Akopov G.P., Petrova E.P., Orlova M.A., Glazachev O.S., Tkatchouk E.N.:
THE EFFECT OF INTERVAL HYPOXIC TRAINING ON THE PSYCHO-PHYSIOLOGICAL STATUS OF HEALTHY SUBJECTS
Hyp. Med. 1997. V. 5. N 2. P. 20-22.
Placebo-controlled study of interval hypoxic training (IHT) effect on psycho-physiological status was performed in healthy young men. IHT induces significant changes of psycho-physiological status in healthy subjects, reflected in switching of anxiety realization from somatic and emotional level to behavioral one, and in reduced use of immature forms of psychological defense. The obtained data suggest increased reserve of adaptive sleep function resulting from IHT.

D M Bailey, L M Castell, E A Newsholme and B Davies. Continuous and intermittent exposure to the hypoxia of altitude: implications for glutamine metabolism and exercise performance *Br J Sports Med* 2000; *34*:210-212
The time spent exposed to the hypoxia of altitude would appear to be an important mediator of sea level performance. A combination of physical exercise and intermittent hypoxia (defined as an exposure time of 30 minutes to 12 hours a day) has been shown to accelerate the normal adaptations invoked by a comparable program of normoxic training with cardioprotective and performance enhancing benefits. In contrast, increased free radical mediated oxidative stress, decreased cell mediated immunity and increased incidence of infectious episodes have been reported in continuous hypoxia (defined as an exposure time of 24 hours a day). We have previously reported two cases of infectious mononucleosis following chronic exposure to 1500–2000 m. In conclusion, a combination of physical exercise and repeated bouts of intermittent hypoxia appears to initiate a disruption in systemic homoeostasis which is followed by an adaptive phase which, in general terms, appears to be beneficial. Adaptation appears to be inadequate during continuous hypoxia, which could have potentially deleterious consequences.

Bailey DM, Davies B, Baker J
Training in hypoxia: modulation of metabolic and cardiovascular risk factors in men.
Med Sci Sports Exerc 2000 Jun;32(6):1058-66
PURPOSE: This study was designed to determine changes in metabolic and cardiovascular risk factors following normobaric hypoxic exercise training in healthy men.
METHODS: Following a randomized baseline maximal exercise test in hypoxia and/or normoxia, 34 physically active subjects were randomly assigned to either a normoxic (N = 14) or a hypoxic (N = 18) training group. Training involved 4 wk of cycling exercise inspiring either a normobaric normoxic (F(IO2) = approximately 20.9%) or a normobaric hypoxic (F(IO2) = approximately 16.0%) gas, respectively, in a double-blind manner. Cycling exercise was performed three times per week for 20-30 min at 70-85% of maximum heart rate determined either in normoxia or hypoxia. Resting plasma concentrations of blood lipids, lipoproteins, total homocysteine, and auscultatory arterial blood pressure responses at rest and in response to submaximal and maximal exercise were measured before and 4 d after physical training. RESULTS: Total power output during the training period was identical in both normoxic and hypoxic groups. Lean body mass increased by 1.4 +/- 1.5 kg following hypoxic training only (P < 0.001). While dietary composition and nutrient intake did not change during the study, both normoxic and hypoxic training decreased resting plasma concentrations of nonesterified fatty acids, total cholesterol, high density lipoprotein (HDL), and low density lipoprotein (LDL) (P < 0.05 - < 0.001).Apolipoproteins AI and B decreased following normoxic training only (P < or = 0.001).Plasma concentrations of resting total homocysteine decreased by 11% following hypoxic training (P < or = 0.05) and increased by 10% (P < 0.05) following normoxic training.These changes were independent of changes in serum vitamin B12 and red cell folate which remained stable throughout. A decreased lactate concentration during submaximal exercise was observed in response to both normoxic and hypoxic training. Hypoxic training decreased maximal systolic blood pressure by 10 +/- 9 mm Hg (P < 0.001) and the rate pressure product by 14 +/- 23 mm Hg x beats x min(-1)/100 (P < or = 0.001) and increased maximal oxygen uptake by 0.47 +/- 0.77 L x min(-1) (P < 0.05).
CONCLUSION: Normoxic and hypoxic training was associated with significant improvements in selected risk factors and exercise capacity.The stimulus of intermittent normobaric hypoxia invoked an additive cardioprotective effect which may have important clinical implications.

Belkina L.M., Budanova O.P., Tkatchouk E.N., Saltykova V.A., Shimkovich M.V.,Ehrenburg I.V., Meerson F.Z.:

THE ANTIARRHYTHMIC EFFECT OF ADAPTATION TO NORMOBARIC HYPOXIA IN LOCAL ISCHEMIA AND REPERFUSION OF THE MYOCARDIUM.
Hyp. Med. J. 1995. V. 3. N 1. P. 15-18.
The antiarrhythmic effects of two regimens of adaptation to normobaric hypoxia (NH; 10% O2 + 90% N2) were compared in acute experiments on anesthetized (nembuthal) Wistar male rats. One group of rats was exposed to interval NH (5 min of hypoxia + 3 min of normoxia) for 1.5 h daily and the other group was exposed to interval NH (5 min of hypoxia + 3 min of normoxia). Both regimens of adaptation significantly decreased the incidence and duration of ventricular tachicardia during a 10 min coronary occlusion and subsequent reperfusion. Furthermore the preventive effect of continuous hypoxia was more pronounced in ischemia whereas that interval hypoxia - in reperfusion. The data indicate certain prospects on the application of adaptation to NH for prophylaxis of cardiac arrhythmias.

Chesnokova V.V., Vorobieva O.K., Fetisova E.V.:
CLINICAL ASSESMENT OF INTERVAL HYPOXIC TRAINING EFFECT IN PATIENTS WITH CENTRAL CHORIORETINAL DYSTROPHY
Hyp. Med. J. 1993. V. 1. N 3. P. 24-27.
A course of IHT was given to 30 patents suffering from central chorioretinal dystrophy (CCRD). The duration of breathing the 10-12% 02 hypoxic mixture during 1 session was 20 to 60 min., the course consisted of 20 daily sessions. The patients were divided into 3 groups of 10 individuals each: group I was given conservative treatment, group II only IHT, group III - IHT against conservative therapy. The visual acuity increased significantly in group III patients, in a lesser degree in group II and insignificantly in group I patients. Group II and group III showed an improved arterial and venous circulation. Clinical investigation showed a reduction or disappearance of visual discomfort. The best effect was noted in group III followed by group II and the least effect was seen in group I. It is concluded that IHT both alone and combined with conservative therapy affects positively the dynamics of the initial dry form of CCRD and favours the patients- rehabilitation in a larger measure than conventional therapy.

Chizhov Aia. Physiologic basis of the method to increase nonspecific resistance of the organism by adaptation to intermittent normobaric hypoxia. Fiziol Zh 1992 Sep-Oct;38(5):13-7
Impulse biorhythm of cyclic pO2 change in the uterus tissues and intrauterine fetus of rats, guinea pigs and dogs is regarded as evolution-fixed, physiological mechanism aimed at increasing nonspecific resistance of the fetus. Modeling of this mechanism by adaptation to intermittent normobaric hypoxia under impulse conditions permits more significantly increasing nonspecific resistance of the organism than application of hypoxic effect under constant conditions.

Dupin A.M, Lyzhin A.A., Khaspekov L.G., Viktorov I.V.

HYPOXIC PRECONDITIONING REDUCES INJURY TO CULTIVATED NEURONS IN FOLLOWING OXIDATIVE STRESS

Research Institute of Clinical Psychiatry, Russian Academy of Medical Sciences and Research Institute of Brain, Russian Academy of Medical Sciences, Moscow

Abstract of the lecture on the 2nd International Conference "Hypoxia in Medicine"
A number of studies have demonstrated that short term global and focal brain hypoxia in experimental animals has a clear protective effect and reduces the injury to the neurons in repeated ischemic exposure. (Kitagawa K. et al., 1991; Glazier S. et al., 1994; Matsushima K., Hakim A., 1995) . These phenomena were called "hypoxic preconditioning" and "ischemic tolerance" . It is believed that ischemic tolerance is based on the expression of biologically active compounds, displaying neuroprotective effect, and first of all it concerns the heat shock protein. Our ambition was to reproduce the phenomena of hypoxic preconditioning and of ischemic tolerance in brain cell culture, using the model of oxidative stress. In this we proceeded from the data indicating that one of the main pathogenetic factors causing neurons death in brain ischaemia, is free radical production and neuronal membranes lipid peroxidation (Siesjo B. et al., 1989; White B. et al, 1993) .
Manylayer brain cortex cell cultures of 17-18 rats embryos after two weeks cultivation were exposed to 1-3 h hypoxia in the chamber with anaerobic gas mixture (N2 95%, CO2 5%; t= 36,5(C) in the absence of glucose .

Such an exposure resulted in partial death of cells at the distanced terms of exposition. After hypoxic preconditioning culture was subjected to lipid peroxidation by iron-ascorobate system (20 (M FeSO4, 400 (M ascorbic acid in the balanced saline solution) . As a control we used cultures exposed to oxidative stress without hypoxic preconditioning. Hypoxic exposure caused suppression of the ascorbate- dependent LPO in neuronal culture, reaching the peak already in the 2 h ischaemia. In this "antioxidant" effect persisted , gradually decreasing for not less than 4 hours after the cessation of the hypoxic exposure. The data obtained show that hypoxic preconditioning prevents injury and death of the neurons caused by the oxidative stress.

Ehrehbourg I.V., Gorbatchenkov A.A.:
INTERVAL HYPOXIC TRAINING OF PATIENTS WITH CORONARY HEART DISEASE
Hyp. Med. J. 1993. V. 1. N 1. P. 14-16.
A course of IHT was given to 24 patients with ischemic heart disease (IHD) associated with stable angina and with a past history of myocardial infarction. The patients underwent 15 to 25 daily sessions of IHT with the total duration of breathing the hypoxic mixture 20 to 60 min. The completion of the IHT course was marked by a lower incidence of anginal attacks, better physical stress tolerance and a 25.1-3.5% increase in the threshold capacity. The efficiency of respiration improved, the antiarrhythmic effect was manifest as well. IHT is recommended as a non-drug method of treatment and rehabilitation of IHD patients with associated stable angina of effort..

Ehrenbourg I.V., Kondrykinskaya I.I.:
THE EFFICIENCY OF INTERVAL HYPOXIC TRAINING IN THERAPY OF CHRONIC OBSTRUCTIVE PULMONARY DISEASES
Hyp. Med. J. 1993. V. 1. N 1. P. 17-18.
A course of IHT was given to 118 patients with chronic obstructive pulmonary disease (COPD), chronic obstructive bronchitis (COB), infection-dependent form of bronchial asthma (IBA) and non-infectious bronchial asthma (NIBA). The IHT course was administered with the concomitant use of necessary broncholytics. The best clinical effect of IHT was noted in NIBA patients(improvement in 78% of cases). The clinical improvement in COB was observed in 88% and was accompanied by improvement in bronchial patency. In the IBA group the condition of 3 of 6 patients with severe steroid-dependent BA deteriorated. The clinical effect of IHT persisted an average of 4 months after treatment. The conclusion is made as to the positive effect of IHT primarily on NIBA and COB patients, the steroid-dependent form of BA being a relative counterindication for IHT.

Emerson MR, Nelson SR, Samson FE, Pazdernik TL.

A global hypoxia preconditioning model: neuroprotection against seizure-induced specific gravity changes (edema) and brain damage in rats.
Brain Res Brain Res Protoc 1999 Dec;4(3):360-6

Hypoxia preconditioning states that a sublethal hypoxia episode will afford neuroprotection against a second challenge in the near future. We describe and discuss a procedure for the development of global hypoxia preconditioning in adult male Wistar rats, using a mildly hypoxic (9% O(2), 91% N(2)) atmospheric exposure of 8 h. The persistence of neuroprotection was analyzed using a kainic acid (KA) model of brain injury. Rats were challenged with KA (14 mg/kg, i.p.) on 1-14 days post-hypoxia. The effects of hypoxia preconditioning on seizure score, weight loss, brain edema and histopathology were assessed. Brain edema, predominantly of vasogenic origin, was measured 24 h after KA administration using a reproducible and quantitative method based on the specific gravities of tissue samples. A density gradient column (1.0250-1.0650 g/cm(3)) comprised of kerosene and bromobenzene was used to assess the presence of edema in regions involved in seizure initiation and propagation that are normally extensively damaged (i.e., piriform cortex and hippocampus). Specific gravities of tissues were calculated through extrapolation with known NaCl standards. We found that hypoxia preconditioning prevented the formation of edema in these brain regions when KA challenge was given 1, 3, and 7, but not 14 days post-hypoxia exposure. Furthermore, neuroprotection was observed in animals that had robust seizures. The described procedure may be used to examine the neuroprotective mechanisms induced by global hypoxia preconditioning against many subsequent challenges reflecting a variety of experimental models of brain injury, and will provide a better understanding of the brain response to hypoxia and stress.

Fliss H., Comas T.M., Ehrenburg I.V., Gulyaeva N.V., Tkatchouk E.N.:
EFFECTS OF IN VIVO HYPOXIC PRECONDITIONING ON TRANSCRIPTION FACTORS IN RAT HEART Hyp Med. J. 1997. V. 5. N 3. P. 9-10.
We examined the possibility that the cardioprotective effects of in vivo hypoxic preconditioning achieved with intermittent hypoxia training (IHT) may be attributable to attenuation of the proinflammatory transcription factors (NF-kB, AP-1, Sp1). Male rats were subjected to 20 sessions of IHT of increasing duration and decreasing O2 content. Electrophoretic mobility shift assays with myocardial nuclear extracts showed a large decrease in the nuclear content of NF-kB, AP-1, and Sp1 in the hypoxic hearts. The data suggest that IHT cardioprotection may be caused by an increased antiinflammatory capacity and decreased susceptibility to stress in preconditioned hearts.

Gulyaeva N.V., Stepanichev M.Yu.,Mitrokhina O.S., Moiseeva Yu.V., Onufriev M.V., Sergeev I.V., Lazareva N.A.,Tkatchouk E.N.:
EFFECTS OF INTERVAL HYPOXIC TRAINING ON PARKINSONIAN SYNDROME MODEL IN RATS. 1.EFFECTS ON BEHAVIOR IN THE TOPEN FIELDL TEST
Hyp. Med. 1996. V. 4. N 4. P. 7-11.
Effects of interval hypoxic training on behavior in the Topen fieldL test was studied in rat model of Parkinsonian syndrome - intranigral administration of 1-methyl-4-phenyltetrahydropyridine (MPTP). MPTP administration resulted in behavioral disturbances characteristic for this model: decrease of locomotor (horizontal and vertical) activity, increase of freezing time and defecations number. IHT course carried out before neurotoxin administration prevented these behavioral disturbances.
The results suggest that IHT provides for a stable physiological adaptation of dopaminergic system, of other systems of the brain and of the whole organism, this adaptation preventing the damaging effect of the neurotoxin.

Gulyaeva N.V., Tkatchouk E.N.:
ANTIOXIDATIVE EFFECTS OF INTERVAL HYPOXIC TRAINING
Hyp. Med. J. 1997. V. 5. N 3. P. 18.
Free radical homeostasis of the organism involves the reactions of active oxygen species generation (different systems producing superoxide, hydroxyl radicals, hydrogen peroxide, singlet oxygen, nitric oxide etc.) and the activity of enzymatic and non-enzymatic systems of free radical elimination. Disturbances of the steady state of free radicals - increase in their generation and/or decrease in antiradical defense systems - result in oxidative stress, a common step in the pathogenesis of different diseases. Acute hypoxia and especially subsequent reoxygenation induce excessive active oxygen species generation. Repeated moderate oxidative stress in hypoxia-reoxygenation episodes is suggested to be an important factor of antiradical defense systems training in the course of interval hypoxic training (IHT). This suggestion is supported by the data obtained in Clinical Research Laboratory of "Hypoxia Medical Academy" in collaboration with Laboratory of Heart Patho-physiology, Institute of General Pathology and Patho-physiology RAMS, Moscow; Laboratory of Functional Biochemistry, Institute of Higher Nervous Activity and Neurophysiology RAS, Moscow; Maternity Hospital No. 2, Saratov. The data are presented demonstrating antioxidative effects of IHT both in animal experiments and in human studies. In rat brain, IHT resulted in an increase of superoxide dismutase activity and decrease in Fe/ascorbate induced lipid peroxidation. IHT suppressed different systems of free radical generation (including microsomal cytochrome P-450 and nitric oxide synthase) in brain, lung and liver of rats. Beneficial changes in lipid peroxidation and antioxidative defense systems induced by IHT in normal animals are moderately expressed. Effects of IHT are much more pronounced in situations promoting oxidative stress. In a placebo-controlled experiment on rats, IHT was shown to prevent oxidative stress in striatum induced by intranigral administration of the dopaminergic neurotoxin MPTP (rat model of Parkinsonism). In a placebo-controlled study in pregnant women, IHT-induced decrease in active oxygen species generation in blood serum as well as increase in red blood cell superoxide dismutase activity were demonstrated. Moreover, antiperoxidative effects of IHT were revealed in umbilical blood serum and placenta where both free radical generation and lipid peroxidation were suppressed. IHT

prevented increase in free radical generation in blood serum of pregnant women undergoing abdominal delivery in both pre-operational and early post-operational periods. This phenomenon indicates one of the mechanisms of preventive effect of IHT in operational stress. Thus, antioxidative effects of IHT include: a) decrease of active oxygen species generation; b) decrease in lipid peroxidation; c) increase in antiradical defense systems, and d) prevention of excessive free radical generation in conditions promoting oxidative stress. These effects represent an important mechanism of beneficial results of IHT in a wide spectrum of diseases and health-relating conditions.

Kovalenko E.A., Tkatchouk E.N., Volkov N.I., Shaov M.T.:
ACTIVIZATION OF ADAPTIVE MECHANISMS IN THE COURSE OF THE INTERVAL HYPOXIC TRAINING IN PATIENTS //
Hyp. Med. J. 1993. V. 1. N 1. P. 8-9.
The use of the principle of interval hypoxic training and adaptation to hypoxia under normobaric conditions appeared to be beneficial in the treatment of bronchial asthma, ischemic heart disease, autonomic vascular neuroses, neuralgia, peptic ulcer, moderate hypertension, reduction in stress-related conditions in the pre- and postoperative period. IHT mechanisms are considered, the importance of training enzymatic processes of the macroerg biological oxidation and resynthesis, the increase in the activity of the whole group of antioxidant enzymes, namely superoxide dismutase, glutathione reductase, glutathione peroxidase, catalase and the mechanisms of defense against free radicals are emphasized.

Kotliarova L.A., Ehrenbourg I.V., Kondrykin-skaya I.I., Gorbatchenkov A.A.:
INTERVAL HYPOXIC THERAPY IN COMPLEX TREATMENT OF RHEUMATOID ARTHRITS
Hyp. Med. J. 1993. V. 1. N 1. P. 18.
The IHT course was given to 10 patients with rheumatoid arthritis (RA) of 2 to 15 years duration. The course lasted 15-22 days. The dynamics of clinical and laboratory variables was assessed 3.5 weeks after IHT. IHT resulted in lesser duration of morning rigidity (from 199 to 15 min), active joints decreased in number (from 3.1 to 1.8), arthralgias disappeared or abated, the gait was normalized. 3-4 IHT sessions improved mood, sleep, appetite and physical activity. The daily intake of anti-inflammatory drugs was reduced. 3 patients did not show positive dynamics.

Krasikov S.I., Tverdokhlib V.P., Chavkin I.I., Budza V.G., Petrov V.N.:
THE DIMINUTION OF CARDIAC RHYTHM DISORDERS IN PATIENTS WITH CHRONIC ALCOHOLISM BY THE ADAPTATION TO PERIODIC HYPOXIA
Hyp. Med. 1996. V. 4. N 3. P. 21-22.
Fifty five patients with chronic alcoholism aged 25-45 years were examined. The period of addiction was 3-11 years. The patients of experimental group underwent the course of adaptation to periodic hypoxia in the Ural-1 type altitude chamber. No treatment was given to the patients of control group during this period. The state of cardiac rhythm and the character of disorders were estimated using 24 h ECG monitoring. To evaluate the degree of cardiac rhythm disorders, the extrasystolic index, (percentage of the extrasystolic number to the total number of systoles) was used. The adaptation of patients with alcoholism to periodic hypoxia lead to a lesser expression of of rhythm disorders, that was demonstrated in two times decrease of the extrasystolic number, and to the normalization of cardiac rhythm in about 25% of patients. The mechanisms of the anti-arrhythmic effect of adaptation to hypoxia are discussed.

Pohle W; Rauca C. Hypoxia protects against the neurotoxicity of kainic acid.
Brain Res 1994 May 2;644(2):297-304
A normobaric hypoxia (9% oxygen) of 8 h reduces the neurotoxicity of a subcutaneous injection of 10 mg/kg kainic acid given one week later. Both seizures and degenerative changes, including cell death of hippocampal and cortical neurons are markedly decreased by hypoxia. It is also shown that hypoxia also markedly reduced the extensive depletion of zinc from mossy fiber terminals normally induced by kainic acid. This suggests that a

protective mechanism induced by hypoxia may affect the glutamatergic transmission in these synapses and prevent excessive synaptic excitation. The possible involvement of adenosine and/or GABA in this protective mechanism is discussed.

Pshennikova M.G.:
SIMILARITY AND DIFFERENCES OF ADAPTATION TO HYPOXIC HYPOXIA,
TO PHYSICAL LOADS AND THEIR PROTECTIVE EFFECTS
Hyp. Med. J. 1994. V. 2. N 3. P. 3-10.
Adaptation to intermittent hypoxia and adaptation to physical loads possess many similar components of structural changes formed at the level of regulatory systems and organs in the process of adaptation (components of the structural trace of adaptation). This defines the similarity of protective effects of these adaptations in damaging actions. At the same time differences in their cardioprotective effects have been recently revealed. The differences are associated with different formation of cytoprotective mechanisms at the myocardial level. These mechanisms seem to depend on the nature of cardiocyte production of so-called stress proteins (heat shock proteins) which possess protector and repair properties. The prospect of using combined adaptation is under discussion.

Sazontova T.G., Tkatchouk E.N., Golantzova N.E., Ehrenburg I.V., Meerson F.Z., Arkhipenko Yu.V.:
THE STATE OF SARCOPLASMIC RETICULUM Ca-PUMP AND THE ACTIVITY OF MYOCARDIAL ANTIOXIDANT DEFENSE IN ADAPTATION TO NORMOBARIC HYPOXIA. Hyp. Med. J. 1995. V. 3. N 3. P. 5-9.
The effect of adaptation of rats to normobaric hypoxia induced with 10% O2 at different regimens (interval hypoxia: 5 min of hypoxia alternating with 3-min intervals of normoxia for 90 min; intermittent hypoxia: 60 min of continuous hypoxia). Each kind of adaptive exposure was carried out for 23 days daily on the state of myocardial sarcoplasmic reticulum (SR) Ca2+-transport system was studied. The initial rate of SR Ca2+ transport, its resistance to the in vitro induction of lipid peroxidation (LP), the activity of antioxidant defense enzymes, and the resistance of Ca2+ transport to high concentrations of free Ca2+ were studied. It was shown that adaptation to interval hypoxia did not induce activation of myocardial catalase and superoxide dismutase but it significantly increased the initial rate of SR Ca2+ transport and enhanced its resistance to induced LP and high Ca2+ concentrations. Adaptation to intermittent hypoxia significantly activated catalase but it did not increase the initial rate of SR Ca2+ transport. Furthermore, the resistance to induced oxidation increased in comparison with the control, while the response to high Ca2+ was close to that in the myocardium of rats adapted to hypoxia. We conclude that adaptation to normobaric hypoxia optimizes the performance of SR Ca-pump in the myocardium though the milder exposure to interval hypoxia can exert a better preventive effect.

Sazontova T.G., Tkatchouk E.N., Kolmykova S.N., Ehrenbourg I.V., Meerson F.Z., Arkhipenko Yu.V.:
COMPARATIVE ANALYSIS OF PEROXIDATION AND ANTIOXIDANT ENZYME
ACTIVITIES IN RATS ADAPTED TO DIFFERENT REGIMES OF NORMOBARIC HYPOXIA
Hyp. Med. J. 1994. V. 2. N 4. P. 4-7.
The intensity of lipid peroxidation (LPO), the initial level and rates of oxidized product accumulation under the LPO induction in homogenates of different tissues in vitro) and activities of antioxidant defense enzymes were compared in adaptation of rats to normobaric hypoxia (NH) produced by inhalation of a gas mixture containing 10% of O2 using two regimes -alternation of 5-min hypoxia and 3-min normoxia for 90 min, interval hypoxic training (IHT); continuous hypoxia for 60 min daily, 23 days (intermittent hypoxia (IH). It was shown that in red cells IHT let unaffected the catalase activity and increased the superoxide dismutase (SOD) activity by 25%. In the liver, the intensity of LPO induced in vitro was decreased with persisting activities of catalase and SOD. In the brain the SOD activity was considerably increased after NH in both groups: in the IHT group by 30% and in the IH group by 47% as compared to the control. The catalase activity was 27% higher in the IH group than in control. The intensity of LPO induced in the brain substantially decreased in both NH groups. This indicates that adaptation to NH provides a considerable protective effect against free-radical processes in animal tissues.

Smolyagin A.I., Frolov B.A.:
PROTECTIVE EFFECT OF ADAPTATION TO INTERMITTENT HYPOXIA ON STRESS- INDUCED DISORDERS OF ANTIBODY AND CELL-MEDIATED RESPONSE
Hyp. Med. J. 1995. V. 3. N 1. P. 9-12.
The effect of adaptation to intermittent hypoxia (AIH) on stress disorders of antibody and cellular immune response in CBA and (CBAxC57B16)F1 mice was tested. AIH was created in conditions of animal residence Tat heightL of 5000 m for 45 days. Immobilization stress was used as a stress exposure. It is evident that 6- or 15-hour stress supresses the immune response. However the degree of its supression in adapted mice is less pronounced than in nonadapted ones. The lack of poststress increase in DTH in using the splenocytes from adapted animals was observed.

Sokolov E.I., Mushinskaya K.V., Davydov A.L., Starkova N.T., Ehrenburg I.V., Tkatchouk E.N. EFFECTS OF THE INTERVAL HYPOXIC TRAINING ON LIPID PEROXIDATION IN NON-INSULIN-DEPENDENT DIABETES MELLITUS
Hyp. Med. J. 1999. V. 7. N 3-4. P. 37-40.
There is much evidence that the oxidative stress is of great importance in the pathogenesis of diabetes mellitus of the 2nd type (NIDDM). We applied the method of the interval hypoxic training (IHT) for decreasing the level of the oxidative stress in patients with the NIDDM. The IHT course (15 sessions, in an individual mode) was administered to 16 NIDDM patients and 14 practically healthy persons.
We found that after the IHT the blood concentration of the primary and secondary products of lipid peroxidation decreased by 18.5 and 36.4% in the group of the NIDDM patients and by 14.9 and 23.5% in the control group, respectively. A significant decrease in the levels of cholesterol, triglycerides, very
low-density lipoproteins, free fatty acids, and glucose as well as increase in the level of high-density lipoproteins were observed in patients with NIDDM after the IHT. Thus, the IHT provides a means for decreasing the level of the oxidative stress during NIDDM.

Wada T, Kondoh T, Tamaki N.
Ischemic "cross" tolerance in hypoxic ischemia of immature rat brain.
Brain Res 1999 Nov 20;847(2):299-307.

The phenomenon of ischemic tolerance has been closely associated with the expression of heat shock proteins but recently, stress tolerance not related to hsp72 has been reported. In the present study, we focused on ischemic tolerance induced by hypoxia and hyperthermia in neonatal rat brain and analyzed the expression of hsp72. In a neonatal rat model of hypoxic ischemia (H-I), preconditioning by whole-body hyperthermia or hypoxia was induced 24 h prior to the ischemia. Brain damage was histologically evaluated and the expressions of hsp72 were analyzed. Hyperthermic preconditioning at 41 degrees C for 15 min, as well as hypoxic preconditioning with 8% hypoxia for 3 h, had almost complete neuroprotective effects. However, we failed to detect the expression of hsp72 in any of preconditioning. Only the H-I insult itself induced hsp72 in the dorsal striatum and slightly in the thalamus and the hippocampus. Hyperthermic preconditioning has neuroprotective effects which are comparable to hypoxic preconditioning in immature brain. The expression of hsp72 is not likely necessary for the ischemic tolerance in immature brain.

Vardya I.V., Balezina O.P., Koshelev V.B.:
HYPOXIC INTERVAL ALTICHAMBER TRAINING ACCELERATES REINNERVATION OF M. EXTENSOR DIGITORUM LONGUS IN MOUSE
Hyp.Med. J. 1998. V. 6. N 4. P. 144-147.
Effects of hypoxic interval altichamber training (HACT, 4-6 hours per day, 3500 m above sea level, 10 days) on regeneration of the crushed motor nerve n.peroneus communis and reinnervation of the skeletal muscle m.extensor digitorum longus (EDL) were studied in mice. It was found that the HACT induced the facilitation of the nerve trunk regeneration and the recovery of the neuromuscular apparatus function. In animals subjected to

10-day HACT after crushing the nerve trunk, more efficient (by 31%, $p<0.05$) recovery of the normal excitability of the regenerating nerve was observed as well as an increase (by 48%, $p<0.05$) in the rate of motor units involvement into the total response of the muscle

Zhuang J, Zhou Z.
Protective effects of intermittent hypoxic adaptation on myocardium and its mechanisms.
Biol Signals Recept. 1999 Jul-Oct;8(4-5):316-22
Intermittent hypoxic adaptation offers as many beneficial effects in protecting against myocardial injuries as chronic continuous hypoxic adaptation. However, chronic continuous hypoxic adaptation readily causes some adverse effects on the organism, which may be prevented by intermittent hypoxic adaptation. As an approach to potentiate the protective effects, intermittent hypoxic adaptation is also much easier to apply to subjects who are not living at high altitude. The mechanisms underlying the cardioprotective effects of intermittent hypoxic adaptation are less understood, although great similarities exist between chronic continuous and intermittent hypoxic adaptation. The participation of several factors, such as myocardial vascularity, coronary blood flow, and cardiomyoglobin, which comprise the oxygen uptake system is not apparent, while the more efficient energetic metabolism after intermittent hypoxic adaptation may be a mechanism for cardioprotection. The possible roles of several signaling transduction pathways, including adrenoceptors, prostaglandins, and the adenosinergic system, in the beneficial effects of intermittent hypoxia are compared to those of chronic continuous hypoxic adaptation. Antioxidant enzymes and stress proteins may also be part of the mechanisms contributing to the cardioprotection of the intermittent hypoxic adaptation. As the cardioprotective effects of intermittent hypoxic adaptation employ multifold mechanisms, their clear elucidation needs more efforts.