

# SPACE WEATHER AND A STATE OF CARDIOVASCULAR SYSTEM OF HUMAN BEING WITH A WEAKENED ADAPTATION SYSTEM

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**ABSTRACT.** As has been shown in [Samsonov et al., 2013] even at the considerable disturbances of space weather parameters a healthy human being did not undergo painful symptoms although measurements of objective physiological indices showed their changes. At the same time the state of health of people with the weakened adaptation system under the same conditions can considerably be deteriorated up to fatal outcome. The analysis of results of the project “Heliomed” and the number of calls for the emergency medical care (EMC) around Yakutsk as to cardiovascular diseases (CVD) has shown:

- the total number of calls for EMC concerning myocardial infarction (MI) per year near the geomagnetic disturbance maximum (1992) exceeds the number of calls per year near the geomagnetic activity minimum (1998) by a factor of 1,5 and concerning to strokes – by a factor of 1,8.

- maxima of MI are observed during spring and autumn periods coinciding with maxima of geophysical disturbance;

- the coincidence of 30-32 daily periods in a power spectrum of MI with the same periods in power spectra of space weather parameters (speeds and density of the solar wind, interplanetary magnetic field, geophysical disturbance);

- the existence of 3 maxima of the number of calls for EMC: a) at the moment of disturbance on the Sun; during a geophysical disturbance (in 2-4 days after a disturbance on the Sun); in 2-4 days after a geophysical disturbance;

- the availability of coincidence of insignificant disturbances of space weather parameters with changes of the functional state of cardiovascular system of a human being with the weakened adaptation system and the occurrence of MI and strokes at considerable values of such disturbances is explained by a quasi-logarithmic dependence of the response of human being organisms to the environment disturbance intensity.

**Key words:** space weather, the Sun, cardiovascular system of a human being, a myocardial infarction

## 1. Experimental data

To detect real space weather parameters influencing a cardiovascular system (CVS) of human being with a weakened adaptation system the data of the numbers of calls for the emergency medical care (EMC) around Yakutsk for years of high and low geophysical activity have been used. More than 144000 cards of calls for EMC around Yakutsk have been treated. In this work a special attention is paid to years near to the maximum (1992) and minimum (1998) of geophysical disturbance.

As was shown in [Samsonov et al., 2005; Samsonov, Manykina, 2013] a CVS of a human being responds to changes of space weather parameters, such as: the electromagnetic solar radiation, interplanetary magnetic field, solar wind. In the work both phase methods and spectral ones of experimental data treatment are used.

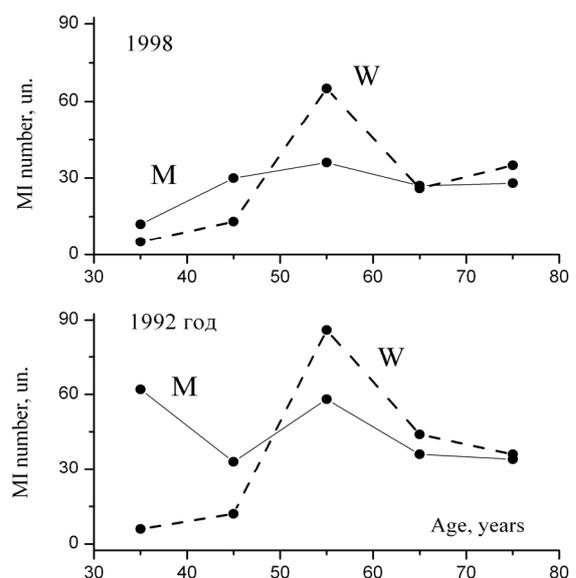


Figure 1: Distribution in sex and age of the number of myocardial infarctions diseases for women (W) and men (M) in 1992 and 1998

## 2. Analysis of experimental data

Fig. 1 presents a distribution in sex and age of the number of MI diseases for women (W) and men (M) in 1992 and 1998 by data of the Yakutsk EMC. As is seen from Figure the total number of calls concerning MI for EMC per year near to the geomagnetic disturbance maximum (1992) exceeds the number of calls per year near to the geomagnetic activity minimum (1998) by a factor of 1,5. And the total number of calls concerning strokes for EMC in 1992 exceeds the number of calls in 1998 by a factor of 1,8 (it is not shown in Figure). At the same time as has been shown in [Samsonov & Manykina, 2012] maxima of MI are observed in spring and autumn periods coinciding with maxima of geomagnetic disturbance. Thus, one can note that near the geomagnetic activity maximum there were more calls concerning CVD for EMC by a factor of 1,5-1,8 than near the geomagnetic activity minimum.

Besides, from Fig. 1 it follows that in 1992 the number of calls concerning MI for EMC to men at the age from 30 to 50 years old exceeded the number of calls to women of the same age by a factor of 5. And at the age from 50 to 60 years old the situation cardinally changes, the number of calls for EMC to women exceeds the number of calls to men by a factor of 1,5. At the age from 60 to 70 years old the number of calls for EMC to women exceeds number of calls to men, but only by a factor of 1,2. And at the age of 70-80 years old the number of calls to women and men is practically leveled off.

Hence it follows that men are magnetolabile and are exposed to the risk of development of ischemic heart disease (IHD) and its complications at the age of under 50. Men after 50 years old have a drop of magnetosensitivity, most likely it is caused by stabilization of adaptive processes of an organism, at the expense of formation of stability to factors of space weather. Women are more magnetosensitive after 50 years old and older (especially at the age of 50-60 years) during the period of peri- and post-menopause which is accompanied by a deficiency of estrogens, sexual globulin connecting steroids at the expense of natural fading of ovary function.

With applying of a phase method (superposed epoch technique) it was shown in [Samsonov et al., 2005] that the number of calls for EMC around Yakutsk as to: a hypertensive disease, a hypertensive crisis, CVD of the patients being registered on a dispensary, had two maxima. The first maximum took place at the moment of disturbance on the Sun, and second one in 2-4 days after a geomagnetic disturbance. At the same time, the number of calls for EMC concerning a MI and stroke, besides these two maxima, had also the third maximum at the moment of geomagnetic disturbance. In [Samsonov & Manykina, 2012] it has been shown that the first maximum of the number of calls for EMC concerning CVD coinciding with the disturbance on the Sun is connected with the increase of electromagnetic solar radiation. Thus it has been shown that the increase of electromagnetic solar radiation intensity immediately influences on CVD of a human being.

The power spectra calculated by the number of calls for EMC around Yakutsk concerning CVD [Samsonov et al., 2005] have shown the availability of maximum with a period of 30-32 days coinciding with the same maxima in the following space weather parameters: the interplanetary magnetic field (IMF), solar wind (SW), geomagnetic disturbance and auroral absorption. And in [Samsonov & Manykina, 2012] the coincidence of power spectra of the state of CVS of the volunteer group with the power spectra of space weather parameters (has been shown by the total intensity of IMF vector, speed, density and dynamic pressure of SW, geomagnetic disturbance) and the absence of such coincidence with power spectra of parameters of the usual ground weather. In the same place it has been shown that the disturbance of IMF and SW are transformed in the Earth's magnetosphere into the disturbance of the geomagnetic field which, finally, influences on CVD of a human being with the weakened adaptation system.

In [Garkavi et al., 1998] it has been shown that the response of living organism to the external action is described by the quasi-logarithmic law. In our case we have studied the dependence of response of the CVS of human being with the weakened adaptation system to geomagnetic field disturbances and have discovered that such response is quite well described by quasi-logarithmic dependence. Fig. 2 presents the plot describing the dependence of state of human being CVD on the level of geomagnetic disturbance. As an index of functional state of the CVS of human being such index of an electrocardiogram (ECG) as a T-wave symmetry coefficient (TSC) is used. One can acquaint oneself with applicability of TSC for the estimation of CVS state of a human being in more details in [Fainzilberg, 1998; Vishnevsky et al., 2003]. As is seen from Figure the dependence has three fields differing from each other designated by the numbers from 1 to 3. The first field is characterized by the increase of TSC with the growth of level of geomagnetic disturbance. The second field is characterized by a practical termination of the growth of TSC, and the third field leads to the sharp change of state of the CVS of human being, indicating to the approach of CVD.

Insignificant geomagnetic disturbances play a role of the "starting" adaptive factor transferring the work of CVS into the optimum mode corresponding to the level of geomagnetic disturbance. In this case the TSC starts to

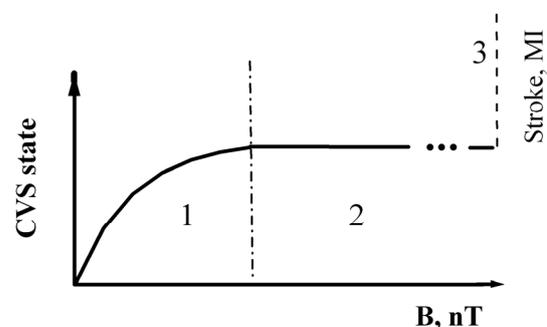


Figure 2: Dependence of the CVS state of a human being on the geomagnetic disturbance level

grow together with the growth of geomagnetic disturbance. When exceeding the level corresponding to the boundary of fields 1 and 2 by the geomagnetic disturbance, the functioning of CVS is stabilized in a state which is relatively refractory to the changes of external actions that can have the protection moment for patients with a cardiovascular pathology. In this case, TSC does not grow with the growth of geomagnetic disturbance. Definitely, a similar stability is reached by the effort of adaptation-compensating mechanisms of CVS.

The confirmation of given interpretation are observational results obtained in the course of the experiment "Heliomed". The volunteers are students (young and healthy) participating in the given experiment showed the coincidence of changes of geomagnetic disturbances with TSC all the time, i.e. they were in the field 1 all the time.

The volunteers of the middle (30-50 years) and older age (older than 50 years) participating in the experiment as relatively healthy people, usually were divided into two approximately identical groups by the response to geomagnetic disturbances. First half of group, also as well as students, showed the coincidence of changes of geomagnetic disturbance with TCS, i.e. they were in the field 1.

The second half of group showed only a partial coincidence of changes of geomagnetic disturbance with TSC, i.e. they were in the fields 1 and 2. Probably those examined "healthy" volunteers already had a certain state of latent "pre-disease" that was characterized by a tension of adaptation mechanisms of CVS and development of an adaptive stability to changes of geomagnetic disturbance.

By our assumption people with the weakened adaptation system the field 1 has a very narrow range of values, and the insignificant geomagnetic disturbance transforms the state of CVS to the field 2. Therefore such people don't show the coincidence of changes of geomagnetic disturbance with TSC.

### 3. Conclusions

The analysis of results of the project "Heliomed" and the number of calls of EMC around Yakutsk as to CVD has shown the following:

- the total number of calls concerning the MI for EMC per year near to the geomagnetic disturbance maximum (1992) exceeds the number of calls per year near to the

geomagnetic activity minimum (1998), and strokes- by a factor of 1,8;

- maxima of MI are observed during spring and autumn periods coinciding with maxima of geophysical disturbance;

- the coincidence of 30-32 daily periods in the power spectrum of MI with the same periods in the power spectra of space weather parameters (speeds and densities of the solar wind, interplanetary magnetic field, geophysical disturbance;

- the existence of 3 maxima of the number of calls of EMC: a) at the moment of disturbance on the Sun; b) during geophysical disturbance (in 2-4 days after a disturbance on the Sun); c) in 2-4 days after a geophysical disturbance;

- the availability of coincidence of insignificant disturbances of space weather parameters with changes of the functional state of cardiovascular system of a human being with the weakened adaptation system and approach of MI and strokes at insignificant values of such disturbances is explained by quasi-logarithmic dependence of the response of human being organisms to the intensity of environment disturbance.

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