MEDICAL AND BIOLOGICAL ASPECTS OF THE ASSESSMENT OF THE RISK FACTORS

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INFLUENCE EXERTED BY RISK FACTORS OF SPACE AND ERATH WEATHER ON FREQUENCY OF EMERGENCY CALLS FROM PATIENTS WITH ACUTE CEREBRAL CIRCULATION DISORDERS

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High morbidity with cardiovascular pathology increases loads on a public healthcare system and is not only social but also an economic problem. To optimize cardiovascular pathology prevention, it is necessary to thoroughly analyze risk factors which cause its occurrence. Our research goal was to examine a dynamics of acute cerebral circulation disorders depending on meteorological factors and heliofactors allowing for a seasonal component. We performed a retrospective analysis of morbidity with acute cerebral circulation disorders in winter, spring, and summer in 2012 on the basis of the archives obtained from an emergency station in Vladikavkaz. We analyzed 509 cases of the disease (294 women and 215 men). On the basis of our analysis results we assessed influence exerted by external factors on frequency of applications to emergency from patients with acute cerebral circulation disorders. We analyzed meteorological factors and heliofactors and their derivatives: average daily temperature, air pressure, relative humidity, wind speed, cloud coverage, weather pathogenicity, Sun radiation flux density at a wave length equal to 10.7, and a number of sunspots.

We detected that in winter negative influence was exerted by temperature; there was also a multi-factor dependence between frequency of acute cerebral circulation disorders and such predictors as temperature pathogenicity index and speed of changes in Sun radiation flux density during a day ($R_{multi} = 0.50$; $R^2 = 0.25$). Drastic temperature fluctuations make for increase in morbidity in spring. Morbidity cases frequency in women in this period correlates not only with temperature pathogenicity index but also with pathogenicity index of air pressure changes. Morbidity increase in summer is caused by simultaneous drop both in air pressure and relative humidity ($R_{multi} = 0.59$; $R^2 = 0.35$). Overall, correlation between external factors and morbidity with acute cerebral circulation disorder has seasonal specificity in different seasons. The obtained data make it possible to predict unfavorable influences exerted by meteorological factors and heliofactors allowing for seasonal dynamics and to plane prevention activities.

Key words: *acute cerebral circulation disorders, seasonal morbidity, emergency, patient, risk factors, meteorological factors, heliofactors.*

Cardiovascular diseases hold the first place in terms of worldwide prevalence and are the most widely spread mortality cause. Issues related to meteotropic reactions of a healthy and especially of a sick person have great medical and social significance due to the fact that the cardiovascular system is the basic target under exposure to external environmental factors [6, 14]. Various phenomena associated with solar physics are considered to be a stress factor for a body as they are able to cause

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exacerbation of an already existing pathology [7, 9]. A number of hemorrhagic strokes, subarachnoid hemorrhages, and intra-cerebral hematomas is known to grow considerably during periods when the Sun is active [4, 8].

Seasonality factor plays a great role in cardiovascular pathology occurrence and evolvement. Seasonal changes in the nature are an integral part of the environment, and fluctuations in environmental factors which are attributable to them become conditioned reflex significant [5]. Some researchers note that morbidity with acute cerebral circulation disorder (ACCD) grows in autumn and winter [18, 20, 21]. But some insist that a number of acute cerebral circulation disorders grows in spring and summer [16, 17]. And, finally, there are works which don't contain any data on detected seasonal dynamics in morbidity with this pathology [13]. Such great differences in existing data require further research in the field and development of prevention techniques aimed at decreasing risks of such a grave disease as acute cerebral circulation disorder. It is necessary to examine and to predict influences exerted by meteorological and heliophysical factors on morbidity with acute cerebral circulation disorders when we plan emergency stations functioning in various geographical regions.

Our research goal was to examine dynamics in acute cerebral circulation disorders frequency depending on meteorological and heliofactors allowing for the seasonal component.

Data and methods. We performed a retrospective analysis of the archive data provided by an emergency station in Vladikavkaz in winter, spring, and summer 2012. We analyzed frequency of emergency calls related to acute cerebral circulation disorders depending on meteorological and heliofactors in the examined period. There were 509 acute cerebral circulation disorder cases fixed in the period (294 women and 215 men). Average daily emergency calls related to the examined pathology was equal to 3.2±0.22 patient/day. There were more calls from women than from men (1.8±0.14 against 1.3±0.14; t=2.56; p=0.010). Average age of patients was 71.4±0.5 (women were 72.6±0.7; men, 69.7±0.7). Correct and prompt diagnostics of acute cerebral circulation disorder as such is a basic task at the pre-hospital stage as it is extremely vital to render proper medical assistance within a "therapeutic window" [3]; therefore, our research tasks didn't include an exact determination of a stroke nature. Moreover, it is next to impossible to determine its nature when the first medical aid is rendered as there are no diagnostic signs which are characteristic only for ischemic or hemorrhagic acute cerebral circulation disorder. A stroke nature is usually determined only in hospital via computer tomography or magnetic resonance imaging of the brain [10].

Meteorological parameters (average daily temperature (0C), air pressure (gPa), relative humidity (%), wind speed (m/sec), cloudiness (scores)) were obtained on the web-site "Weather Schedule" (http://www.rp5.ru) maintained by Vladikavkaz meteorological station.

Apart from the absolute parameters we determined certain weather pathogenicity indexes which reflected negative influence exerted by fluctuations in temperature (it), humidity (ih), wind speed (iv), cloudiness (in), and air pressure (ip), as well as changes in these parameters in different days.

Pathogenicity indexes show how pathogenic this or that specific meteorological situation is for patients; they are determined as a mathematical function of

changes between days and deviations of basic meteorological parameters from their optimal values. Formulas for their calculation are given in the works by V.G. Boksh and B.V. Bogutskiy [2]. When meteorological parameters are at their optimal values or when pathogenic parameters are equal to zero, the weather doesn't cause any negative reactions in a body, and changes in any parameter in any direction lead to an increase in pathogenicity indexes and negative reactions risks which are proportionate to them.

We also analyzed the following heliofactors: the Sun radiation flux density at a wave length equal to 10.7 cm (s.r.f.), a number of sunspots (SSN), as well as their derivatives, namely parameters values which determined speed of their changes (-3, -2, -1 days prior to measuring). Numeric values of the parameters were taken from SPIDR (Space Physics Interactive Data Resource) international database.

We performed statistical analysis of the data with the help of Statistica 6.0. To compare average values in two independent groups, we applied Student's t-criterion. We assessed influence exerted by external factors on frequency of emergency calls from patients with acute cerebral circulation disorders via correlation and regression analysis. Critical significance in statistical hypotheses verification was taken as equal to ≤ 0.05.

Results and discussion. Analysis of all-season correlations between frequency of emergency calls from patients with acute cerebral circulation disorders and meteorological factors over the whole examined period revealed that there was a correlation on the whole ACCD sampling with average daily temperature (r=0.23; p=0.008) and relative humidity (r=-0.20; p=0.007). Having divided the sampling as per sex, we detected that correlation with the temperature factor in the whole sampling structure was caused by increase in ACCD morbidity in women when the temperature grew (r=0.19; p=0.03); while correlation with relative humidity was caused by increasing morbidity of men when humidity dropped (r=-0.19; p=0.023).

Further seasonal analysis of correlations between frequency of emergency calls and the examined factor reveled there was seasonal specificity, and correlation coefficients values were even higher. In winter we detected correlation between ACCD morbidity and speed of changes in the Sun radiation flux density during a day (s.r.f. (-1)) (r=0.42; p=0.009), and also average daily temperature (r=-0.39; p=0.012). There was a growing trend in frequency of emergency calls when temperature pathogenicity index (it) grew (r=0.38; p=0.06). Therefore, we can conclude, that morbidity with ACCD grows when temperature drops and also when there are drastic fluctuations in the Sun radiation density flux during a day.

Mechanisms of influences exerted by meteorological factors, heliofactors, and geomagnetic ones on a human body have not been fully examined so far since different levels of its structural and functional organization are involved into reactions evolving as a response to these influences. Increase in morbidity with cardiovascular pathology is supposed to result from adaptation desynchronosis [15]. In particular, when low temperatures exert their impacts on weakened patients with reduced body adaptation reserves and with already existing cardiovascular pathology, it leads to greater vasoconstrictors production and arterial stiffness as sympathetic nervous system becomes more active; consequently, hypertensive reactions occur. Due to it cardiovascular disasters risk increases considerably [19]. Increase in mortality caused by

this pathology is usually detected in winter [12].

We should take into account that various meteorological and solar physics factors interact with each other and can act as synergists or antagonists thus changing body responses [1]. We performed multiple regression analysis which allowed us to detect multiple correlation ($R_{mult} = 0{,}50$; $R_{mult}^2 = 0{,}25$) between ACCD morbidity and the following predictors: it (p=0.016), s.r.f. (-1) (p=0.01), and to create ACCD morbidity model in winter time (Figure 1). (left axis: ACCD morbidity).

As we can see from the Figure 1, when weather pathogenicity index and speed of changes in the Sun radiation flux density grow simultaneously during a day, morbidity with acute cerebral circulation disorders, that is, these factors act as synergists in this case.

In spring we detected a positive correlation between ACCD morbidity and temperature pathogenicity index (r=0.26;p=0.05). Drastic fluctuations in average daily temperature cause more frequent emergency calls from patients suffering from ACCD. We also detected that in spring ACCD morbidity in women correlated positively not only with temperature pathogenicity index (it)(r=0.29; p=0.028), but also with pathogenicity index of air pressure changes (iΔp) (r=0.31; p=0.019). As climate has been rather unstable over the last years, substantial differences in meteorological factors are detected in this region in spring and summer, and it causes greater information loads on a body and adaptation mechanisms stress [11].

We detected negative correlation between ACCD morbidity and the following meteorological factors: air pressure (r= -0.48; p=0.0116) and relative humidity (r= -0.34; p=0.047) in summer.

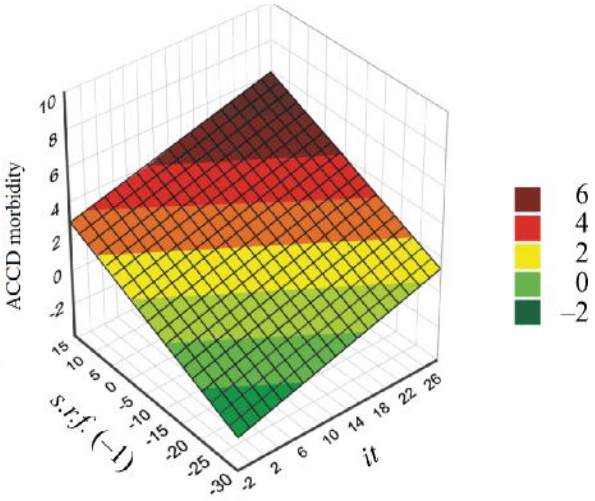

Figure 1. Correlation between ACCD morbidity and weather pathogenicity index (it) and speed of changes in the Sun radiation flux density during a day (s.r.f.(-1)) in winter (3D ACCD surface graph (men/day) = 1,374+0,113*x+0,1081*y).

Decrease in air pressure causes lower partial oxygen content in the air and it can cause hypoxic reactions in a body which become obvious via weakness, somnolence, dyspnea, and ischemic pains with different localization [2]. It is also known that as air pressure drops, a number of thrombocytes grows, and blood clotting period becomes shorter [1]. Allowing for the geographical position of Vladikavkaz which is located from 659 to 732 meters above sea level we can state that negative influence exerted by this factor is even more apparent and can cause increase in morbidity with cardiovascular pathology. Further multiple regression analysis revealed that dependence of emergency calls frequency on air pressure and humidity was a multi-factor one. Morbidity with ACCD grew at simultaneous decrease in air pressure (p=0.002) and relative humidity (p=0.009) (Figure 2).

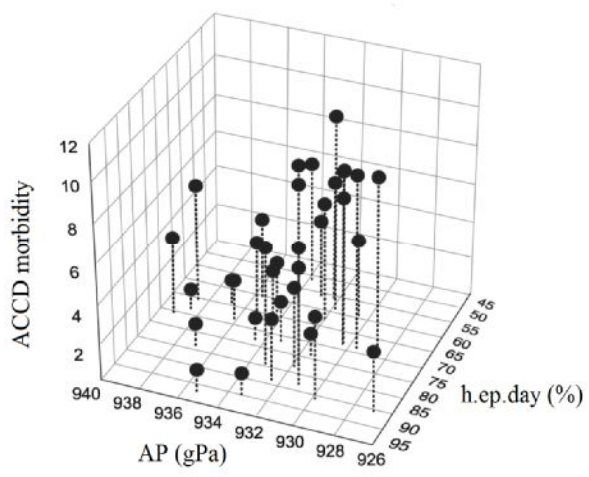

Figure 2. Correlation between ACCD morbidity with air pressure (AP) and relative humidity (h average daily) in summer (3D dispersion diagram: AP (gPa) and h.ep.day,% and ACCD morbidity (men/day))

Multiple correlation coefficient was R_{mult} = 0.59, multiple determination coefficient was $R_{mult}2$=0.35 (p=0.004), therefore, 35% ACCD cases were determined by a complex negative influence exerted by the above-mentioned factors in summer. As we divided our sampling as per sex, we detected that air pressure was the basic predictor influencing ACCD occurrence frequency in women in summer (r= -0.47; p=0.004); as for men, relative humidity was the basic predictor in their case (r= -0.42; p=0.013).

Conclusion. In winter emergency calls frequency related to ACCD grows when average air temperature drops and speed of changes in the Sun radiation flux density increases during a day. We detected a multi-factor dependence between ACCD occurrence frequency and the following predictors: temperature pathogenicity index and speed of changes in the Sun radiation flux density during a day.

In spring frequency of emergency calls related to ACCD correlates positively with temperature pathogenicity index regardless of patients' sex. Air pressure pathogenicity index is an additional predictor for women which determines ACCD morbidity growth.

In summer ACCD morbidity growth is caused by air pressure and relative humidity drops. Women are apparently more sensitive to air pressure fluctuations in terms of summer ACCD morbidity; men, to relative humidity fluctuations.

The obtained data help to plan prophylaxis activities aimed at ACCD prevention for people who are in risk groups allowing for external factors and season specificity.

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