms of flickering light in different parts of the rabbit brain with total body exposure to 1,000 to 4,000 H SMF lasting 30 minutes to 24 hours.

Method

Chronic experiments were conducted on 35 waking rabbits with electrodes implanted in different structures of the brain. In some experiments, the animals were immobilized with diplacin (1 ml 2% solution intravenously per animal) with the use of artificial respiration.

We used an SP-15A electromagnet with flat parallel bars 400×300 mm in size, and 14 cm distance between them. The magnetic field was virtually homogeneous in the central part of the interpole space 300×200 mm in size, and the drop in tension in the remaihing part did not exceed 15-20% of its value in the middle. For exposures lasting up to 1 hour the rabbits were placed in the opening of the magnet, immobilized belly down on a stand, for longer exposure they were put in a plexiglas cage. Thus, the rabbits were exposed to total body SMF with vertical passage of force lines. The set strength was reached in 30 seconds. Each animal was exposed once or twice to SMF with an interval of at least 1 week. Control experiments were conducted on the same rabbits under analogous immobilization and set-up conditions. Since the SP-15A magnet creates a field with 1.8% pulsation, in order to demonstrate the role of the variable [alternating] component, the animals were submitted to total body exposure to an alternating [intermittent] magnetic field of 100 H at a frequency of 100 Hz, which was somewhat greater than the variable component for the maximum CMF of 4,000 H used in our experiments.

There was unipolar derivation of spontaneous bioelectric activity from the sensorimotor and optic regions of the cortex, dorsal hippocampus, preoptic region, medioposterior parts of the hypothalamus, reticular formation of the mesencephalon and cortex of the vermis cerebelli. The position of implanted electrodes was verified histologically after the experiments. We used silver electrodes for derivations from the cerebral cortex and Nichrome ones for subcortical structures and the cerebellar cortex, the tip being 150 microns in diameter. The silent electrode was attached to the concha.

Action currents were recorded on a magnetic recorder; conclurrently respiration was recorded on the encephalogram and electrocardiograms in the second standard lead. Subsequently, the magnetic recordings were reproduced on the electroencephalograph with an automatic frequency analyzer. The analyzer period constituted 10 seconds, and we averaged the indices over a 1-minute period.

A study was made of the reaction of adopting the rhythms of light flickers in the same brain structures; for this purpose, rhythmic photic stimuli from a photophonostimulator were delivered for 1 minute at 1-minute intervals. The frequency of stimulation was progressively increased from 2 to 24 Hz. The extent to which a rhythm was adopted was assessed by the change in intensity of the corresponding band, as percentage of initial level.

Results and Discussion

Significant changes occur in background bioelectric activity of the brain during exposure to strong SMF. These changes extend to all of the cortical and subcortical structures studied, and they consist primarily of appearance on the electrograms of high-amplitude synchronized discharges the shape of which resembles spindles. The extent, duration and frequency characteristics of these discharges vary in different structures and in different animals. According to the results of automatic analysis, during the discharges there is predominant increase in intensity of beta-1 and beta-2 bands (Figure 1, *1*) or alpha and beta-1 (Figure 1, *2*). The bursts of bioelectric activity could be correlated with faster respiration (Figure 1, *1*). Changes in action currents can be obs-rved in all derivations (Figure 1, *1*, *3*) or only in some of the structures (Figure 1, *2*). We observed considerable variations of individual sensitivity of the animals to SMF. In approximately 25% of the rabbits, there was a very strong reaction to SMF of 3,000-4,000 H. During exposure of the animal to SMF, electrograms of different brain structures (Figure 2, *1*, *2*) revealed regular hypersynchronized activity, mainly referable to alpha and beta-1 rhythm. Against this background we were able to observe periodic increase in amplitude of biopotentials at a frequency of 1/sec.

It is important that the severity of the magnetic effect is related to the animal's general condition. Figure 2, *3*b shows that during exposure to SMF of 3,000 H electrograms of the hypothalamus and optical cortex revealed considerable increase in intensity of beta-1 and beta-2 rhythms. With development of acute hypoxia due to exclusion of artificial respiration (Figure 2, *3*b') there was a decrease in changes in background rhythm due to the magnetic field: sharp decrease in intensify of high frequencies. Concurrently there was development of signs typical of cerebral hypoxia: increased intensity of slow rhythms. There was distinct predominance of theta rhythm in the hypothalamus.

Thus, according to the examples given in Figures 1 and 2, during exposure to strong SMF there is intensification of bioelectric activity of different parts of the brain in the range of alpha and beta frequencies, without appreciable changes in intensity of delta and theta rhythms. The severity of the effects increases with increase in strength of the field.

The correlation between changes in bioelectric activity and force of the field is demonstrated on Figure 3, on the example of frequency analysis of electrograms of the sensorimotor cortex. We see that with increase in strength of SMF from 1,000 to 3,000-4,000 H there is an increase in increment of intensity of alpha and beta-2 rhythms. It is also apparent from the diagram that exposure to an intermittent magnetic field of 100 H at a frequency of 100 Hz (the variable component of a 4,000 H field) does not lead to a perceptible change in intensity of action currents in all ranges analyzed. The latter circumstance indicates that intensification of action currents in the alpha and beta ranges, occurring in a a strong SMF, is unrelated to field pulsation which occurred in our experiments.

Changes in background rhythm of biopotentials occur in the first minute of exposure to SMF, and they usually persist, with some fluctuations, for the entire exposure period. In the course of 60-minute exposure, after an initial peak, there may be weakening of the effect which, in some cases, progresses to the end of the exposure period. The severity and dynamics of changes in different rhythms in the 8-30 Hz range may vary somewhat in different structures of the brain. After turning the electromagnet off, the electrograms assume their usual appearance; within a few minutes the intensity of action currents in the alpha and beta ranges reverts to the initial level.

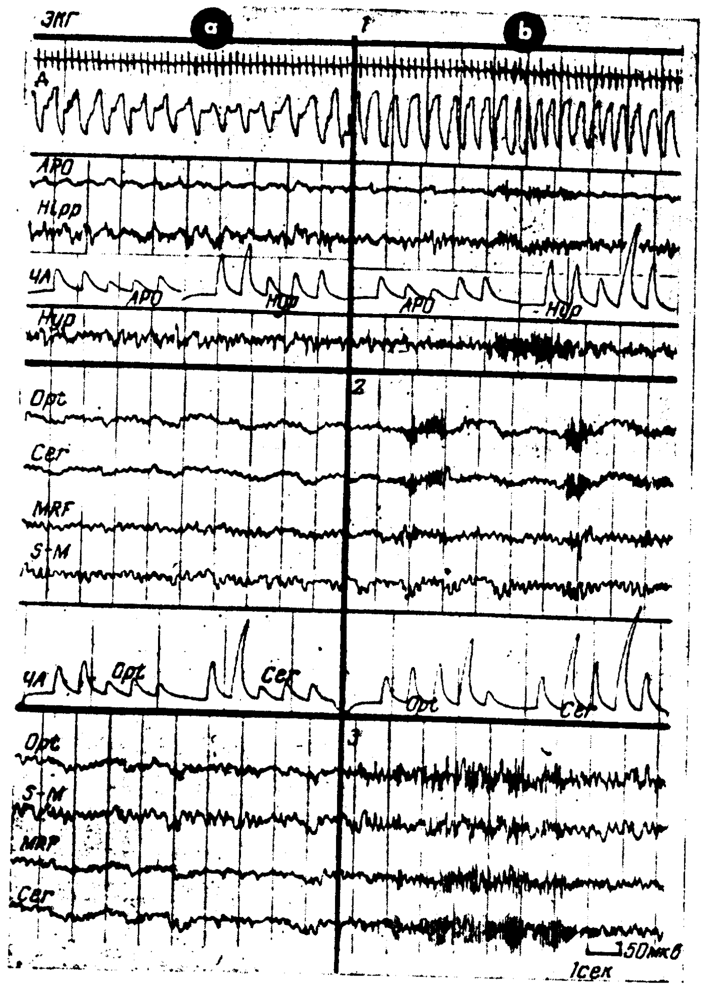

Figure 1. Changes in background bioelectric activity of brain structures exposed to SMF of 1,000 H (3) and 3,000 H (1, 2).

a) before exposure b) during exposure
1-3) fragments of tracings from different experiments on different animals
ЭКГ) electrocardiogram Opt) optical cortex Hyp) hypothalamus
д) respiration Hipp) hippocampus MRF) mesencephalic reticular form.
S-M) sensorimotor cortex APO) preoptic region Cer) cerebellum
ЧА) frequency analyzer tracings, showing two periods of analysis, in each of which delta, theta, alpha, beta-1 and beta-2 ranges are indicated from left to right

Changes in frequency spectrum of electrograms of the rabbit brain under the influence of SMF, 3,000 H

Brain structure	Recording conditions	Voltage of each frequency band, % of total power				
		delta	theta	alpha	beta-1	beta-2
Sensorimotor cortex	Before exposure	23,5±1,2	45,7±1,2	14,1±0,5	11,0±0,4	5,2±0,6
	SMF, 30 min	18,3±1,5*	36,4±4,2*	15,8±2,0	19,6±3,8*	9,0±1,3*
Optical cortex	Before exposure	24,6±1,4	31,1±1,3	15,1±0,5	16,0±0,7	13,3±1,1
	SMF, 30 min	15,7±3,2*	16,4±2,7*	23,5±3,2*	29,9±3,5*	13,7±2,5
Hippocampus	Before exposure	35,4±1,7	33,1±1,8	13,2±0,6	11,3±0,2	6,9±0,9
	SMF, 30 min	27,3±2,7*	32,5±5,3	16,9±3,6	15,7±0,8*	8,2±1,8
Preoptic region	Before exposure	36,7±1,8	28,0±1,6	12,2±0,5	13,3±0,9	9,6±2,3
	SMF, 30 min	25,9±4,7*	23,6±2,7	18,0±5,1	18,7±2,0*	13,7±4,4
Hypothalamus	Before exposure	34,0±1,1	28,1±1,9	12,2±0,3	14,1±0,9	11,1±1,6
	SMF, 30 min	21,7±3,7*	23,2±3,9	19,1±3,4*	22,5±3,4*	13,4±3,0
Reticular formation of mesencephalon	Before exposure	23,9±1,3	42,7±2,2	13,5±0,4	10,9±0,6	8,5±1,6
	SMF, 30 min	17,5±3,0*	29,5±4,9*	18,4±3,7	23,4±4,8*	10,7±1,5
Cortex of vermis cerebelli	Before exposure	24,4±1,2	35,2±1,8	12,1±0,6	14,2±1,3	14,0±2,0
	SMF, 30 min	15,0±2,9*	24,8±4,3*	20,8±3,2*	26,9±4,9*	12,4±2,3

*Deviation from initial level is reliable with P<0.05

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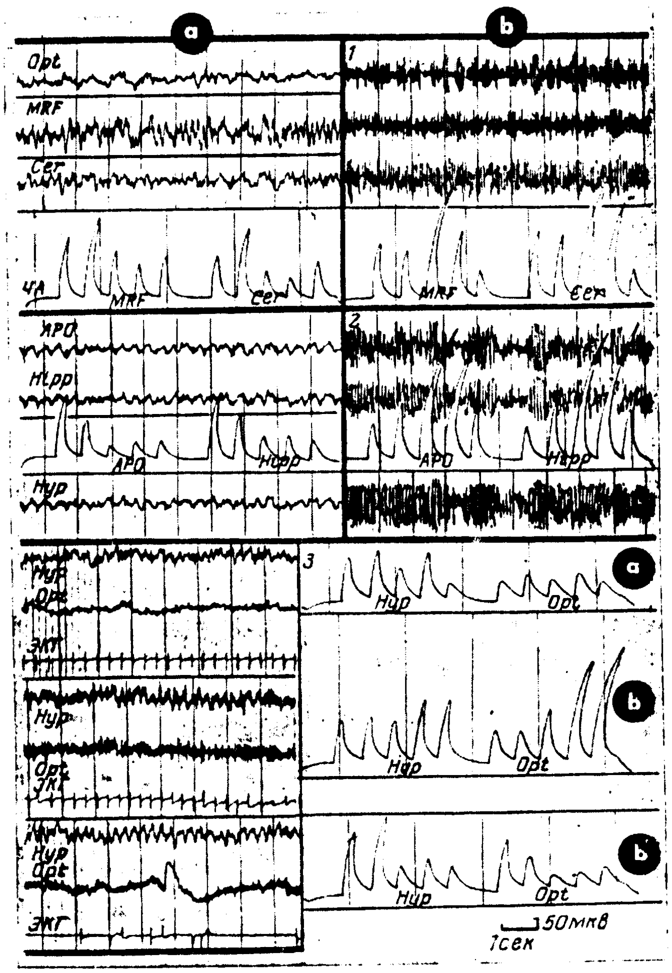

Figure 2. Change in background bioelectric activity of different brain structures exposed to 3,000 H SMF.

a) before exposure
b) during exposure
b') exposure with excluded respiration
1-3) fragments of tracings from different experiments on different animals

Other designations are the same as in Figure 1.

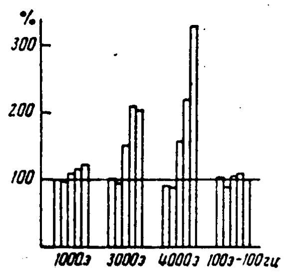

Figure 3.
Change in intensity of action currents of sensorimotor region in 2d minute of exposure to SMF varying in force. Mean data on 5 rabbits for each strength of SMF. Vertical axis, changes as percentage of initial level. Columns: five successive frequency ranges: delta, theta, alpha, beta-1 and beta-2

The increase in intensity of action currents in the alpha and beta ranges leads to an increase in overall voltage and reorganization of the frequency spectrum of the brain electrograms. Thus, with exposure to 3,000 H SMF there is a mean 115-130% increase in voltage of electrograms of the sensorimotor cortex, hippocampus, preoptic region and mesencephalic reticular formation, while that of electrograms of the optical cortex, hypothalamus and cerebellar cortex even increases to 150-170% of the initial level.

We detected a shift in spectrum of bioelectric activity, in the direction of higher frequencies (see Table) in all of the structures examined. Electrograms of all structures demonstrated a reliable decrease in percentage of delta waves. In addition, there was a drop in percentage of theta waves on electrograms of the cerebral cortex, reticular formation and cerebellar cortex. At the same time, there was an increase in voltage of faster oscillations. Electrograms of all structures examined showed a significant increase in percentage of beta-1 waves. Alpha rhythm content increased in electrograms of the visual cortex, hypothalamus and cerebellum. A distinct tendency toward an increase in beta-2 waves was demonstrable in electrograms of all structures with the exception of the visual cortex and cerebellum.

It is important to determine the extent to which a change in frequency characteristics of bioelectric activity of the brain affects its functional state. For this purpose, we studied the driving responses to rhythms of light flickers in ascending frequency prior to exposure to SMF, in the 30th minute of exposure of the animal to a 1,000 or 3,000 H field, and 10 minutes after turning the electromagnet off. Following responses were also studied in rabbits exposed to 1,000 H SMF for 24 hours, 30 minutes after prolonged exposure and in a control experiment.

During exposure to 1,000 H SMF, a significant increment of intensity of action currents in the alpha and beta ranges was noted in some animals, and it did not exceed a mean of 25-50%. Against this background, we observed distinct persistence of photic following responses. In some rabbits, most often when the initial magnitude of the reaction was low, we were able to detect improvement thereof. This applied to different structures of the brain, and it was manifested both by intensification of the response to different flicker frequencies and broadening of the range of driving rhythms. The same tendency persisted after turning the electromagnet off, with virtually complete normalization of background activity. We also observed signs of intensification of the driving response after 24-hour exposure to 1,000 H SMF (Figure 4).

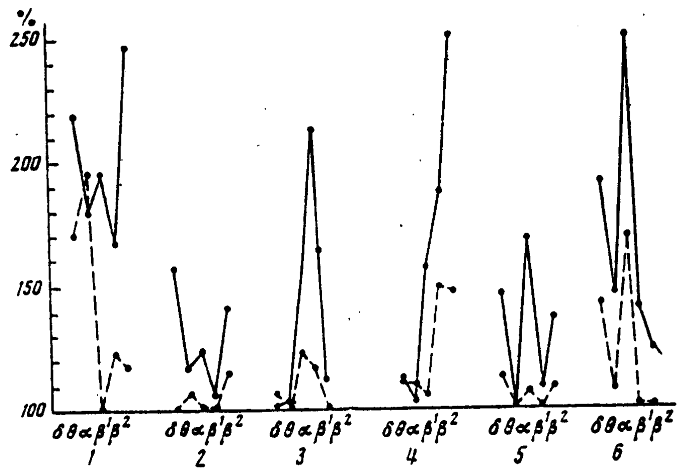

Figure 4. Effect of 1,000 H SMF on following response to light flickers (individual data). Ordinate axis, change in intensity of corresponding bands, % of initial level. On all graphs, the dotted lines refer to the control and solid lines to exposure (1-3) and after 24-hour exposure (4-6).

1) visual cortex
2,5) hippocampus
3) reticular formation of mesencephalon
4) sensorimotor region
5) preoptic region

Opposite changes in the following response were observed during exposure to 3,000 H SMF. Figure 5 shows marked weakening of light flicker following response, particularly at frequences of 12, 18 and 24 Hz. Let us recall that there was a sharp increase in intensity of these frequency ranges in the background rhythm with exposure to 3,000 H SMF.

After termination of SMF exposure there is restoration of background rhythm of action currents and of magnitude of driving response.

Thus, total body exposure to 1,000 H SMF elicits in rabbits a shift in the spectrum of background bioelectric activity of cortical and subcortical structures of the brain, in the direction of higher frequencies and somewhat better following of imposed rhythms. These phenomena may be interpreted as signs of prevalence of excitatory processes in central nerve structures and

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increased lability thereof. Typically enough, in different animals the magnitude of the reaction of SMF varied over a wide range, from negligible to rather marked.

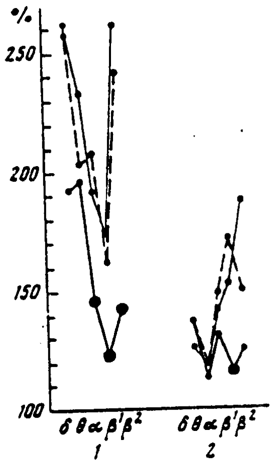

Figure 5.
Effect of 3,000 H SMF on photic following response (mean data). Ordinate axis, same as in Figure 4. Dotted line, control; boldface line, during exposure; thin line, after exposure; boldface dots, reliable differences from control
1) visual cortex
2) reticular formation of mesencephalon

With 3,000-4,000 H SMF, we observed a significant shift of the spectrum of bioelectric activity in the directi-n of high frequencies. In some animals, electrograms of the brain began to show regular high-amplitude hypersynchronized activity, mainly in the range of 13-20 Hz. Evidently, the nature of changes in background rhythm remains the same even with further increase in strength of SMF. There are data indicative of an increased frequency and amplitude of EEG rhythms in squirrel monkeys exposed to total body SMF, at 70,000 H [6]. It may be assumed that the poorer following response with exposure to 3,000 H SMF, which we observed, is due to involvement of a large number of nerve elements in synchronized activity, rather than a reflection of serious functional disturbances. We base this on the rapid recovery of the reaction after turning the electromagnet off.

The results of our experiments did not enable us to demonstrate appreciable differences in sensitivity of different parts of the brain to SMF. The CNS reaction of strong SMF was generalized, and the time of appearance and severity of changes in background rhythm were about the same in all brain structures studied.

At this time, we do not have any data that would enable us to explain the origin of the shift in frequency spectrum of bioelectric activity of the brain when animals are exposed to SMF. There are considerable grounds to believe that the changes in bioelectric activity are due to the direct effect of SMF on brain tissue elements. Some convincing data to confirm this were obtained in experiments on an isolated strip of cortex [2]. It is difficult to interpret the results obtained because we still have virtually no substantiated hypothesis to explain the mechanism of biological effects of SMF. According to some theoretical assumptions, the effects of SMF of the order of 10^4 H on electrogenesis (shifting of transmembrane flux of ions, influence of electromotive force of induction on depolarization and repolarization processes, and others) in some nerve elements are negligible per se, and they are virtually immeasurable; however, in the case of functioning of complexly organized nervous structures, they may multiply and lead to significant neurophysiological effects [7].

Conclusions

1. Total body exposure to 1,000-4,000 H SMF elicits in rabbits a change in background bioelectric activity of cortical and subcortical structures of the brain, consisting of increased intensity of action currents in the range of 8-30 Hz without appreciable changes in slower rhythms. The effect increases with increase in SMF strength within the range used in our experiments.

2. With 1,000 H SMF, we observe a tendency toward improved light flicker following response which persists as well in the aftereffect period. At 3,000 H SMF, we found a weakening of rhythm following response. This response is rapidly restored after discontinuing exposure.

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SOME ASPECTS OF ETIOLOGICAL DIAGNOSTICS OF OCCUPATIONAL DISEASES AS RELATED TO THE EFFECTS OF MICROWAVE RADIATION

Moscow GIGIYENA TRUDA I PROFESSIONAL'NYYE ZABOLEVANIYA in Russian No 3,1976 pp 14-17

[Article by A. K. Gus'kova and Ye. M. Kochanova (Moscow), Institute of Industrial Hygiene and Occupational Pathology, USSR Academy of Medical Sciences, submitted 13 Sep 1975]

[Text] One of the industrial factors, the effects of which on the cardiovascular system are reflected, according to the results of some studies of recent years, in the incidence of cardiovascular disease, is microwave radiation (B. V. Il'inskiy et al.; V. P. Medvedev). It is very difficult to make etiological diagnoses of pathology of the circulatory system in the group of workers dealing with sources of superhigh frequency radiation, whether it involves tuning radio equipment or work as operators of radar stations, since such work requires a high degree of nervous and emotional tension and involves other deleterious factors.

According to the data of different authors, the changes in activity of the cardiovascular system occurring in individuals working with sources of microwave radiation form the syndrome of neurocirculatory dystonia of the hypotensive or hypertensive type (Ye. V. Gembitskiy; N. V. Tyagin; K. V. Glotova and M. N. Sadcnikova), and they could lead to development of essential hypertension and cardiac ischemia (B. V. Il'inskiy et al.; V. P. Medvedev).

If we compare the data over a period of several years pertaining to the incidence of arterial hypertension and hypotension among those working with SHF [superhigh frequency] radiation, we can see that there was been a perceptible decline in incidence of arterial hypotension in the last few years, from 38% according to 1948 data (A. A. Kevorkyan) to 7%, according to 1971 data (M. N. Sadchikova and K. V. Nikonova). The higher incidence of arterial hypotension, according to the results of examining workers exposed to the most deleterious conditions in 1948-1964 (22% according to Yu. A. Osipov, 26% according to N. M. Konchalovskaya et al.), when safety devices were not adequately used, is indicative of the significant probability of a link between neurocirculatory hypotension and microwave radiation. As for arterial hypertension, the incidence thereof has been increasing in the last few years among those exposed to UHF ration: 5.8-7.6% according to 1963-1964 publications, and 28% according to those of 1971-1972. In spite of the fact that many investigators do not indicate the criteria they used to assess high arterial pressure, on the whole the incidence of hypertension with chronic exposure to SHF fields coincides, according to the results of studies pursued in 1970-1972, with the findings of a screening of the nonorganized population of Moscow and use of WHO criteria (V. I. Metelitsa): 28% in males 35-64 years of age.

Table 1. Occurrence of the five main risk factors and their influence on incidence of cardiac ischemia

Risk factor	Occurrence %	Occurrence mean age (years)	Occurrence Criteria	Increased risk of cardiac ischemia
Hypercholesterolemia	23 or more	35-64	Over 259 mg%	2.2-5.5 times greater, firmly established
Arterial hypertension	28	35-64	Arterial pressure, 140 mm Hg or higher systolic, 90 mm Hg or higher diastolic	1.5-6 times greater, firmly established
Smoking	50	30-64	Regular smoking	1.5-6.5 times greater, firmly established
Inactive life style	--	---	---	1.4-4.4 times greater, inadequately investigated
Obesity	22	35-64	9 kg above average weight	1.3-3.4 times greater, poorly documented

The wide distribution of functional cardiopathies is indicative of a need for comprehensive analysis of each specific case of determining the occupational etiology of a cardiovascular disease.

At the present time, there has been comprehensive investigation of so-called risk factors in development of essential hypertension and cardiac ischemia.

The occurrence of the five main risk factors and their involvement in development of cardiac ischemia are shown in Table 1, which we took from the works of V. I. Metelitsa.

In addition to those listed in Table 1, the following are proven risk factors in development of cardiac ischemia: genetic, emotional stress, psychological personality factors that determine an individual's reactivity to environmental conditions, etc.

The objective of our work was to make a comprehensive analysis of the possible risk factors in development of cardiovascular pathology in 21 patients with the diagnosis of radiowave disease.

The patients were hospitalized a second time in 1973-1974. All of the subjects had previously worked under adverse conditions, with exposure to radiation in excess of the permissible level. By the time they were rehospitalized, 2-3 years had elapsed after discontinuing work involving radiation. All of the subjects were men ranging in age from 35 to 54 years; most (19) were 40 to 54 years old and had been in contact with radiation for over 10 years.

Table 2. Quantitative distribution of some deleterious factors, with reference to development of cardiovascular disease, in 21 patients with the diagnosis of microwave sickness

Factors	Number of patients related to the factor
Nervous and emotional stress	14
Combining work with studies	4
Night shifts	17
Regular smoking	7
Moderate drinking	7
Hereditary burden	5
History of skull trauma	3
Obesity	5
Hypercholesterolemia	12
Arterial hypertension	10

The following cardiovascular diseases were demonstrated on the basis of general clinical diagnostic criteria: neurocirculatory dystonia of the hypertensive type in 7 cases; essential hypertension in 10; cardiac ischemia in 2; hypothalamic deficiency in 2. According to our findings individuals 40-49 years of age are the most susceptible to these diseases.

An interval of 2-3 years after discontinuing contact with radiation did not lead to a perceptible change in course of cardiovascular disease in any of the subjects. It was possible to normalize high arterial pressure (over 160/100 mm Hg) in the clinic only by means of complex hypotensive therapy in the cases of essential hypertension. In three cases, in spite of therapy, hypertensive crises developed in the clinic, with transient signs of impaired cerebral circulation.

During the examination, two patients with cardiac ischemia reported pain in the region of the heart and retrosternally, with irradiation under the left scapula and left arm, which was curbed by validol or nitroglycerin. Electrocardiographic examination of these patients revealed changes of the 4-1, 4-2, 5-1 and 5-2 type, according to the Minnesota code, which are typical for cardiac ischemia.

Table 2 shows that nervous and emotional stress, and bad habits were the main exogenous risk factors in the 21 patients with the diagnosis of radiowave sickness. Hypercholesterolemia, arterial hypertension, obesity and hereditary burden were the most common endogenous factors.

Table 3 illustrates combinations of different risk factors in 10 patients with arterial hypertension, with the diagnosis of radiowave sickness. In 5 out of the 10 cases, we observed a combination of at least 3 deleterious factors, and in the other 5 there were 4 to 6 risk factors. Thus, all of the usual risk factors retain their significance in onset of cardiovascular pathology in these 10 cases.

Table 3. Occurrence of deleterious factors in 10 patients with arterial hypertension and the diagnosis of radiowave sickness

Name of patient	Age group (years)	Nervous & emotional stress	Work + studies	Night shifts	Heredit. burden	Skull trauma	Obesity	Hypercholesterolemia
Zhad-v	35-39(37)	+	+		+			+
R-k		+	+	+			+	+
A-n		+		+				+
Zh-v	40-44	+		+				+
Chev-ov		+	+	+	+	+	+	
Chi-ov		+		+		+		+
T-n	45-49	+		+	+			
Vl-v		+		+				+
T-ko	50-54	+		+				+
Sh-v		+		+		+	+	+

For this reason, when diagnosing cardiovascular pathology in individuals exposed to UHF, in addition to assessing working conditions, the general rules should be followed in analyzing etiological and pathogenetic causes. In each case, it is also imperative to take into consideration such very frequently encountered causes of cardiopathy as changes in the cervicothoracic spine, intercostal neuralgia, cardiospasm, spastic or atonic colonopathy. When investigating working conditions, this should not be limited to demonstration of of a high level of UHF fields; one must also pay attention to the extent of nervous and emotional stress, combination of work and studies, working in night shifts.

As for the effects of microwave radiation on onset of cardiovascular pathology, in our opinion it may take a certain place among other deleterious factors. However, for the time being there is no reason to relate development of disease to it alone. This question can be definitively answered only on the basis of the result of well-organized epidemiological screening of the relevant groups, with investigation of the incidence among them of proven risk factors.

The results of such an investigation, in conjunction with information concerning the incidence of such disease in the nonorganized population, will help single out the role of microwave radiation as a more or less significant etiological factor in development of cardiovascular pathology.

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EFFECTS OF THE SHF FIELD OF SMALL INTENSITY ON THE STATE OF THE CARDIOVASCULAR AND RESPIRATORY SYSTEMS

Kiev VRACHEBNOYE DELO in Russian No 4, Apr 76 pp 131-132

[Article by M. I. Rudnev, S. I. Nozdrachev, and N. Ye. Tarasyuk, Laboratory of Biological and Hygienic Studies (director -- M. I. Rudnev, doctor of medical sciences) of the Kiev Scientific Research Institute of General and Social Hygiene]

[Text] Under modern conditions, human life is closely connected with a complex of external physical factors among which electromagnetic fields occupy an important place (modern living and industrial conditions, development of new territories, space explorations, etc). Their parameters sometimes reach very high values (in relation to adequate values to which human beings and animals have become accustomed in the course of their evolutionary development) and can cause functional shifts which, in many cases, can develop into pathological states.

It is quite obvious that not only people working with irradiation sources, but also those who are relatively far from them, are exposed to irradiation. The latter group of the population includes many people with accompanying chronic diseases. Therefore, it was of particular interest to study the reaction of the organisms against the background of hypertension, as the most frequent pathological state.

The experiments were conducted on four groups of rats, 10 animals in each. The first group consisted of intact animals and served as the control group. Renal hypertension was induced in the animals of the second group by means of ischemization of the kidneys. The third group of animals was irradiated with a superhigh frequency field of a moving permanent magnet of 50 microwatt/cm^2 for 7 hours daily for 10 days. The fourth group of animals, after the ischemization of the kidneys, was exposed to a superhigh frequency field of a moving permanent magnet of 50 microwatt/cm^2 for 7 hours daily for 10 days. Studies were done on the electrocardiogram and on the frequency of cardiac contractions and respiratory movements. The indexes were recorded on an ink-recording electroencephalograph 4 EEG-3. The frequency of respiratory movements was measured by recording a pneumogram on an encephalograph.

For this purpose a cuff was placed on the thorax of the animal and changes were recorded in the resistance of the sensor caused by its lengthening or shortening during inhalation and exhalation of the animal. The source of the microwave superhigh frequency field was "LUCh-58". The data of the indexes are shown in the table.

Table

Группы животных (1)	Частота сердечных сокращений (в мин) (2)	Амплитуда зубца QRS электрокардиограммы (мкв) (3)	Частота дыхательных движений (в минуту) (4)
(5) Первая (контр.)	491±15	95±18,5	88±5
(6) Вторая	489±10	70±8,5	86±4,2
$P_{2,1}$	>0,05	>0,05	>0,05
(7) Третья	509±20	73±10,7	97±6,1
$P_{3,1}$	>0,05	>0,05	>0,05
(8) Четвертая	475±15	90±14,5	122±10,1
$P_{4,1}$	>0,05	>0,05	<0,05
$P_{4,2}$	>0,05	>0,05	<0,05
$P_{4,3}$	>0,05	>0,05	<0,05

Key: 1. Groups of animals
2. Frequency of cardiac contractions (in minutes)
3. Amplitude of QRS wave of the electrocardiogram (microvolts)
4. Frequency of respiratory movements (per minute)
5. First (control)
6. Second
7. Third
8. Fourth

As can be seen from the data given in the table, there are sharp changes in the frequency of respiratory movements in the animals of the fourth group. A sick organism reacts by a considerable increase in the frequency of respiratory movements (changes are certain) in comparison with the irradiated healthy rats (third group), whose repiration rate is close to that of the control group.

The results of the study indicate that the healthy and the diseased organisms show different responses to the effect of superhigh frequency energy of the same levels and duration.

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