be restored.

Conclusion. Thus, the results of the SEM study obtained by us indicate that the forms of erythrocytes in persons who died from various causes differ, namely, during overcooling - erythrocytes take echinocytic form, and when wounded - acanthocytic. This fact gives us the opportunity to assume that the process of dying during hypothermia has its own characteristics. It is necessary to further in-depth study of this pathology at the molecular-cellular level to find solutions to restore the body’s vital activity in the first days after death from hypothermia.

References

1. Alekseev R.Z., Tomskij M.I., Gol’derova A.S. [et al.] Preduprezhdenie razvitiya nekroza pri otmorozheniyah s oledeneniem tkanej [Prevention of the development of necrosis during frostbite with icing of tissues] Mezhdunarodnyj zhurnal prikladnyh i fundamental’nyh issledovanij [International Journal of Applied and Fundamental Research.], 2015, V. 8-1. pp. 35-41.

2. Maksimov G.V., Mamaeva S.N., Antonov S.R. [et al.] Izmerenie morfologii ehritrocitov metodom ehlektronnoj mikroskopii dlya diagnostiki gematurii [Measurement of erythrocyte morphology by electron microscopy for the diagnosis of hematuria]. Metrologiya. Ezhekvartal’noe prilozhenie k Z. Izmeritel’naya tekhnika. [Metrology. Quarterlyannexto J. Measuringequipment], 2016, V.1, pp. 47-52.

3. Foglia A. The Acanthocyte-Echinocyte differential. Swiss Medical Weekly, 2010, V.140 (03-04). pp. 1-3; DOI:https://doi.org/10.4414/smw.2010.12963

4. Bosman G.J. Erythrocyte membrane abnormalities in neuroacanthocytosis. Evidence for a neuron-erythrocyte axis? / G.J Bosman., M.W. Horstink, W.J. De Grip // Neuroacanthocytosis Syndromes. Springer Verlag, 2005, pp.153–159.

5. Acanthocyteset hypercholesterolemia / J Perrin, A Georges, A Morali, [et al.] // Ann Biolo Clin., 2008, V.66 (5), P. 56972.

6. Reinhart W.H. Red Cell Rheology in Stomatocyte-Echinocyte Transformation: Roles of Cell Geometry and Cell Shape. / W.H. Reinhart, S.Chien // Blood., 1986, V.4. pp. 1110–1118.

7. Wong P.A. Basis of Echinocytosis and Stomatocytosis in the Disc-sphere Transformations of the Erythrocyte. J Theor Biol., 1999, V.196(3), pp. 343–361. DOI:10,1006 / jtbi.1998.0845

8.Mrowietz C, Hiebl B, Franke RP, et al. Reversibility of Echinocyte Formation after Contact of erythrocytes with various Radiographic Contrast Media. Clin. Hemorheol. Microcirc., 2008, V.39(1–4), pp. 281–286.

9. Schwarz S, Deuticke B, Haest CW. Passive Transmembrane Redistributions of Phospholipids as a Determinant of Erythrocyte Shape Change. Studieson Electroporated Cells .Mol. Membr. Biol., 1999, V.16(3), pp. 247–55.

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GAMMA BACKGROUND ENVIRONMENT DURING MAGNETIC STORMS AND THE CONTENTS OF SODIUM AND POTASSIUM IN ERYTHROCYTES IN PATIENTS WITH ARTERIAL HYPERTENSION DEPENDING ON THE TEMPERAMENT AND ANTIHYPERTENSIVE THERAPY

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ABSTRACT

Arterial hypertension is one of the major independent risk factors for complications of cardiovascular diseases, stroke, myocardial infarction, acute and chronic heart failure. In the structure of cardiovascular diseases arterial hypertension occupies the first position in disability and mortality of the working population. In recent years, this contributes to the growth of psycho-emotional stress, anxiety and depression. Periods of sharp changes heliometeofactors also combined with an increase in the proportion of individuals with complications of hypertension.

Thus, in the period of magnetic storms, there was an increase in gamma radiation power (within the regional norm), an increase in the degree of psycho-emotional stress and a change in the concentration of electrolytes in the blood of both healthy and persons with cardiovascular disease. The aim of the study was to establish the relationship between the dynamics of γ-background of the environment during magnetic storms and the content of potassium and sodium in red blood cells in patients with hypertension with different temperament and anxiety, taking options for antihypertensive therapy: targeted and not targeted (empirical) on the blockade of psychosomatic characteristics of patients, as well as to determine the most effective treatment option. The prevailing temperament – choleric, sanguine, phlegmatic and melancholy – was determined using the psychological test of John Eysenck and A. Belov, the presence and severity of depression – Je. Ahmetzhanov psychological tests. Potassium and sodium content in erythrocytes was determined by ion-selective method. The gamma background of the medium was measured using the dosimeter «Master».

It was found that the decrease in the activity of the sympathetic Department of the autonomic nervous system and the hypothalamic-pituitary-adrenal system (cortisol), and the increase in the activity of the renin-angiotensin-aldosterone system (aldosterone) in the temperamental series of choleric – sanguine – phlegmatic – melancholy was combined with a decrease in the level of oxygen utilization by tissues and potassium content in erythrocytes and an increase in sodium content in both healthy and patients. Compared with the empirical version of antihypertensive therapy, against the background of a targeted treatment option, the period of return of the values of the studied parameters, the level of oxygen utilization by tissues, the content of potassium and sodium in erythrocytes, as well as the degree of reaction of the body (according to the correlation analysis) were practically the same as in healthy individuals of the corresponding temperament, which indicates in favor of a higher efficiency of the treatment option targeted at the relief of psychosomatic features of the patient.

Keywords: hypertension, solar activity, γ-background, erythrocytes, potassium, sodium, correlation.

Introduction. Arterial hypertension (AH) is one of the major independent risk factors for development of complications of cardiovascular diseases [11, 13, 14]. Psychoemotional tension, anxiety and depression contribute to an increase in the proportion of people with AH complications in the modern world [1, 11]. The course of AH is closely related to sodium accumulation and potassium decrease in blood [13,14]. Periods of increased solar activity (SA) are also combined with changes in the electrolyte composition, rheological properties of blood and an increase in the proportion of persons with complications of hypertension [4, 5, 6, 16]. Studies have shown that magnetic storms (MS), as a consequence of changes in CA, are combined with changes in the concentration of electrolytes, as well as the trace element composition of blood (potassium, sodium, magnesium) in healthy and hypertensive patients [4, 5, 16]. However, no studies have been found on the relationship between the γ-background of the external environment in the MS period and the potassium and sodium content in erythrocytes (Er) in people taking different variants of antihypertensive therapy (AHT).

Material and methods of research. In the period from 1995 to 2017, 848 engineering and technical workers of men aged 44-62 years (average 54±1,8 years) were examined in the polyclinic, who were diagnosed with stage II hypertension (GB-II, degree 2, risk 3) in the cardiology Department. The disease duration averaged 11,6±1,4 years. The presence of essential hypertension was determined by the criteria set out in [13, 14]. 422 healthy men, compatible on the main anthropo-social indicators, served as control. The prevailing temperament – choleric (Ch) sanguine (Sg), phlegmatic (Ph) and melancholic (M) was measured using a psychological test [15] by 3 times testing before treatment (0) and after 3, 6, 9 and 12 months of AHT. The magnitude of reactive and personal anxiety was determined by [17]. Persons who scored 32,0±0,6 points, to high-anxiety (HA) from 42,8 ±0,4 points and above are referred to low-anxiety (LA).

The contents of potassium and sodium (mmol/l) in er were determined by ion-selective method on the apparatus "RAPIDLAB-865" (Bayer, UK) [8].

To determine the coefficient of utilization of oxygen by tissues (CUOT, %) account for the voltage of the oxygen (O_2) in the blood (venous and venous arterialization) (pO_2, mm Hg. art.) according to the approved and approved procedure [8], as well as saturation (saturation) of hemoglobin (Hb) with oxygen (SaO_2,%), which was determined using the blood gas analyzer "STAT PROFILE. pHOx". The content of Hb (g/l) was determined by hemoglobincyanide method on the device CFC-2 [8]. The content of O_2 in the blood (CaO_2) was calculated with the formula:

$CaO_2 = 1.34 \times Hb \times SaO_2 /100 + pO_2$, mm Hg. art. x 0.0031,

where CaO_2 – oxygen content in the blood (in 1 ml per 100 ml); 1,34 – Hufner constant; Hb – hemoglobin content in the blood (in g per 100 ml); SaO_2,% – saturation of Hb with oxygen (in %); pO_2 – oxygen tension in the blood (in mm Hg. art.); 0,0031 – the coefficient of oxygen solubility according to Bunsen [8].

Blood sampling was performed from the cubital vein (in dry test tube without preservative) in the morning, fasting, before treatment. The calibration curve was obtained by measuring the optical density of standard sodium nitrate solutions with a concentration of 5 to 320 μmol. All studies were conducted from 8.00 am to 10.00 am, on an empty stomach, before taking AHT.

Features of antihypertensive therapy. According to the method of Je.R. Akhmetzhanov [2] mild depression was observed only in high-anxiety phlegmatics (HA/Ph) and melancholy (HA/M). According to the conclusion of psychoneurologists they did not need inpatient treatment. Perfectionism choleric (HA/Ch) and sanguine (HA/Sg) received anxiolytic that 96% sibazon 2.5 mg in the morning and at night and HA/Ph and HA/M antidepressant that 96% coaxil 12.5 mg in the morning and at night (in 4% of cases the zoloft at 25 mg/day), except lowanxiety individuals [12]. Studies conducted by us using the criteria set out in [3] showed the prevalence of sympathetic (SNS) Department of the autonomic nervous system (ANS) and hypothalamic-pituitary-adrenal system (GGNS, cortisol) in Ch and Sg, and parasympathetic (PSNS) Department of ANS with predominant activity of the renin-angiotensin-aldosterone system (RAAS, aldosterone) in Ph and M persons. Based on the differences above, AHT included drugs that have been approved by order No. 254 of the health Ministry of Russia dated 22.11.2004 «On approval of the standard of care for patients with arterial hypertension» [7, 12]: selective beta-adrenoblockers (β-AB), angiotensin converting enzyme inhibitors (aceis), diuretics (hydrochlorothiazide), cardiomagnyl. From β-AB patients in 96% of cases received metoprolol 200 mg/day (4% of its analogues), and LA/Ch and LA/Sg 100 mg/day) and hydrochlorothiazide: HA/Ch and HA/Sg 25 mg/day, and LA 12,5 mg/day. Of aceis patients in 96% of cases took enalapril 20 mg/day (in 4% of cases its analogues) + veroshpiron 100–200 mg/day (in 75% of cases), rarely (25%) and hydrochlorothiazide 25 mg/day, because the content of potassium in the blood have been lower than those of Ch and Sg. LA/Ph and LA/M were administered enalapril 10 mg/day + hydrochlorothiazide (hydrochlorothiazide) – 12,5 mg/day. All patients received Panangin 2 tab./day and cardiomagnyl on 1 tab./day. Since Ch and Sg patients differed from Ph and M patients PSNS Department of VNS, as well as the activity of the hypothalamic-pituitary-adrenal system (GGNS cortisol), they were prescribed in 96% of cases of β-AB + hypothyazid. Patients with phlegmatics and melancholy differed from h and with the prevalence of PSNS of the VNS Department and the predominant activity of the renin-angiotensin-aldosterone system (RAAS by aldosterone). In this regard, the latter was appointed in 96% of cases of ACEI + veroshpiron. All other treatment options are called empirical (EAHT). In order to exclude the installation (on the result) attitude to the study, the authors did not appoint AHT, but only determined the

temperament, anxiety and the presence of the accepted variant of AHT. The above variant of CAHT was successfully tested during vascular wall remodeling in patients with arterial hypertension [10].

The values of γ-background power (μr/h) were obtained daily by measuring γ-background of workplaces (20 measurements, dosimeter «Master») from 8.00 to 10.00 and compared with the data of the Department of ionospheric-magnetic forecasting of the West Siberian Department of Hydrometeorology and environmental monitoring (Novosibirsk). Variations of γ-background power from 1995 to 2017 (7,6-16,8±0,4 μr/h) did not exceed the permissible regional values.

The method of superimposed epochs was used in the work [9], which takes into account the days before the magnetic storm (-), in the period (0) and after the MB (+): -7 -6 -5 -4 -3 -2 -1 - 0 - +1 +2 +3 +4 +5 +6- +7 accordingly. The results were processed by methods of variation statistics (m±m) using a standard software package "Statistica 7.0" and parametric student t–test, as well as the calculation of the correlation coefficient (r) Pearson. Values at p<0,05 were considered statistically significant. The study was carried out in compliance with the provisions of the Helsinki Declaration on treatment and examination of people and approved by the ethics Committee of the Novosibirsk state medical University on 20.11.2009, Protocol No. 18.

Results and discussion. The data obtained during the study period showed that oxygen utilization by tissues (according to COUT) and potassium content in Er significantly decreased, and sodium concentration increased in the temperamental series HA(LA) Ch > Sg > Ph > M (according to CUOT and potassium) and HA(LA) Ch < Sg < Ph < M (according to sodium) (table. 1 – 3). Thus, in Er HA(LA) of the melancholic content of sodium was higher and potassium lower than that of others. Of the many factors that affect the utilization of oxygen and the content of electrolytes, the observed differences can be linked to the prevalence of the activity of the RAAS (aldosterone) and the parasympathetic section of VNS (index Kerdo and initial vegetative tonus) in the Ph and M compared with Sg and with individuals. The study showed a significant increase in the γ-background of the medium (within the regional norm) for the day (-1) before, and a return to the initial values on the (+4) day from the beginning of MS (table. 1). In the period of magnetic storms in healthy individuals and against any variant of AHT, all patients showed a significant decrease in the value of CUOT (%) and potassium content, but an increase in the concentration of sodium in er. In the groups of HA (LA) choleric these changes were recorded per day (-1), in the groups of HA (LA) sanguine in the first (0) day, and in the groups of HA (LA) phlegmatic and melancholic on the second day (+1) from the beginning of MS (table. 1). In the context of the above, we note that ionizing radiation, including γ-rays, contribute to the ionization and excitation of atoms and molecules, as well as the radiolysis of water to form active forms of oxygen. The consequence of oxidative stress is an increase in the permeability of cell membranes for electrolytes and a number of enzymes. The fact that the changes in Ch-individuals occurred a day before MS is consistent with the results of the study [18], which found an increase in γ-background of the medium a day before MS and is associated with an increase in the

Table 1

Dynamics of γ-background (ur/h) and the coefficient of utilization of oxygen by tissues (%) in HA individuals on the background of EAHT (E) and CAHT(C) in the days of magnetic storms during the study period over the study period from 1995 to 2017

Days		-7–6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	Всего
γ-phone		8.5-8.50± 0.01	8.46±0.01	8.58±0.01	8.41±0.01	8.45±0.01	8.70±0.01	8.78±0.01	8.80±0.01	8.65±0.01	8.70± 0.01	8.59±0.01	8.47±0.01	8.62±0.01	8.49±0.01	8.58±0.007
Choleric	E	34.3-34.7±0.06	35.0±0.07	35.2±0.06	35.0±0.05	33.6±0.04	32.1±0.05	31.6±0.06	31.2±0.06	32.3±0.07	32.6±0.06	33.7±0.05	35.2±0.07	35.3±0.07	35.0±0.06	33.8±0.01
		44-45	44	44	48	43	49	48	46	47	44	43	44	43	45	677
	C	36.1-36.5±0.05	36.2±0.06	37.2±0.07	37.0±0.06	36.3±0.07	35.0±0.06	34.8±0.07	34.6±0.06	35.2±0.06	36.3±0.07	37.7±0.06	35.8±0.05	38.0±0.08	35.9±0.07	36.4±0.01
		44-43	44	44	46	45	44	44	44	44	48	43	46	43	44	668
	Zd	37.9-37.0±0.07	37.0±0.06	38.0±0.07	37.1±0.06	37.6±0.07	35.7±0.05	35.5±0.06	36.0±0.07	36.3±0.06	37.9±0.07	37.6±0.06	36.7±0.05	38.2±0.05	36.8±0.06	36.9±0.01
		45-44	45	44	46	44	46	44	45	44	46	44	44	46	46	673
Sanguines	E	33.3-37.4±0.06	36.9±0.05	34.2±0.07	34.0±0.06	32.8±0.07	30.8±0.06	29.3±0.05	29.2±0.08	29.5±0.07	29.6±0.06	29.6±0.05	32.7±0.07	33.8±0.06	33.6±0.06	32.4±0.01
		46-46	44	47	44	43	48	49	44	43	45	43	46	48	47	683
	C	34.7-34.3±0.07	34.2±0.06	35.4±0.07	35.6±0.06	35.4±0.03	35.1±0.05	33.6±0.06	32.9±0.05	35.3±0.04	33.8±0.04	33.9±0.07	34.9±0.07	37.6±0.06	36.8±0.06	34.9±0.01
		44-46	47	43	44	43	47	48	50	47	44	48	48	45	47	691
	Zd	36.5-35.5±0.06	35.6±0.06	36.7±0.05	36.4±0.06	36.6±0.05	36.6±0.06	34.4±0.06	33.9±0.06	33.7±0.06	33.8±0.06	37.0±0.06	35.6±0.07	38.6±0.05	37.0±0.08	35.8±0.01
		48-45	44	48	44	44	46	45	48	46	44	46	48	46	46	688
Phlegmatic	E	32.5-32.7±0.07	32.9±0.05	32.4±0.06	33.0±0.06	32.8±0.05	32.5±0.04	32.3±0.05	28.1±0.06	28.7±0.07	28.8±0.06	28.5±0.07	33.2±0.07	31.7±0.06	33.3±0.05	31.5±0.01
		44-46	45	44	48	48	49	52	54	47	46	49	48	44	48	712
	C	34.4-34.5±0.06	37.5±0.06	33.6±0.05	34.4±0.04	33.6±0.04	34.5±0.07	33.4±0.06	32.4±0.05	31.5±0.06	31.1±0.05	31.3±0.06	33.4±0.05	33.6±0.06	33.8±0.06	33.3±0.01
		44-43	44	46	44	46	46	48	47	49	44	43	44	43	48	679
	Zd	35.6-35.8±0.06	36.0±0.07	35.8±0.06	35.9±0.05	36.0±0.06	35.9±0.05	35.1±0.06	33.8±0.07	33.4±0.05	32.3±0.04	32.7±0.04	34.9±0.04	36.2±0.05	35.0±0.05	34.9±0.01
		49-49	44	46	44	44	45	45	55	49	46	49	49	48	48	714
Melancholic	E	30.6-30.9±0.06	31.0±0.05	31.2±0.07	31.2±0.06	29.9±0.05	28.9±0.04	28.6±0.05	27.6±0.06	27.3±0.06	27.4±0.05	27.0±0.04	27.4±0.06	30.2±0.05	30.9±0.06	29.3±0.01
		44-45	44	43	43	43	44	47	44	43	44	43	44	43	46	661
	C	33.3-35.4±0.07	35.1±0.06	33.4±0.07	33.2±0.05	33.4±0.04	33.2±0.04	32.4±0.06	31.3±0.05	31.2±0.06	30.7±0.07	29.7±0.06	29.8±0.07	32.8±0.06	32.6±0.06	32.5±0.01
		44-43	47	48	45	48	45	48	45	46	44	43	44	46	44	680
	Zd	34.5-34.8±0.05	34.9±0.05	34.7±0.06	35.1±0.06	35.2±0.05	35.0±0.06	35.3±0.05	31.8±0.05	31.7±0.06	32.0±0.05	32.5±0.05	34.5±0.05	35.5±0.06	35.5±0.05	34.2±0.01
		46-45	46	46	44	44	45	48	49	44	46	47	46	46	44	686

Note. Here and further: ZD-healthy persons; the denominator indicates the total number of examined

Table 2

Dynamics of γ-background (ur/h) and the potassium content in erythrocytes (mmol/l) in РФ individuals on the background of EAHT (E) and CAHT(C) in the days of magnetic storms during the study period from 1995 to 2017

Days		-7–6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	Всего
γ-phone		8.5-8.50±0.01	8.46±0.01	8.58±0.01	8.41±0.01	8.45±0.01	8.70±0.01	8.78±0.01	8.80±0.01	8.65±0.01	8.70± 0.01	8.59±0.01	8.47±0.01	8.62±0.01	8.49±0.01	8.58±0.007
Choleric	E	89.7-89.5±0.4 44-45	89.1±0.3 44	88.2±0.3 44	88.6±0.4 48	88.3±0.3 43	84.1±0.3 49	83.5±0.3 48	83.3±0.4 46	84.9±0.3 47	85.2±0.3 44	86.9±0.3 43	89.6±0.4 44	88.2±0.4 43	89.1±0.3 45	87.2±0.1 677
	C	91.1-90.0±0.4 44-43	89.4±0.3 44	91.5±0.4 46	89.6±0.3 44	89.8±0.3 45	89.0±0.4 44	85.5±0.4 46	85.8±0.4 44	87.2±0.4 44	92.2±0.3 48	91.9±0.3 43	91.4±0.3 46	93.4±0.3 43	91.5±0.01 44	90.0±0.1 668
	Zd	91.4-89.9±0.4 45-44	89.3±0.4 45	91.0±0.4 44	89.8±0.4 46	89.4±0.2 44	87.4±0.3 46	86.6±0.4 44	85.9±0.3 45	86.2±0.4 44	91.6±0.4 46	91.2±0.4 44	90.9±0.4 44	92.5±0.3 46	87.9±0.3 46	89.9±0.1 673
Sanguines	E	88.1-88.0±0.4 46-46	88.3±0.3 44	86.8±0.4 47	87.3±0.3 44	87.0±0.4 43	87.1±0.3 48	84.2±0.4 49	82.0±0.5 44	81.7±0.4 43	81.9±0.3 45	84.8±0.4 43	86.8±0.3 46	87.8±0.4 47	88.2±0.3 47	86.0±0.1 682
	C	89.3-88.1±0.4 44-46	88.6±0.4 47	90.2±0.3 43	88.7±0.3 44	88.9±0.4 43	90.9±0.4 45	84.6±0.3 48	84.0±0.2 44	83.4±0.2 46	86.6±0.4 44	91.0±0.4 46	88.6±0.05 48	91.1±0.3 45	88. 5±0.4 46	88.2±0.1 690
	Zd	89.5-88.8±0.4 48-45	88.7±0.5 44	90.1±0.4 48	89.4±0.3 44	88.8±0.05 44	89.0±0.4 45	88.9±0.3 48	84.0±0.4 46	83.8±0.3 44	85.5±0.3 46	89.9±0.3 48	87.9±0.4 46	90.4±0.3 46	88.0±0.4 49	88.2±0.1 691
Phlegmatic	E	86.8-88.4±0.4 44-46	88.0±0.4 45	85.4±0.3 44	86.0±0.4 48	85.8±0.3 48	85.7±0.4 49	85.1±0.3 52	81.9±0.3 54	80.0±0.3 47	80.2±0.3 46	83.0±0.4 49	83.9±0.4 48	84.1±0.04 44	86.0±0.4 48	84.3±0.1 715
	C	89.4-89.0±0.4 44-43	87.7±0.3 44	88.4±0.4 46	87.0±0.3 44	85.8±0.3 46	87.9±0.2 46	85.2±0.4 48	82.7±0.3 47	82.2±0.3 49	82.1±0.5 44	82.9±0.3 43	86.0±0.4 44	89.7±0.4 43	86.3±0.5 48	86.3±0.1 679
	Zd	89.1-88.7±0.4 49-49	89.7±0.4 44	89.7±0.5 46	90.3±0.4 44	90.0±0.4 44	90.2±0.3 45	89.2±0.4 49	86.8±0.4 55	82.5±0.5 49	83.0±0.4 46	85.3±0.5 44	90.4±0.4 49	88.7±0.3 48	90.4±0.4 48	87.9±0.1 708
Melancholic	E	85.5-85.3±0.3 44-45	85.0±0.4 44	84.0±0.3 43	84.6±0.3 44	84.5±0.4 43	84.3±0.3 44	82.3±0.5 47	82.0±0.3 44	81.2±0.3 43	80.0±0.4 44	80.0±0.5 43	82.5±0.4 44	84.5±0.6 43	85.3±0.6 46	83.4±0.1 661
	C	86.7-86.6±0.3 44-43	86.9±0.3 47	87.2±0.3 48	86.7±0.4 45	86.9±0.3 48	87.3±0.4 45	87.0±0.4 48	81.0±0.4 45	81.1±0.3 46	83.0±0.4 44	83.7±0.3 43	86.5±0.4 44	87.6±0.3 46	86.2±0.4 44	85.6±0.1 684
	Zd	86.9-86.2±0.3 46-45	86.0±0.4 46	86.7±0.4 46	86.0±0.3 44	86.2±0.05 44	87.7±0.4 45	86.7±0.3 48	81.6±0.4 49	81.3±0.4 44	81.1±0.3 46	83.3±0.4 47	86.3±0.3 46	87.3±0.4 46	87.1±0.3 44	85.4±0.2 686

Table 3

Dynamics of γ-background (ur/h) and the content of sodium in erythrocytes (mmol/l) in HA individuals on the background of EAHT (E) and CAHT(C) in the days of magnetic storms during the study period from 1995 to 2017

Days		-7–6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	Всего
γ-phone		8.5-8.50± 0.01	8.46±0.01	8.58±0.01	8.41±0.01	8.45±0.01	8.70±0.01	8.78±0.01	8.80±0.01	8.65±0.01	8.70± 0.01	8.59±0.01	8.47±0.01	8.62±0.01	8.49±0.01	8.58±0.007
Choleric	E	9.7-9.3± 0.08 44-45	9.7±0.07 44	8.9±0.07 44	9.7±0.08 48	9.4±0.07 43	10.7±0.09 49	11.5±0.1 48	11.9±0.1 46	12.1±0.1 47	11.9±0.1 44	9.1±0.1 43	9.1±0.1 44	8.7±0.08 43	9.2±0.1 45	10.1±0.04 677
	C	9.1-9.2± 0.1 44-43	9.3±0.09 44	8.9±0.08 46	9.4±0.08 44	9.2±0.08 45	9.9±0.1 44	10.1±0.1 46	9.8±0.1 44	10.6±0.1 44	8.9±0.1 48	9.4±0.1 43	9.4±0.09 46	8.9±0.09 43	9.4±0.08 44	9.3±0.05 668
	Zd	9.0-9.1±0.07 45-44	9.2±0.06 45	8.6±0.08 44	9.2±0.09 46	9.0±0.06 44	9.6±0.08 46	9.9±0.07 44	9.9±0.06 45	9.6±0.07 44	8.8±0.08 46	8.6±0.09 44	9.2±0.1 44	8.5±0.1 46	9.1 ±0.07 46	9.2±0.06 673
Sanguines	E	10.8-10.9±0.1 46-46	11.1±0.08 44	10.6±0.09 47	10.8±0.09 44	11.0±0.09 43	10.9±0.08 48	12.6±0.08 49	13.3±0.1 44	13.5±0.1 43	13.2±0.1 45	12.8±0.1 43	11.2±0.08 46	11.0±0.07 48	11.0±0.08 47	11.7±0.05 682
	C	9.9-10.0±0.07 44-46	11.0±0.07 47	9.7±0.08 43	11.1±0.1 44	10.8±0.1 43	9.7±0.1 47	11.6±0.09 48	12.4±0.07 50	12.9±0.08 47	11.2±0.08 44	10.2±0.09 48	10.0±0.07 48	10.0±0.08 45	10.1±0.08 47	10.7±0.06 690
	Zd	9.8-9.9±0.07 48-45	10.1±0.07 44	9.5±0.06 48	9.9±0.09 44	9.9±0.08 44	9.1±0.08 45	11.6±0.1 48	12.4±0.1 46	12.9±0.1 44	9.2±0.08 46	10.2±0.1 48	10.0±0.1 46	10.0±0.09 46	10.1±0.1 49	10.3±0.09 691
Phlegmatic	E	11.7-11.5± 0.1 44-46	11.5±0.1 45	11.8±0.08 44	11.3±0.09 48	11.5±0.07 48	11.6±0.1 49	12.0±0.1 52	13.7±0.1 54	14.0±0.09 47	14.3±0.08 46	13.3±0.1 49	11.8±0.1 48	12.0±0.09 44	11.8±0.1 48	12.3±0.07 715
	C	10.6-10.9±0.08 44-43	11.3±0.09 44	10.8±0.08 46	10.9±0.08 44	11.0±0.09 46	11.1±0.07 46	11.1±0.08 48	12.8±0.1 47	13.5±0.1 49	12.3±0.09 44	12.0±0.09 43	11.3±0.008 44	9.9±0.07 43	10.8±0.07 48	11.4±0.06 679
	Zd	10.5-10.8 ±0.07 49-49	11.1±0.06 44	10.7±0.06 46	10.6±0.06 44	10.9±0.09 44	11.0±0.09 45	11.2±0.07 49	12.6±0.06 55	13.4±0.06 49	13.0±0.09 46	12.8±0.08 44	11.8±0.09 49	10.8±0.08 48	11.5±0.07 48	11.5±0.05 708
Melancholic	E	12.8-13.0± 0.08 44-45	12.5±0.07 44	13.3±0.07 43	12.6±0.06 44	12.8±0.09 43	13.0±0.09 44	13.6±0.08 47	14.9±0.07 44	14.9±0.06 43	15.0±0.07 44	14.4±0.08 43	14.1±0.09 44	13.2±0.09 43	13.1±0.08 46	13.6±0.05 661
	C	11.7-11.9±0.09 44-43	12.1±0.08 47	11.6±0.09 48	11.7±0.09 45	11.8±0.09 48	11.7±0.09 45	12.0±0.08 48	13.1±0.09 45	14.3±0.08 46	14.6±0.07 44	13.8±0.06 43	12.1±0.08 44	12.1±0.1 46	11.9±0.08 44	12.4±0.04 684
	Zd	11.6-11.8±0.08 46-45	12.1±0.09 46	11.4±0.07 46	11.5±0.07 44	11.6±0.08 44	11.4±0.1 45	11.8±0.1 48	12.8±0.01 49	14.2±0.1 44	14.4±0.09 46	13.9±0.09 47	12.0±0.08 46	12.0±0.08 46	12.0±0.1 44	12.3±0.04 686

Table 4

Correlation coefficients between the dynamics of γ-background, CUOT, potassium and sodium content in erythrocytes during magnetic storms in high-and low-anxiety patients with AH-II with different temperament against the background of empirical (E) and targeted (C) AHT during the study period from 1995-2017

	CUOT, %				Potassium, mmol/l				Sodium, mmol/days			
	Highanxiety		Lowanxiety		Highanxiety		Lowanxiety		Highanxiety		Lowanxiety	
	Patient	Healthy	Patient	Healthy	Patient	Healthy	Patient	Healthy	Patient	Healthy	Patient	Healthy
ChE	-0.830±0.02	-0.477±0.01	-0.45±0.02	-0.29±0.01	-0.814±0.02	-0.447±0.01	-0.48±0.01	-0.24±0.01	+0.725±0.02	+0.420±0.02	+0.47±0.02	+0.28±0.02
ChC	-0.464±0.01		-0.27±0.01		-0.478±0.01		-0.20±0.01		+0.438±0.02		+0.24±0.02	
SgE	-0.745±0.01	-0.474±0.01	-0.46±0.01	-0.23±0.01	-0.724±0.01	-0.454±0.01	-0.49±0.01	-0.25±0.01	+0.688±0.02	+0.456 ±0.03	+0.46±0.03	+0.27±0.03
SgC	-0.420±0.01		-0.27±0.01		-0.485±0.01		-0.26±0.01		+0.430±0.02		+0.28±0.03	
PhE	-0.638±0.01	-0.394±0.01	-0.37±0.01	-0.27±0.01	-0.583±0.01	-0.482±0.01	-0.43±0.01	-0.27±0.01	+0.621±0.03	+0.470 ±0.03	+0.47±0.02	+0.26±0.01
PhC	-0.453±0.01		-0.25±0.01		-0.463±0.0001		-0.25±0.01		+0.450±0.03		+0.27±0.02	
ME	-0.585±0.01	-0.469±0.01	-0.40±0.01	-0.25±0.01	-0.567±0.01	-0.436±0.01	-0.37±0.01	-0.27±0.01	+0.630±0.03	+0.386±0.02	+0.38±0.02	+0.27±0.02
MC	-0.365±0.01		-0.29±0.01		-0.489±0.01		-0.28±0.01		+0.449±0.03		+0.25±0.02	

concentration of radioactive radon gas on these days several times.

Against the background of EAHT, a significant return of the studied parameters to the baseline values in the groups of HA cholerics was observed on (+4) day, sanguine on (+5), and HA phlegmatic and melancholic on (+6) day from the beginning of MS, and in the groups of LA persons-on the day before: LA/Ch – Sg – Ph - M: +3 – +4 – +5 – +5 (table. 1 – 3). Against the background of CAHT, compared with the EAHT variant, the return to the initial values was recorded a day earlier: in the groups HA/Ch – Sg – Ph - M at +3 – +4 – +5 – +5, and in groups LA/Ch – Sg – Ph - M on: +2 – +3 – +4 – +4 day from the beginning of MS, respectively (table. 1 – 3). In contrast to the groups taking EAHT, against the background of CAHT, the terms of return of the studied parameters to the initial values approached those in healthy HA(LA) persons of the corresponding temperament (table. 1 – 3).The correlation analysis carried out on days using the method of superimposed epochs, between the change of γ-background and the content of potassium and sodium in Er during MS in patients, regardless of the variant of AHT, and in healthy individuals, established a reliable inverse correlation with the value of the CUOT and the concentration of potassium, but direct – with the content of sodium. But in the background, EAHT, correlation at the HA patients was high, and LA patients, the mean order of importance. On the background of CAHT in HA patients correlation was average, and in the groups of LA degree of importance, as well as in HA(LA) healthy individuals of the corresponding temperament (table. 4).

These studies have shown that between the increase in γ-background of the medium in the MS period, on the one hand, and the size of the CUOT, as well as the content of electrolytes in Er, on the other, there was a reliable relationship. Based on these data, already the day before the start and during the period of MS observed increase γ-background environment (within the boundaries of acceptable regional standards). And the first the day before the MS reacted the body sympathotonics choleric, and then the rest in the days of the MS and increase γ-background environment. It is unlikely to increase the activity of free-radiacal lipid peroxidation (SPOL) of membranes under conditions of increasing γ-background of the medium in the normal range. However, under the influence of these heliogeophysical factors (intense electromagnetic field of the Earth and an increase in γ-background of the medium), the obtained combination probably contributed to the development of a cascade of SPOL reactions, which resulted in an increase in the permeability of Er membranes and a decrease in magnesium [4, 16], potassium and CUOT values, but an increase in sodium concentration in Er. In contrast to the empirical AHT, against the background of CAHT, associated with a decrease in the activity of SNS in Ch and Sg and the activity of RAAS (aldosterone) in Ph and M patients, the degree of response (according to correlation analysis), as well as the coincidence of the timing of the return of the value of the CUOT and the electrolyte content to the initial values, plus less significant differences in the magnitude of changes in the CUOT and the content of the studied electrolytes in Er with those in healthy HA(LA) persons of the corresponding temperament, indicates in favor of greater efficiency of CAHT.

References

1. Krasnov V.N., Vasyuk Yu.A., Nesterova E.A., Dovzhenko G.V., Tarasova V.K. Antidepressanty koaksil i zoloft v kompleksnom lechenii bol'nyh arterial'noj gipertenziej s rasstrojstvami affektivnogo spektra [Antidepressants coaxil and zoloft in treatment of patients with arterial hypertension with disorders of the affective spectrum]. Rossijskij medicinskij zhurnal [Russian medical journal]. Moscow, 2004, № 1, PP. 15 – 18.
2. Akhmetzhanov Je.R. Shkala depressii. Psihologicheskie testy [Depression Scale. Psychological tests]. Moscow: List, 1996, 320 p.
3. Vejn A.M. Vegetativnye rasstrojstva: klinika, lechenie, diagnostika [Autonomic disorders: clinical, treatment, diagnosis]. Moscow.: Medicinskoe informacionnoe agentstvo, 2000, 752 p.
4. Usenko G.A., Usenko A.G., Vasendin D.V., Shakirova N.A. Vzaimosvyaz' mezhdu sostoyaniem magnitnogo polya Zemli i soderzhaniem magniya, temperamentom, trevozhnost'yu u bol'nyh stenokardiej napryazheniya [Correlation between magnesium content, temperament, anxiety and earth's magnetic field condition in patients with exertional angina]. Medicinskij vestnik MVD [MIA Medical Bulletin]. Moscow, 2014, Vol. LXVIII, № 1, P. 37 – 43.
5. Usenko G.A., Vasendin D.V., Usenko A.G., Schakirova N.A., Makarova L.I., Machmudyan D.A. Vliyanie geliogeofizicheskih faktorov na minutnyj ob"em

krovi u bol'nyh arterial'noj gipertenziej s razlichnym temperamentom [Influence of heliogeophysical factors on the minute blood volume in hypertensive patients with different temperament]. Vestnik Rossiiskoi voenno-medicinskoi akademii [Bulletin of the Russian military medical Academy]. Saint-Petersburg, 2017, № 1 (61), P. 35 – 37.

6. Gurfinkel Yu.I. Ishemicheskaya bolezn' serdca i solnechnaya aktivnost' [Ischemic heart disease and solar activity]. Moscow.: IICC "Elf-3", 2004, 170 p.

7. Gogin E.E. Vybor taktiki lecheniya bol'nyh gipertonicheskoj bolezn'yu: ego individualizaciya i kriterii [Choice of tactics of treatment of patients with essential hypertension: its individualization and criteria] Terapevticheskij arhiv [Therapeutic archive]. Moscow, 2010, № 12, P. 5 – 10.

8. Kishkun A.A. Rukovodstvo po laboratornym metodam diagnostiki [Manual of laboratory methods for diagnosis]. Moscow.: GEOTAR, 2007, 800 p.

9. Mustel Je.R. Metod nalozhennyh ehpoh [The method of superimposed epochs] Byulleten' nauchnoj informacii Astronomicheskogo Soveta AN SSSR [Bulletin of scientific information of the Astronomical Council of the USSR]. Moscow, 1968, P. 98.

10. Usenko G.A., Demin A.A., Usenko A.G., Vasendin D.V. Osobennosti remodelirovaniya sosudistoj stenki u bol'nyh arterial'noj gipertenziej v zavisimosti ot psihosomaticheskogo statusa i varianta lecheniya [Specifics of vessel wall remodeling in patients with arterial hypertension depending on psychosomatics status and treatment options]. Medicinskij vestnik MVD [MIA Medical Bulletin]. Moscow, 2013, Vol. LXVII, № 6, P. 49 – 55.

11. Oschepkova E.V. Smertnost' naseleniya ot serdechno-sosudistyh zabolevanij v Rossijskoj Federacii v 2001 – 2006 gg. i puti po ee snizheniyu [Mortality from cardiovascular diseases in the Russian Federation in 2001 – 2006 and ways for its reduction]. Kardiologiya [Cardiology]. Moscow, 2009, № 2, P. 67 – 73.

12. Prikaz № 254 Ministerstva zdravoohraneniya i social'nogo razvitiya RF ot 22.11.2004 «Ob utverzhdenii standarta medicinskoj pomoshchi bol'nym arterial'noj gipertoniej» [Order №.254 of the Ministry of health and social development of the Russian Federation dated 22.11.2004 «On approval of the standard of care for patients with arterial hypertension»]. Moscow, 2004, 14 p.

13. Profilaktika, diagnostika i lechenie arterial'noj gipertenzii: Rossijskie rekomendacii (vtoroj peresmotr) [Prevention, diagnosis and treatment of arterial hypertension: Russian recommendations (second revision)]. Moscow, 2004, 37 p.

14. Profilaktika, diagnostika i lechenie arterial'noj gipertenzii: Rossijskie rekomendacii (tretij peresmotr) [Prevention, diagnosis and treatment of arterial hypertension: Russian recommendations (third revision)] Kardiovaskulyarnaya terapiya i profilaktika [Cardiovascular therapy and prevention]. Moscow, 2008, № 7, Suppl. 2, P. 5 – 16.

15. Stolyarenko L.D. Oprosnik Ajzenka po opredeleniyu temperamenta. Osnovy psihologii [Eysenck on the definition of temperament. Fundamentals of psychology]. Rostov-on-Don: Phoenix, 1997, 736 p.

16. Usenko G.A., Vasendin D.V., Usenko A.G. Osobennosti soderzhaniya magniya v organizme bol'nyh arterial'noj gipertenziej v zavisimosti ot psihosomaticheskogo statusa pacienta i varianta antigipertenzivnoj terapii [The content of magnesium in the body patients with arterial hypertension depending on the psychosomatic status of the patient and alternative antihypertensive therapy]. Vestnik Severo-Zapadnogo gosudarstvennogo medicinskogo universiteta im. I.I. Mechnikova [Herald of North-Western State Medical University named after I.I. Mechnikov]. Saint-Petersburg, 2016, Vol. 8, № 3, P. 74 – 81.

17. Hanin Yu.L. Issledovanie trevogi v sporte [Study of anxiety in sport] Voprosy psihologii [Questions of psychology]. Moscow, 1978, № 6, P. 94 – 106.

18. Shemi-Zade A.Ye. Biotropnost' geomagnitnyh vozmushchenij kak sledstvie vyzyvaemogo imi povysheniya udel'noj radioaktivnosti vozduha [Biotropy of geomagnetic disturbances as a consequence of the increase of specific radioactivity of air caused by them] Biofizika [Biophysics]. Moscow, 1978, №23, P. 955 – 958.

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