SEASONAL BIORHYTHMS AS A FEATURE OF HUMAN GENETIC SYSTEMS

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Genetic systems are of great prevalence in nature. They are characterized by interrelation between three sequential functional statuses of complex biological systems: Past, Present and Future; and differ from occasional processes by an After-effect. Traditionally the models of genetic systems are used in Biology for description of Genetic Heredity and Genetic Variability. At the present work the models of genetic systems are used to describe human phenotypic variability. We also present a comparative analysis of seasonal biorhythms in two groups under study: Ural and Northern, residents of Midlatitudes and immigrants from Midlatitudes, Polar region migrants correspondingly. Discrete statuses of biorhythms pattern, interrelated within the flow of nonrandom sequential events are described. We show, that the biorhythms modification, formed in past, is a stable phenomenon, it can not be cleared by corrective impact in present and determines the stimulation response of human organism in future. The interpretation of the results is made in the models of genetic processes: the complex of seasonal biorhythms is defined as a self-optimizing system having an after-effect; and its discrete statuses are described as a dynamic sequence of events in that system.

Problem description

Genetic systems are of great prevalence in nature. They make possible appropriate descriptions of complex biological systems having an after-effect. Genetic Systems Theory as currently applied to Biology is Genetic Heredity and Genetic Variability. The researches of the Urals scientists in genetic systems theory use for phenotypic variability modeling are not so familiar [1 - 4].

Our concern in presentation of phenotypic variability in the scheme of genetic systems can be explained as follows. Modern living environment suffers anthropogenic and industrial transformation. The tempo of artificial transformation of environment is many times as quicker than human evolution as a species, if we can take into consideration only the processes of genetic variability, caused by mutation. Steady increase of disproportion between the tempo of environment transformation and genotype evolution menaces human survival as a species. This is a new scientific problem. We believe that its successive solution is possible if the mechanisms of human adaptation fitting with rapidity, self-organization and ability to function within the schemes of genetic systems are discovered.

The aim of the present research is to analyze the human seasonal biorhythms within the theory about self-organizing systems having an after-effect.

Stuff and Methods of investigation

The seasonal biorhythms are investigated in two categories of individuals having the initial signs of disadaptation syndrome and various geographic pre-history. The results of examination of men, suffering the ischemic heart disease (IHD) working at metallurgical plants of the Middle Urals (first group, 113 persons) and Polar region (second group, 102 persons) are taken in operation. The groups match in age, prescription of the disease and the main signs of the disease. The clinical characteristics of patients with IHD from various geographic groups was similar in follow aspects: age, prescription of the disease, complaints (heart pain, typical irradiation of pain, neurosis-like complaints), data of medical examination (heart edge extension to the left, apical systolic murmur, accent in II tone in aorta), electrocardiography and X-ray data, liquid homeostasis factors (advanced hydrocortone antibody titer, cholesterin and triglyceride level)

Along with it, seasonal biorhythms in two groups under study differ substantially, being not just a complex of discrete rhythmical processes, but functional systems able to self-organization and self-development. Seasonal biorhythms of the inhabitants of the Middle Urals industrial region are nearer to the rhythm of climate and weather fluctuations in the Midlatitudes and demonstrate authentic seasonal periodicity in the most of homeostasis factors analyzed (tab. 1)

Table 1. - Seasonal biorhythms of tolerance to exercise stress of IHD patients from various geographic groups (residents of the Urals and the Polar region)

Factors	Winter	Spring	Summer	Autumn
The Urals residents				
CR at rest (beats/minute)	72.19±2.93 *	63.62±2.43	71.70±3.69	71.36±2.23
Interval PQ, sec*10^{-2}	15.89±0.34 *	16.29±0.33	14.80±0.62	16.45±0.44
Systolic factor, %	2.18±0.34 *	1.29±0.29	1.50±0.68	1.74±0.35
Vegetal Index Kerde	-10.84±3.57 *	-23.51±4.30	-9.75 ±3.54	-15.32±4.55
Volume of the work done, kilogrammeter	5456.25 ±834.59 *	7128.57 ±639.04	9344.12 ±877.46	4764.00 ±521.80
Cholesterin mmol/l	6.41±0.20 *	6.46±0.17	7.14±0.41	6.45±0.19
Betalipoproteins, g/l	6.92±0.54 *	6.30±0.28	7.39±0.76	6.30±0.28
the Atherogenic index	3.18±0.23 *	2.63±0.18	3.80±0.57	2.78±0.22
triglyceride mmol/l	1.06±0.10 *	1.26±0.07	1.39±0.19	1.29±0.11
The Polar region nonresidents				
CR at rest (beats/minute)	75.31±2.07	71.09±1.82	72.09±2.10	72.82±4.04
Interval PQ, sec*10^{-2}	16.15±0.40 *	16.07±0.23	15.03±0.20	15.96±0.36
Systolic factor, %	2.31±0.25	2.48±0.42	2.31±0.20	2.72±0.42
Vegetal Index Kerde	-11.31±5.12	-16.73±7.28	-14.12±4.66	-15.30±8.43
Volume of the work done, kilogrammeter	7868,75 ±554,04	8382,00 ±654,19	7421,74 ±422,66	6703,85 ±660,15
Cholesterin mmol/l	6.87±0.25	6.78±0.22	6.86±0.26	6.96±0.29
Betalipoproteins, g/l	6.81±0.55	7.48±0.44	6.98±0.44	7.48±0.50
the Atherogenic index	3.04±0.19	3.08±0.14	2.78±0.30	3.27±0.30
triglyceride mmol/l	1.08±0.09	1.17±0.11	1.04±0.09	1.10±0.10

NOTE (*) – the dynamics inside a group during the seasons is authentic, $p<0.05$

Statistically important seasonal biorhythm is registered in PQ interval value that is the speed of electric arousal distribution in atrium and in systolic ECG factor that is the effectiveness of electric activity in myocardium. The range of seasonal fluctuations of these factors has been substantial for a year: it has made 10.3% for the length of PQ interval, and 53.3% for systolic factor average annual. The dynamic of cardiac rate (CR) hasn't got the degree of statistic authenticity, but nevertheless, it follows the seasonal pattern of systolic factor, i.e. is synchronized with it in the phase of rhythm. CR is higher in winter and in summer and it is lower in spring and in autumn. Qualitative seasonal evaluation shows the absence of authentic seasonal distinctions in frequency and character of pathologic variations in ECG in the group of the Urals residents under study. It may be interpreted as a rather high efficiency of annual heart electric activity of IHD patients from the Urals region. The residents of The Urals have inter-synchronized variations of pulse, double product and vegetation index Kerde at rest. The seasonal variations have 2 cycles in a year (the rates increase in summer and in winter and decrease in spring and in autumn) and inversion in relation to seasonal fluctuations of diastolic blood pressure.

Variations of systolic arterial tension (AT) and tolerance to exercise stress (TES) has one peak each during the year, dislocated relative to each other in a season: the highest level of systolic blood pressure is registered in spring, and physical efficiency is the highest in summer. Fluctuations of CR, of involuntary nervous system tonus (index Kerde) and TES are statistically important; the range of there fluctuations is 12.3%, 87.9% and 70.3% of annual average. Variations of AT and double product (DP) that characterizes oxygen consumption by myocardium, at rest are unessential during the year, and their ranges are lower than those of the forgoing factors. The range of seasonal variations of systolic AT makes 3.4% of the annual average, 3.2% for diastolic AT and 10.4% for DP.

The range of seasonal variations of cholesterin level in blood makes 11.1% of annual average, 16.4% for betalipoprotein, 26.6% for triglyceride, and 39.0% for the Atherogenic index. Seasonal variations of blood cholesterin, betalipoprotein and the Atherogenic index are synchronized and show the increase of hyperlipemia patients quantity twice a year – in winter and in summer and sequent decrease in spring and autumn. The dynamic of blood triglyceride is inverse.

The seasonal variations of physiological factors in the group of the Urals residents show that 17 of 28 homeostasis number factors have authentic seasonal biorhythms; 13 of them have evident 6-month component and biorhythms look like a two-peak curve.

The specific character of seasonal biorhythms of the Polar region nonresidents-IHD patients is as follows. The Northerners are different in the range (2.0 – 4.8 times lower) of seasonal variations of circulatory dynamics, liquid homeostasis and immunological status up to absence of any statistical differences in a number of factors analyzed during the year. Seasonal variability of bioelectric heart activity in the group of the Northerners also differ from the same of the Midlatitudes residents. The difference is that the ranges of interseasonal fluctuations in the group of the Northerners are even, authentic biorhythm is found only in one of the analyzed ECG factors (PQ rhythm).

Seasonal rhythm of the Northerners in comparison with the Urals residents is characterized by the slower variations of the factors analyzed during the year. Two-peak curve of annual biorhythms, common to ECG parameters of the Urals residents, continues only in systolic factors of the Northerners. Other ECG factors in the group of the Northerners have only one peak a year that is the fact of biological time slowdown in this group in comparison with the Urals group. Besides maximum value of slow waves fluctuations in the group of the Northerners have phase deviation in time and are in disagreement: the maximum value of PQ interval length biorhythm is in winter, CR – in spring, QRS interval length (ventricular excitability) – in autumn. It is not impossible that the type of seasonal rhythms of the Northerners is approximate to the peculiarity of photoperiodism in the polar region with long polar day and wasting polar night, fully level by their length the processes of rapid spring and autumn. Seasonal variations of CR, systolic AT, DP and Kerde index show the tendencies to have two cycles of fluctuations during a year with the increase in winter and in summer and decrease in spring and autumn. However maximum value of the indicated factors is in summer and minimum value – in spring. The dynamics of diastolic AT is more monotonous, gradually decreasing from maximum value in autumn to minimal value in spring. The range of CR seasonal fluctuations makes 5.8% of the annual average, 8.3% and 3.5% for systolic and diastolic AT correspondingly, and 38.5% for Kerde index. CR, AT, DP and Kerde index fluctuations in seasons are insignificant and do not make authentic differences as when intercomparing the seasons, so comparing the seasons and the annual average.

Seasonal variations of cholesterin, betalipoprotein, triglyceride in blood and the Atherogenic index of polar region IHD patients are not statistically significant as in absolute values of the foregoing factors, so in the number of hyperlipemia patients, testifying to stable hyperlipemia during the whole year and to the absence of authentic seasonal biorhythms of liquid homeostasis factors. The range of cholesterin seasonal fluctuations makes 2.6% of the annual average, 9.3% for betalipoprotein, 11.7% for triglyceride and 15.6% for the Atherogenic index in the Polar region.

Only 7 of 28 homeostasis numeric parameters analyzed in the Polar region group have authentic seasonal variations. So the Northerners, in comparison with the Urals residents, have a spectrum of seasonal biorhythms providing the climate and geographic adaptability more rigid and narrower in range, consisting of smaller number of authentic rhythmical fluctuations. Comparison of the schemes of the Northerners' and the Urals residents' seasonal neorhythmostasis made on the measuring at rest, shows a constriction of the physical fluctuations corridor of the people at stress, experienced the severe Polar climate and geographic environment.

Nevertheless within the present message another aspect of experimental data under study is more important. It is important, that the people having equal severity of the general adaptability syndrome defect (primary evidences of IHD) have different schemes of their seasonal biorhythms and therefore may have different response to additional effect of industrial factors of the environment. The results of physical therapy realized in hospital environment were measured to verify the stated supposition.

Successful adaptation of IHD patients from the Midlatitudes to the changing environment may be proved not only by their safe seasonal biorhythms, but also by the fact that their clinical state didn't suffer any substantial breakdown during the year. The complex physical therapy was more effective in intermediate seasons: in spring and in autumn, and especially in autumn (table 2). The nonresidents of the Polar region have a different scheme of the biorhythms system and algorithm of its response to the outer influence that that of the Middle Urals residents.

The Northerners have no statistically significant fluctuations of homeostasis factors during the year. Substantial breakdown of clinical evidences of the disease in winter and autumn period was registered. Physical therapy was the least effective in intermediate seasons: in spring and in autumn, and especially in autumn.

Comparison of the results of examination in the two groups (table 3) shows that the effectiveness of treatment of the Urals residents has authentic seasonal variability; seasonal fluctuations in effectiveness of treatment in the group of Northerners are not statistically significant. There is a definite seasonal dynamics of TES factors, oxygen pulse and the factor of energy consumption for a stress unit in the structure of biological time of the Urals residents after a course of impulse physical therapy. In the group of Northerners there is no seasonal rhythmic of the physiological factors analyzed after a course of physical therapy.

Table 2. Clinical effectiveness of physical therapy of IHD patients from various geographic groups according to the season of treatment (% of the whole number of cured in a season)

Factors	Considerable improvement	Improvement	Insignificant improvement	No changes	Breakdown
The Urals residents					
Winter, n=27	-	92.8	3.6	3.6	-
Spring, n=34	8.8	76.5	11.8	2.9	-
Summer, n=20	-	85.0	10.0	5.0	-
Autumn, n=31	16.1*	67.7	9.7	6.5	-
The Polar region nonresidents					
Winter, n=26	-	84.6	7.7	3.8	-
Spring, n=29	3.3	83.3	6.6	3.3	3.3
Summer, n=22	8.6	87.0	-	4.3	-
Autumn, n=25	8.6	78.3	4.3	8.6	-

NOTE (*) – In pair comparison (spring-autumn) – (winter-summer) the differences in the effectiveness of treatment in the Urals group were authentic (P<0.01). In the Northern group authentic differences were not found out.

Discussion

The results, to our opinion, may be interpreted as follows. There are 3 sequential phases in the both groups under study: 1 – the initial status before the treatment, 2- the period of treatment itself and 3- the final response to the completed treatment. When modeling the process in the perms of genetic systems the situation may be presented as follows. The initial phenotype of seasonal biorhythms of the people under study specified by geographic peculiarities of their permanent residence is the prior status, or prehistory. The state of biorhythms at the moment of admission to the clinic and during the treatment is the current event, causing the response of the multicomponent homeostasis system in the organisms of the patients cured. Clinical effectiveness of the treatment conducted and transformation of the biorhythmologic status of the cured after the course of treatment is the after-effect, caused by the interaction in the initial status of the system and its responsiveness at the present moment. That is to say, clinical effect of the treatment may be considered as an after-effect of the events that happened at previous stages of ontogenesis during the process of life activity of an organism.

In our research the initial functional status in two groups under study was the same concerning all parameters, excepting the state of their biorhythms. According with it, one can logically suppose that the status of biorhythms itself is the carrier of the key information determining unequal response of the patients organisms from the first and the second group to the same course of treatment. As far as the final (after the treatment) state of biorhythms of the patients from the groups under study remained not unified with qualitative differences, we may state that further provocative environmental impact will be accepted differently by the patients from the first and the second group and have different results.

Thus, various climate and geographic prehistory of the patients destined different action of their system of biorhythms in present and extended to the result of the treatment that logically extrapolates in future. Various biorhythmic status of the patients in past caused various reactivity in present and resulted in various effects of treatment thereafter. The course of treatment in autumn was the most effective for the patients from the Midlatitudes and on the contrary the least successful for the Northerners.

As one can see from the displayed data there are diverse processes of homeostatic regulations in subpopulations of Homo sapiens. By means of different modes of changeability in these subdivisions two various in quality subtypes of “industrial” communities of people form. According the factor of organization of seasonal biorhythms the groups under investigation formed two sets various in quality, two various types of self-organizing systems differentiating in algorithm of perception, processing and reproduction of information from their prior state through the present into the future.

Conclusion

Human biorhythms are not only the carriers of the information about the algorithm of an organism functioning in the past, present and future; they are also the instruments of interrelation of these three discreet states. Biorhythms provide consolidation of short-term adaptation effect in long-term behavior of biosystems and function as genetic systems having an after-effect. The result of empiric investigation seems to be important because it starts a new phase in chronobiology and concentrates the attention of researchers at studying aftersound effects in three-component rhythmical system. In general, three-component aftersound may appear as a result of interrelations of three comparatively independent rhythmical processes, that is: human biorhythms, environmental natural rhythms (barometric, heo-heliomagnetic etc.), and also artificial rhythms, generated by industrial plants. In anthropogenic ecosystems in the condition of industrial transformation of environment the problem of phenotypic variability, after-effect persistence, inheritance of gained features and forming of bio-geo-industrial aftersound becomes current and turns from theoretically possible to practically realizable.

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