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DYSADAPTATION MECHANISMS OF THE HUMAN'S IN ANTARCTIC

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Summary. Long-term complex monitoring medical-biological researches of the human's functional systems status at the prolonged stay in the conditions of isolation at the off-shore (coast) Antarctic station were focused on finding out of mechanisms of dysadaptive disorders development of integrative and oxygen-transport systems of organism in the absence of essential reduction of the oxygen content in atmospheric air. Work was based on the results of medical-biological studies, which were conducted with participation of the crew members of the Antarctic station Academician Vernadskiy (Vernadsky – 65°14'43"S; 64°15'24"W). The average age of examinees was 39,8±2,4 years (130 men). The medical-biological studies included the modern clinic-laboratory, functional, instrumental, biochemical, immunologic, genetic, statistical methods. The participants' examinations of the expedition were conducted before expedition, at a period of transatlantic transition, on Antarctic station (in mode of the monitoring by means of telemedical connection), after returning from expedition.

In Antarctic the unique complex of physical, chemical, biological, of social, nature (the metheo-heliogeophysical, biorhythmological, deprivation) factors, exceeding by power and duration, affect a human. Long influence of these factors brings to the adaptation processes disorders and dysadaptive development. It is shown that the mechanisms of dysadaptive disorders of oxygen-transport systems of the human organism at the long stay under the influence of the complex of extreme factors of Antarctic expedition developed on the background of the chain neurohumoral, neuroimmune, metabolic, cellular dysfunctions, which indicated on the presence of signs of long stressful condition (the stress-syndrome) that brings to adaptive mechanisms exhaustion of compensation and requires using the methods of correction. At the long stay of a human on the coast Antarctic station, there was revealed the seasonal dynamics of adaptive-dysadaptive rebuildings of regulative and oxygen-transport systems, there was revealed the presence of signs of stressful status and development of tissue hypoxia. It was shown the pathogenic mechanisms of development of dysadaptive disorders of integrative systems (change in cerebral electrogenesis, the activation of sympathoadrenal system, immune malresistance), respiratory, circulatory and hemic mechanisms of regulation of organism oxygen modes (the fall in efficiency and economy of the regulation mechanisms). It is shown the role of biorhythmologic and heliophysical factors of environment in development of dysadaptive disorders. It is for the first time fulfilled the genetic typization of the participants of Antarctic expedition on the presence of an allele polymorphism of specific genetic factor (hypoxia induced factor - HIF-1 α). The significance of such human gene HIF-1 α polymorphism is studied in correction to development of adaptive-dysadaptive rebuildings of the functional systems at a continuous stay in Antarctic. It is shown the stable reduction of regulation mechanisms of an organism oxygen modes under influence of Antarctic factors and hypoxia loading among winterers with C/T polymorphism of the gene HIF-1 α , that has prognostic importance and opens way to deepened study of the molecular mechanisms role in development adaptive-dysadaptive processes in a human in extreme conditions.

Key words: dysadaptation, adaptation, Antarctic conditions, hypoxic status, gene polymorphism, extreme conditions, biological rhythms.

Динамика механизмов дизадаптации человека в Антарктике. Моисеенко Е.В.

Реферат. Многолетние комплексные мониторинговые медико-биологические исследования состояния функциональных систем человека при длительном пребывании в условиях изоляции на прибрежной антарктической станции направлены на выяснение механизмов развития дизадаптационных нарушений интегративных и кислородтранспортных систем организма при отсутствии существенного уменьшения содержания кислорода в атмосферном воздухе. Исследования проводились с участием членов экипажей

(130 мужчин в возрасте $39,8 \pm 2,4$ г.) антарктической станции Академик Вернадский (Vernadsky – $65^{\circ}14'43''S$; $64^{\circ}15'24''W$). Показано, что развитие дизадаптационных нарушений кислородтранспортных систем организма человека при длительном пребывании под влиянием комплекса экстремальных факторов антарктической экспедиции происходит на фоне цепочки нейрогуморальных, нейроиммунных, метаболических, тканевых, клеточных дисфункций, которые приводят к истощению адаптационных механизмов и требуют применения методов коррекции. Выявлена сезонная динамика адаптационно-дизадаптационных перестроек функциональных систем организма, выяснены патогенетические механизмы развития дизадаптационных нарушений интегративных систем (изменения церебрального электрогенеза, активация симпатoadреналовой системы, иммунная гипорезистентность), респираторных, гемодинамических, гемических механизмов регуляции кислородных режимов организма (падение эффективности и экономичности механизмов регуляции), показана роль биоритмологических и гелиогеофизических факторов среды в развитии дизадаптационных нарушений. Впервые исследовано значение аллельного полиморфизма гена HIF-1 α в развитии адаптационно-дизадаптационных перестроек функциональных систем человека в экстремальных условиях Антарктики.

Ключевые слова: дизадаптация, адаптация, антарктические условия, гипоксические состояния, генный полиморфизм, экстремальные условия, биологические ритмы

Резюме. Багаторічні комплексні моніторингові медико-біологічні дослідження стану функціональних систем людини при тривалому перебуванні в умовах ізоляції на прибережній антарктичній станції спрямовані на з'ясування механізмів розвитку дизадаптаційних порушень інтеграційних та киснетранспортних систем організму за відсутності суттєвого зниження вмісту кисню в атмосферному повітрі. Роботу виконано за участі членів екіпажів (130 чоловіків віком $39,8 \pm 2,4$ року) антарктичної станції Академік Вернадський (Vernadsky – $65^{\circ}14'43''S$; $64^{\circ}15'24''W$). Показано, що розвиток дизадаптаційних порушень киснетранспортних систем організму людини при тривалому перебуванні під впливом комплексу екстремальних факторів антарктичної експедиції відбувається на фоні низки нейрогуморальних, нейроімунних, метаболічних, тканинних, клітинних дисфункцій, що призводить до виснаження адаптаційних механізмів і потребує застосування методів корекції. Встановлено сезонну динаміку адаптаційно-дизадаптаційних перебудов функціональних систем організму, з'ясовано патогенетичні механізми розвитку дизадаптаційних порушень інтеграційних систем (зміни церебрального електрогенезу, активація симпатoadреналової системи, імунна гіпорезистентність), респираторних, гемодинамічних, гемічних механізмів регуляції кисневих режимів організму (падіння ефективності та економічності механізмів регуляції), показано роль біоритмологічних і геліогеофізичних факторів середовища в розвитку дизадаптаційних зрушень. Уперше проведено дослідження ролі алельного поліморфізму гена HIF-1 α у розвитку адаптаційно-дизадаптаційних перебудов функціональних систем людини в екстремальних умовах Антарктики.

Ключові слова: дизадаптація, адаптація, антарктичні умови, гіпоксичні стани, поліморфізм генів, екстремальні умови, біологічні ритми.

Introduction

At the Antarctic station a human's is under act of extreme factors, that can be negatively reflected on the functional systems of organism [1, 3, 6, 8, 10].

Development of adaptation and dysadaptation depends on efficiency of mechanisms of adjusting of psychophysiological functions and of oxygen regimes of organism [9].

The participants of the Antarctic expeditions have problems of disfunction of the systems of organism with development of chronic stress which can be reason of origin of the "Antarctic syndrome" [10, 11].

Such changes under act of stress factors can make basis of pathogenetic mechanisms of development of dysadaptations disorders, origin of the hypoxic status, protracted motion of adaptation of human to the Antarctic terms [1, 9].

That is why research of features of mechanisms of dysadaptation can be reliable basis for application of complex pathogenetic correction of disorders in the functional systems of organism and prophylaxis of pathology of human's at the protracted stay in the extreme terms of Antarctic.

Materials and research methods

Work was based on the results of medical-biological studies, which were conducted with participation of the crew members of the Antarctic station Academician Vernadskiy (Vernadsky – 65° 14'43"S; 64° 15'24"W). The average age of examinees was 39,8±2,4 years (130 men). The medical-biological studies included the modern clinic-laboratory, functional, instrumental, biochemical, immunologic, genetic, statistical methods. The participants' examinations of the expedition were conducted before expedition, at a period of transatlantic transition, on Antarctic station (in mode of the monitoring by means of telemedical connection), after returning from expedition [4].

Psychofisiologic of function was explored by the programs (the system of type is “Prognosis”) and testing (activity, mood; scale of anxiety; levels of the emotional burning; questionnaires of Rozentzveig, Hamylton and others like that) technologies, EEG was conducted on telemedical technology of the system of DX-Expert of firm TREDEX (Ukraine).

The status of the system of the external breathing was determined after parameters by the functions of the external breathing (respiratory volume, vital capacity of lights, breathing frequency, indexes of pulmonary ventilation, status of communicating of respiratory tracts, diffusive ability of lights), which was registered the methods of bodypletismografic (JAEGER) and spymetric.

The status of the system of circulation of blood was estimated on indexes: frequencies of cardiac reductions, electric activity of myocardium, changeability of cardiac rhythm, which was determined the methods of electrocardiography (RADIOHOLTER, Ukraine); arterial pressure which was measured after the method of Korotkov (Omron); morfological-functional structure of heart, which was registered the method of echocardiography (automated analyzer of polycardiography); biomagnetic status of myocardium which was measured the method of MagnetoCardioGraphy (MCG) (a center of MCG is in Institute of cardiology of N.D.Strajesko AMN Ukraine); status of regional circulation of blood, which was determined the methods of reovasography and reoencefalography.

Bearableness of physical work (stage-by-stage increase of loading to 75% maximal of oxygen capacity) was conducted with synchronous registration of parameters of circulation of blood, external breathing, microgazoanalyzer of (Radelkis, Hungary) with the next calculation of parameters oxygen modes in organism and their expert estimation.

Biochemical researches of blood were conducted by the method of “dry chemistry” (Reflotron) with registration: haemoglobin of blood; indexes of protheinic metabolism (creathinin, urea, urinary acid); lipidic metabolism (cholesterol, tryglicerids); carbohydrate metabolism (glucose, amylase); general bilirubin. The analyses of urine on maintenance of cathecholamynes (adrenalin, noradrenalin, dofamin, DOFA) measured the method of fluoromethryc in tests from day's amount of urine. The global analyses of blood (red corpuscles and haemoglobin, leicythy formula) were executed with application of well-known laboratory methods. Oxydation – antyoxydation homeostasis studied on the indexes of dialdegid malonic and activity of superoxyddysmutase in blood.

Status of the immune system of winterers was determined on the indexes of phagocytic activity of neitrophyls (NDT test), maintenance in the whey of blood of immunogiobulins, immune complexes, leicogramm after the generally accepted methods.

Genetic researches included genetic analyses in the presence of allelic polymorphism the gene of HIF-1 α with the use of methods PCR.

In addition, for determination of dynamics of individual level of radiation contamination of organism, winterers were inspected through the method of count of radiations (on the base of the Scientific center of radiation medicine of AMN of Ukraine, laboratory of meters of radiation of human).

During the protracted stay at the Antarctic station the estimation of psychophysiological functions of winterers was carried out as a result of testing (Feel, activity, mood – FAM, proof-reading test of Landolt, method of Lucher, registration of EEG), estimation of the status of the breathing system – as a result of spirometry research; systems of circulation of blood – from data of ECG, indexes of arterial pressure; systems of blood – as a result of biochemical and laboratory analyses. At the station measured mass of body of winterers and executed research of psychophysiological functions and function of circulation of blood and temperature of body in the mode of day's monitoring. The hidden forms of desynchronization appeared at biorhythmical approach, on what specify violation in the phase-peak structure of circadian rhythms of the functional systems of human. In the process of processing of data the parameters of day's architectonics of rhythms of higher nervous performance of human indicators were calculated (average daily level, to the acrophas maximum and minimum).

Meteorological and the helioheophysical parameters of environment were registered the specialized technological complexes by forces of specialists of the National Antarctic scientific center of MES of Ukraine.

Results of researches and their discussion

The personal touches of influencing of winterings in Antarctic on a human's above all things showed up violation of disfunctions of the systems of integrations. Thus there were changes of processes electro-genesis of brain. The spectral picture of bioelectric activity of brain was characterized growth of power of rhythms of range of delta at a tendency to the increase of μ -rhythms which can testify to the presence of strengthening of functional tension in CNS.

Alteration in the structure of spectral biorhythms of EEG show up in the right hemisphere of brain which can be the sign of certain disfunctions changes in CNS and negatively reflected on the psychophysiological status, assisting development of dysadaptation disorders of the functional systems.

Change in the spectral structure of correlations of biorhythms of brain had features in accordance with the seasons of year and on the final stage of expedition characterized strengthening of power of range of α -and diminishing of power of α -rhythms (Fig.1)

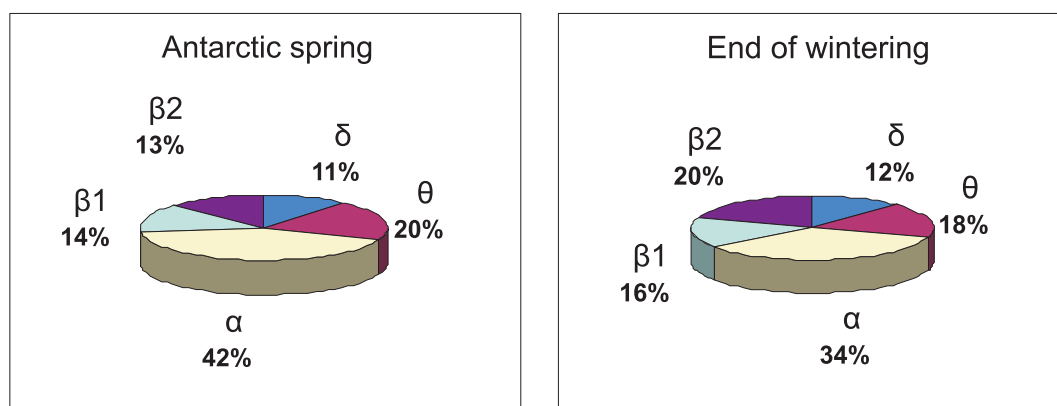


Fig. 1. Brain activity (EEG) in winterers.

Parallel with the changes of cerebral biorhythms, a spiritual fatigue and worsening of indexes of psychophysiological functions appeared in winterers.

Thus, certain alterations of central mechanisms of adjusting could be the displays of presence at the winterers of general stress-syndrome which develops under winterers in Antarctic.

Therefore, the certain changes of central mechanisms can testify to development at the winterers of general stress-syndrome [5, 6, 7].

Confirmed growth of secretion of catecholamines with urine, that was the sign of certain changes in the sympathic-adrenalic system. General growth of secretion of catecholamines more distinctly showed up on the initial stage of expedition and could testify to the presence of stress-syndrome with activating humoralic mechanisms in the phase of urgent adaptation to the terms of Antarctic.

After the protracted influencing of the Antarctic terms at winterers was found out the decline of phagocytes activity of neutrophyles. Thus the individual indexes of falling of phagocytes activity hesitated within the limits of 30–70% (Fig.2).

Except for it, in winterers in the whey of blood the amount of immunoglobulines of IgM comparatively with the initial state went downward (on 44,1%, $p < 0,05$). Such violations of immune defence testified to the decline of immunoresistens organism in phagocytes and to humoral links, for certain as a result of development of disfunction processes in the system of immune homeostasis.

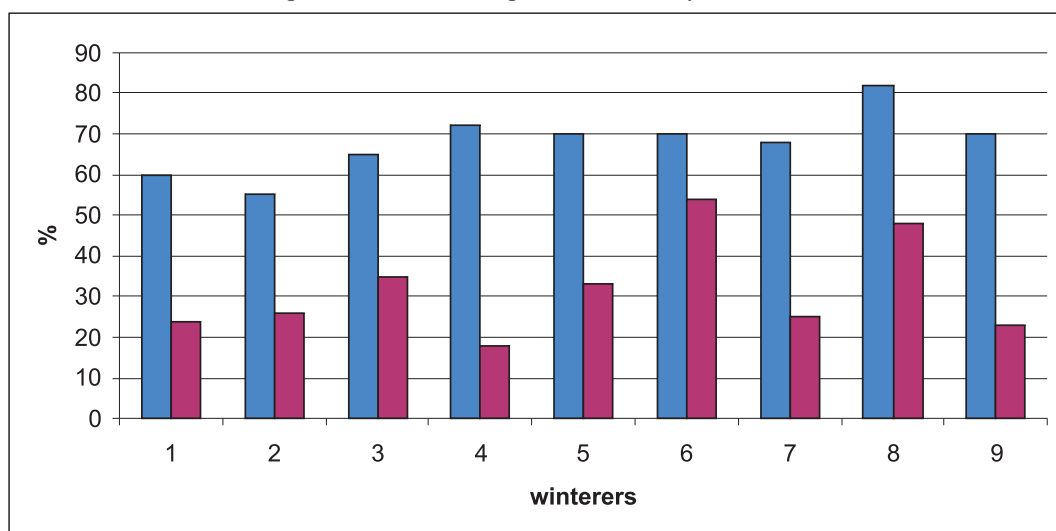


Fig. 2. Individual changes of phagocytes activity at winterers after (dark column) return from the Antarctic expedition in relation to the indexes of the initial state (light column).

The mechanisms of such alterations in the immune system can be related to violations in other systems (to nervous and endocrine), as such distributing of the systems of organism is conditional and in development of reactions of syndrome of stress they take incorporated part. Co-operation of the systems (nervous, endocrine, immune) on the modern stage of development of scientific researches seems extraordinarily difficult, as it is proved that the cages of CNC can product hormones and matters of immune activity which must ability take part in adjusting of all systems of integrations of organism.

From other side, aggregate of results of research of the immune system that presence of changes of certain faction (IgM) specified on the reliable diminishing of the exogenous irritating influencing of mainly biological nature on the immune system in times of a stay at the Antarctic station.

Consequently, the results of researches demonstrate the decline of immunobiological firmness of organism of human under act of the protracted stay in Antarctic, which needs application of effective facilities of its increase both in the conditions of expedition and on the stage of rehabilitation.

Researches of mechanisms of adjusting of the modes of oxygens of organism of winterers and mechanisms of indemnification of hypoxia which arises up during the strained physical work defined the decline of functional backlogs, that showed up in inadequacy of indemnification of hypoxia of loading. The protracted stay of human's in the Antarctic expedition results in dysregulation of oxygen modes even at peace. Regulation of organism oxygen modes of winterers at the protracted stay at the Antarctic station was characterized dysregulation of the mechanisms (decline of efficiency and economy). During physical loading the minute volume of blood rose due to growth of frequency of cardiac reductions, and retractive activity of myocardium went (fraction of banishment of blood diminished to $63,1 \pm 2,3\%$ against $68,5 \pm 2,5\%$, $p < 0,05$, in a control) down, that was the sign of falling of efficiency of cardiac activity. Thus growth of respiratory volume of lights and ventilation did not provide support of adequate level of maintenance and tension of oxygen in blood, that testified to incomplete indemnification of hypoxia (Fig.3).

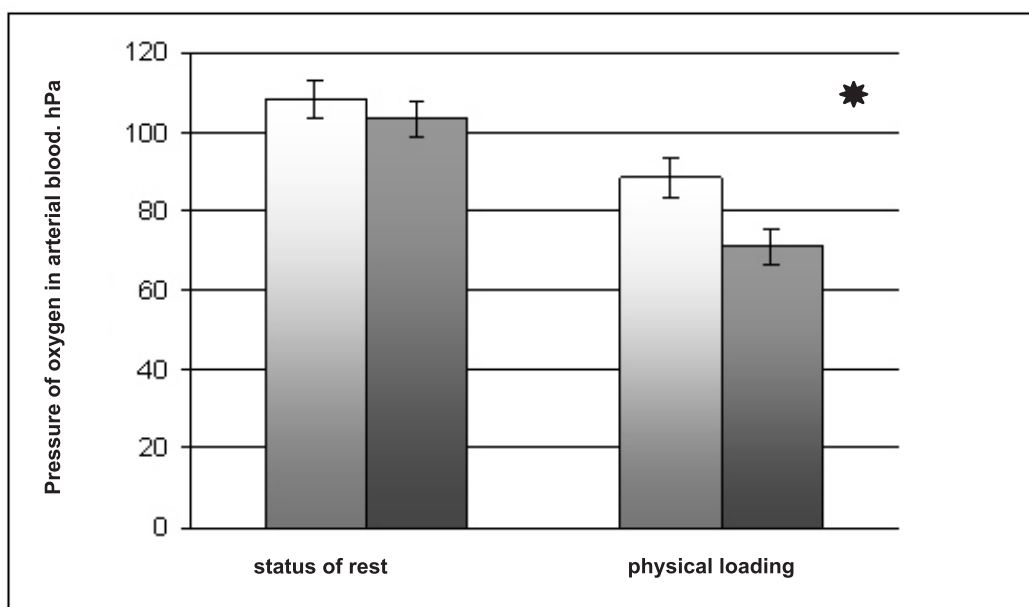


Fig. 3. Changes of p_aO_2 (pressure of oxygen in arterial blood) at winterers to the expedition (light column) and after wintering (dark column)

* – $p < 0,05$.

Except for it in blood of members of expedition it was found anymore dialdehyd malonic (on 41,2% higher than control), that demonstrated activating of oxydation processes in an organism. Parallel, at 80% winterers the decline of activity of enzyme of SOD was found with maximal deviation from a control on 58%. Development of such status can be conditioned the protracted influencing of complex of factors, related to the terms of stay at the station (winter-over syndrome, winter-over mental syndrome, adaptive trouble, regional meteorological influencing and others like that). The factors of stay are marked at the Antarctic station can be active stressful and to act dominant part in forming of a stress status and origin of row of dysadaptation disorders in the organism of winterers.

Disorders of the normal functioning of the oxygen systems at stress are experimentally proved researches in a department on the study of the hypoxia status of A.A. Bogomoletz Institute of Physiology National Academy of Sciences of Ukraine and consist in because the protracted stress results in the decline of backlogs of function of the external breathing and origin of arterial hypoxia. It was explained: violation of co-ordination between intensity of pulmonary blood stream and alveolar ventilation; promoted shunting of blood in lights; by the decline of diffusive ability of fabric of lights and others like that. Such sequence of violations is possible at a human which long time was under act of the extraordinary Antarctic factors [8,9].

Indeed, at winterers some decline of functional volumes of lights (the vital capacity of lights is forced – to $4,83 \pm 0,17$ l is against $5,98 \pm 0,24$ l, $p < 0,05$; vital capacity of lights – to $5,0 \pm 0,2$ l is against $5,7 \pm 0,2$ l, $p < 0,05$) was found with a tendency to worsening of communicating of bronchial tubes of small caliber and decline of their diffusive ability. Arterial pressure had a general tendency to growth, and pulse pressure – to the decline due to the greater increase of indexes of diastolic pressure. As a result of analysis of variation rythmocardiografic the sympathocotonical influencing predominated in adjusting of operation of heart. Thus subject to the condition increase of diastolic pressure, decline of pulse pressure and prevailing of influencing of likable department of the vegetative nervous system of loading on a heart can grow, accompanied a certain redistribution, especially in the system of small circle of circulation of blood.

At winterers studied electric conductivity of heart the method of MagnetoCardioGraphy (MCG). It enabled to expose disorders of processes of repolarysation. Such disorders can be the signs of the promoted work of heart [9].

Thus, as a result of complex research of the state of the functional systems of the Antarctic winterers after the protracted stay in an expedition the certain picture of violations appears both in the integrative systems and in the oxygen systems of organism.

The results of this series of researches and certificate of literary sources are got allow to do the following supposition: in the conditions of the protracted influence on the human of the Antarctic factors of dysadaptation disorders of the functional systems of organism take place on a background the complex of dysregulations disorders of the systems (nervous, endocrine, immune) of integrations, systems of adjusting of prooxydation-antyoxydation homeostasis, respirations, hemodynamic and hemic mechanisms of adjusting of the oxygen systems, which can be description of presence of a certain stress status (the stress-syndrome).

Monitoring researches at the Antarctic station allowed to find terms and mechanisms of development of a stress status, dysregulations and dysadaptation disorders in the organism of winterers. Long-term researches of the status of psychophysiological functions of human at the Antarctic station with application of methods of testing and registration of electroencephalogram allowed to trace the certain dynamics of changes of psychophysiological functions and bioelectric activity of brain during wintering. The substantial changes of the psychoemotional and psychophysiological status of winterers took place from the beginning in Antarctic, and they were characterized by not only alterations of normal circadian structure but also changes in correlations of basic bioelectric rhythms of brain (EEG).

Except for that, daily blitz-testing after the modified method (Feel, Activity, Mood) found out cases of disorders of normal duration of sleep, head pain and promoted anxiety. Such changes in combination with the signs of activating of the sympathoadrenal system (the secretion of catecholamins is megascopic) ground to examine the functional state of organism as stress. However much the general tendency of alterations of psychophysiological functions on the initial stage of stay in Antarctic did not have signs of the obvious pathological status and had individual character especially.

In a period Antarctic the winter of condition of sensory deprivation increase the protracted absence of sunlight, forced hypodynamic, achromatism of environment, social isolation of crew. At this time there were most of disorders of normal duration of sleep (up to development of the status of insomnia), the cases of worsening of mood became more frequent at winterers, microgrups after interests, which kept away from a collective, were formed. Thus circadian architectonics of psychofisiologicals functions had total curvature and a psychical fatigue accumulated, what the results of the test questioning testified about. On EEG the signs of depression of α -rhythm were saved. Tension of functions of organism and reactions of adaptations in this period, for certain, rose to the critical sizes, as cases of signs of dysregulations and dysadaptations disorders became more frequent among winterers, especially from the side of the system of blood circulation (increase of arterial pressure, tahicardia, arrhythmia, symptoms of anginal), the cases of origin of head pain became more frequent. On a background such "sensitiveness" systems of organism many winterers had signs of increase of meteorological and heoheliological sensitiveness, which was characterized addition of amount and depth of the subjective feelings at indignations of processes of external environment. Consequently, in a winter period at the winterers of symptomatic phenomena of a stress status can deepen, that, obviously, assisted development of dysadaptations disorders [2, 9].

In spring the subjectively estimated status of winterers got better, the picture of biorhythmical of brain some got better and curvatures of cyrcadian structure of psychofisiologicals functions diminished. However here were consequences of the carried in winter stress status, that showed up in saving of microgrups and proof worsening of mood, and at separate winterers – status of insomnia, and also in the presence of signs of psychical fatigue. Except for that, the Antarctic spring were declines of oxygen capacity of blood due to erytopenia and diminishing of haemoglobin. Depressed changes of red blood at winterers the Antarctic spring can be by investigation surplus the protracted winter stressogenic and possible hypoxic stimulation, as in this period on the European breadths in the organism of healthy human of similar age-old category there is an appropriate increase of haemoglobin and amount of red corpuscles in blood. From other side, in the region of the Antarctic station a "ozone hole" which results in the frequent increase of sun radiation in an ultraviolet range is opened in a spring period, and the harmful action of surplus ultraviolet irradiation of human can be negatively reflected on the function of erhytropoesis.

In spring indexes of common of cholesterol in blood, tryglyceryd, and also creatynin, urea and urinary acid remained promoted, that testified to dysregulations disorders of squirrel and fats metabolism. Therefore in spring functioning of the systems of organism for certain is under a less stress influencing, but sign of dysregulations and dysadaptations disorders of the functional systems remained.

There was a new wave of desynchronosis and dysadaptations disorders on the final stage of expedition (by the Antarctic summer). The cases of psychoemochens instability, crabbiness, anxiety became more frequent. In this period the amount of persons was multiplied with disorders of normal duration of sleep, head pain, worsened mood. The increased signs of depression showed up as a result of testing, on EEG – power of α -rhythm diminished, the particle of low on frequency rhythms grew in the general spectrum of bioelectric activity of brain. Thus winterers had substantial curvatures of normal day's rhythm of psychofisiologicals functions, the signs of chronic fatigue were saved and increased. For completion of expedition the row of signs of oppressing immunobiologyc rezystens of organism which also is the certificate of influencing of processes of dysregulations as a result of development of a stress status appeared at them. At the end of wintering respirations and hemodynamicals mechanisms regulated of oxygen modes of reduced their efficiency, that resulted in rapid exhaustion of functional backlogs and loss of capacity for indemnification of hypoxia of loading [1, 9].

Consequently, during the protracted stay at the Antarctic station in the organism of human terms were constantly created for development of the status of stress.

Thus, obviously, the processes of adaptations *de bene esse* can be divided into the phases of initial adaptation, functional tension, relative stabilizing and depression.

The phase of initial adaptation was characterized the active processes of biorhythmological nature, which is confirmed disorders of normal circadian architectonics of psychophysiologicals and visceral functions, temperature of body, day's dynamics of which is the mediated certificate of violation of rhythm of secretion of hormone melatonin. A characteristic sign was a substantial increase of levels of excretion of catecholamines with urine (adrenalin, noradrenalin), that testified to stimulation of the sympathoadrenal system as a result of the obvious stressogenic influencing of extreme terms in Antarctic

A phase of functional tension was the result of the complex influencing of biorhythmological factors, sensory deprivation and hypodynamic status, characteristic changes of correlation of rhythms of EEG, which demonstrated strengthening of depression of power of α -rhythm, growth of particle of α - and α -rhythms in the general spectrum of bioelectric activity of brain, that testified to deepening of dysregulations disorders in CNS. At this time there were extraordinarily ugly curvatures of circadian rhythms of psychophysiologicals functions which was characterized a presence during days a few to the acrophasis maximum and minimum. The vegetative adjusting of cardiac activity had unsteady character, vegeto-vascular reactions were increased, what growth of cases of increase at the winterers of arterial pressure testified about. The vital capacity of lungs was contained on the reduced indexes, that could relate to the redistribution blood stream in the small circle of circulation of blood. In this period there were changes of squirrel and fats metabolism, which showed up some growth in blood of cholesterol, urinary acid, tryglicerids, that are atherogenetical characteristics.

In the phase of the relative stabilizing which showed up with arrival of the Antarctic spring, the collective of crew of the station had relations of interpersonalities, the indexes of breathing and circulation of blood were some stabilized, correlations of rhythms of electroencephalogram were optimized. However the oxygen capacity of blood had a tendency to the decline, there were intensive alterations of leucocytes formula. The signs of accumulation of chronic fatigue were saved in the phase of the relative stabilizing.

The final phase of depression was characterized the promoted levels of anxiety, crabbiness, emotional instability, gain in specific weight of low rhythms of electroencephalogram, proceeding in desynchronical disorders, falling of indexes of immunoresistens organism. After return from Antarctic symptoms of the last phase some time saved, signs appeared of dysadaptations disorders, decline of immunoresistens of, which complicated motion of processes of readaptations, which can last during months, and even years.

Thus, phasic adaptations and dysadaptations of human in the Antarctic terms dictates the necessity of development of the differential system of psychophysiological accompaniment of expeditions and effective medical and prophylactic technologies at the station, and also methods of rehabilitation of winterers after an expedition. Except for that, possibility is opened research of influencing of extraordinary factors of environment of Antarctic is taking into account the features of the functional status of organism in the proper phase of adaptation [11].

Research of influence on the winterers of complex of biorhythmological of meaningful factors of region of the Antarctic station showed the presence of considerable violations of normal circadian rhythms of the functional systems of organism, which have certain seasonal and individual features (Fig. 4).

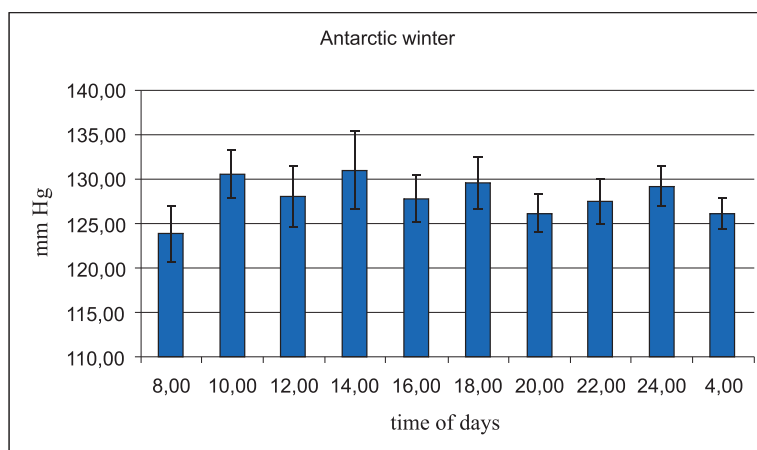


Fig. 4. Curvature of day's rhythm of systolic of arterial pressure of participants of the Antarctic expedition in winter (origin a few to the acrophases maximum with a sentinel change on 10, 14, 18 and 24 hours and to the acrophases minimum – on 8, 20 and 4 hours).

The results of these researches enabled to examine the forms of destruction of rhythms of daily allowances as possible link of chain of mechanisms of development of dysregulations and dysadaptation disorders and showed the presence of the protracted periods of the Antarctic stay, when such changes show up especially distinctly (Antarctic the winter and Antarctic summer). One of mechanisms of such changes there can be changes of normal rhythms of secretion of “hormone of sleep” of melatonin, that is confirmed strengthening of disorders of circadian architectonics of temperature of body in proper periods finding of human in Antarctic.

Application of biorhythmological approach at the estimation of the status of the functional systems of organism of human in Antarctic something extends the picture of mechanisms of development of dysadaptations disorders and the “Antarctic syndrome” which has prevalence in Antarctic continent, as in the synchronously standardized researches with participation of the Ukrainian and Polish crews by us were found out the similar changes of psychophysiological functions during wintering. It is possible to assume from data of results of biorhythmological inspection of winterers, that the processes of destruction of circadian rhythm of psychophysiological functions are saved during all wintering, that is able to be negatively reflected on quality of processes of adaptations in an organism and to promote authenticity of development of desynchronical disorders, accumulation of fatigue and development of dysadaptations disorders.

Among the participants of the different Antarctic expeditions always appears certain amount of persons (about 30–40%) which had objective (disorders of cardiac rhythm, electric activity of heart, increase of arterial pressure) and subjective (worsening of feel, origin of head pain, anxiety) signs of reaction on changing of meteorological and helioheophysical situations. It was thus marked that at meteorological changes there are the certain subjective experiencing which are perceived as original presentiment or investigation of influencing. Such displays more frequent arise up during the late Antarctic autumn and in a winter period, when a meteorological situation is complicated the sharp overfalls of barometric pressure, megascopic humidity of air, sharp strengthening of the wind loading which provokes fluctuation of level of oxygen in a respiratory environment, especially in the side of his decline [1, 3, 10].

The results of correlation analysis witnessed the presence of close correlation connection between the parameters of barometric pressure and humidity of external air and indexes of work heart and common resistance of vessels. Except for that, a correlation analysis showed the presence of close intercommunication of parameters of barometric pressure with the indexes of bioelectric conductivity (interval of R–R, QRS). It was a close enough line correlation dependence of parameters of ozone and K_1 (indexes) with the indicated intervals, that testifies to the possible role of helioheophysical factors and megascopic sun radiation [2].

Therefore in a period the protracted stay at the Antarctic station of change in the cardiac and vascular system of human have most attitude toward the changes of barometric pressure and humidity

of air. Thus falling of barometric pressure calls with growth of frequency of cardiac reductions and tension in the robot of heart. Such changes touch the system of heart and vasculares mechanisms, that testifies to including of central mechanisms of adjusting. Variations and changes in composition an ozone layer, for certain, have other level of biological answer which is the article of subsequent researches of the systems in the indicated direction.

The features of oxidation - antioxydation status of human in Antarctic consist in development of oxidative stress as a result of the protracted complex influence on the organism of the Antarctic factors. Probably oxydative stress has a main value in development of dysadaptations disorders, but can have individual features.

The problem of analysis and interpretation of individual variations of functioning of the systems of organism and mechanisms of development of dysadaptatives disorders and indemnification of hypoxia complicates the study of physiological and pathophysiological mechanisms considerably. Our the research was set substantial individual disagreements at development of adaptations and dysadaptations reactions of winterers in Antarctic. For example, not all winterers suffered from the origin of the "Antarctic syndrome", cyrcadian and seasonal violations of the functional systems of organism had individual features, degree of development of signs of a stress status, dysregulations and dysadaptations reactions also had certain individual differences, and others like that. That is why an attempt to define the role of molecular-genetic mechanisms was done in our work [12].

On attention one of basic alarm ways of the HIF (hypoxia induced factor)– complex of protein, which finds out transcription activity mainly subject to the condition reduced oxygen. Allelic polymorphism was recently described to the oxygen domain of degradation (ODD) of gene of HIF-1 α , which can matter in the oxygenic of regulation of the squirrel HIF-1 α through hydroxylation of prolinic remain in position 564 (P564) by HIF-1 α of prolilhydroxylase. It is expedient to mark that frequency of different variants of gene of HIF-1 α in of specialists of Antarctic activity is explored by us first, and a study of value of allelic polymorphism of this gene in the mechanisms of adaptation and development of dysadaptation disorders of human in Antarctic is on the initial stage.

The results of our researches showed that depending on the genotype of winterers of the oxygen-transport systems in Antarctic acquire certain features, and their reactions on hypoxia of loading have a difference which gives additional confirmation of role in this process of gene polymorphism.

It is set that in Antarctic in the organism of persons with the heteroszygus genotype of HIF-1 α on a background the signs of the promoted status of stress (growth of particle of power of high-frequency rhythms of EEG, increase of level of ecretion of catecholamines, disorders of biorhytm) there can be more favourable terms for development of dysadaptation disorders of the oxygen systems.

The results of research of transport for oxygen systems and their mechanisms showed tension of function of blood circulation in status of rest and decline of efficiency of hemodynamical connection of adjusting of transport for oxygen systems in the physical loading which resulted in development of the mixed form of acydosis.

Consequently, a presence at winterers with allelic polymorphism of HIF-1 α of tension of function of the system of circulation of blood can be the certain certificates of individuality of reactions of organism on influencing of the extreme Antarctic factors and hypoxia, that regulated the mechanisms of molecular-genetic level. Information is got first give a shove to subsequent researches with the purpose of establishment of physiology value of polymorphism of gene of HIF-1 α at development of adaptations and dysadaptations alterations of the functional systems of organism at protracted influential extreme factors.

Thus, at the protracted stay of human in the conditions of the off-shore Antarctic station under act of complex of extreme factors the numerous changes of the normal functioning of the systems of organism and mechanisms of adjusting of oxygen homeostasis are possible able to entail stress status with development of dysregulations and dysadaptations disorders. Thus latent motion of dysregulations and dysadaptations disorders especially subject to the condition permanent

influencing of variations of the extreme Antarctic factors, becomes extraordinarily dangerous, as obvious pathological displays can arise up at the additional loading on the functional systems of organism, and the permanent presence of signs of syndrome of stress is capable long time negatively to influence on organs-targets which most need normal providing oxygen (Fig. 5).

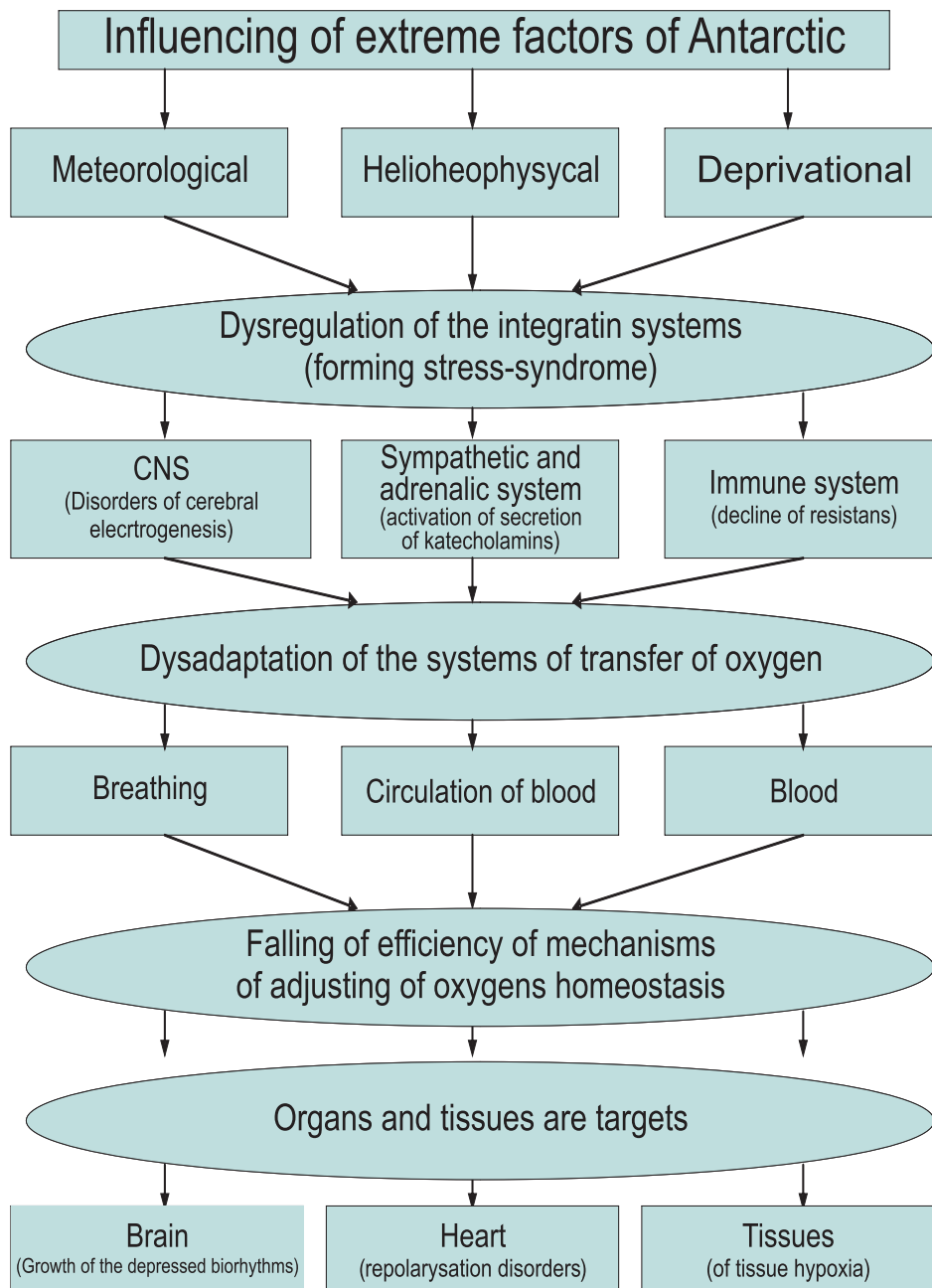


Fig. 5. Winterers have a general chart of development of dysadaptative violations.

Thus, the results of researches were shown by the features of mechanisms of adaptation and dysadaptation human in Antarctic. It can be reliable foundation for development of effective methods of correction and prophylaxis of pathology of the Antarctic winterers.

Conclusions

1. Psychophysiological, physiological, pathophysiological, clinical, genetic, and telemedical researches (in the mode of monitoring) of mechanisms of adaptations and dysadaptations alterations of the functional systems of human in Antarctic open the new pathogenetical mechanisms of development of dysadaptations disorders of the oxygen-transport systems of organism. The dynamic changes of quantitative and high-quality indexes of dysfunction of the regulation systems of integrations are certain, and also respirations, hemodynamic and hemic mechanisms of adjusting of oxygen-transport systems, immunoresistance, oxidation-antioxidation and leucocytic of the homeostasis, metabolism of fats and albumens and carbohydrate of human at the protracted stay under act of complex of extreme factors of the Antarctic expedition testify to the permanent presence of a stress status (stress-syndrome), which results in development of dysadaptations disorders which need application of methods of correction.

2. Alterations of adaptations and dysadaptations processes at a human in Antarctic are characterized the special stages: initial adaptation (Antarctic autumn), functional tension (Antarctic the winter), relative stabilizing (Antarctic spring) and depression (The Antarctic summer is a final period).

3. The features of adaptations and dysadaptations alterations of the functional systems of organism of human at the protracted stay in Antarctic depend on the presence of polymorphism of HIF-1 α [replacement of citozin (C) is on timin (T) in 1772 positions of gene], which opens the prospects of study of genetic mechanisms of individual firmness and adaptation of organism of human to the extraordinary terms.

4. The basic mechanism of development of dysadaptations disorders of the functional systems of winterers, in the first turn, dysregulations is homeostasis of the systems of integrations – nervous (change of spectral balanced of bioelectric activity of brain), sympatho-adrenalic (growth of secretion of catecholamines) and immune (decline of immunoresistens), that is accompanied subsequent development of dysadaptations disorders of respirations, hemodynamic and hemic mechanisms of adjusting of oxygen-transport systems of organism, by the origin of signs of oxydative stress status (activating of processes of oxidization and oppressing the system of antyoxydation defence) and displays of the hypoxia status.

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