JPRS L/9882

31 July 1981

Translation

AEROSPACE MEDICINE

SIXTH ALL-UNION CONFERENCE

ON SPACE BIOLOGY AND AEROSPACE MEDICINE

KALUGA 5-7 JUNE 1979

Part II

FBIS FOREIGN BROADCAST INFORMATION SERVICE

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

APPROVED FOR RELEASE: 2007/02/09: CIA-RDP82-00850R000400030063-5

JPRS L/9882

31 July 1981

AEROSPACE MEDICINE
SIXTH ALL-UNION CONFERENCE ON SPACE BIOLOGY AND AEROSPACE MEDICINE
KALUGA 5-7 JUNE 1979
PART II

Complete translation of the Russian language book edited by Academician O. G. Gazenko: "Aviakosmicheskaya meditsina. VI Vsesoyuznaya konferentsiya po kosmicheskoy biologii i aviakosmicheskoy meditsine. Kaluga 5-7 iyunya 1979. Chast' II", USSR Ministry of Health, Department of Physiology of the USSR Academy of Sciences, Institute of Biomedical Problems of the USSR Ministry of Health and State Museum of History of Cosmonautics imeni K. E. Tsiolkovskiy, published in Moscow, 204 pages [summaries of papers]

CONTENTS

Psychophysiological Distinctions of Activities

Other Pressing Problems of Aerospace Medicine

PSYCHOPHYSIOLOGICAL DISTINCTIONS OF ACTIVITIES

PSYCHOLOGICAL SUPPORT AND PSYCHOLOGICAL ADJUSTMENT OF CREWS DURING LONG-TERM FLIGHTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 5-6

[Article by V. I. Myasnikov, O. P. Kozerenko, A. A. Gerasimovich and E. V. Ryabov]

[Text] The increasing duration of space missions, involving a full program of work for the crew in an unusual environment, raises with particular acuity the question of development of psychological means of preventing potential disorders due to the stress factors of flight.

The experience of medicopsychological support of 96- and 140-day flights indicates that the level of emotional and work tonus of cosmonauts is closely related to the process of psychological adaptation, the effectiveness of which is determined by the nature of the professional task, stage of flight, specific situation on board, psychological personality distinctions, in particular, motivations.

We have singled out two stages in the dynamics of psychological adaptation, which is manifested in the form of so-called functional needs. The first corresponds to the first stage of the flight, and it is determined by formation of new skills in interaction with surroundings. Thus, according to the results of the international "Questionnaire" experiment (Intercosmos program), for the first 3-7 days of flight, the functional needs of individuals working in space for the first time reflect corresponding changes in sensory and motor systems of the body, with fixation of attention on internal sensations (sensation of insufficient sleep, transformation of appetite and taste, temperature-related discomfort, desire to immobilize oneself, control movement in space). They are met in the course of individual experience in being in an unusual environment.

The next stage of psychological adaptation is related to the isolation factor, information "hunger," insufficient volume and means of communication with individuals outside the spacecraft. The needs that form at this time apparently reflect the decline of activation of the body, and this was confirmed by the crew's requests for increasing the flow of news, broadcasting of music (mainly rhythmic), radio communication with their families and friends, scientific consultants, etc. When such requests were satisfied by the ground-based service, by means of a set of supportive measures, the crew adapted and was functionally efficient.

Among the means of compensating for the information "hunger" special attention was given to musical and television programs.

As shown by the results of ground-based studies of mobilization readiness of operators, viewing specially selected video programs and listening to music in the presence of fatigue and asthenization was associated with a marked mobilizing effect: increased intensity of elements of "mental calm" and "active actions" in self-appraisals; better results of psychomotor tests, model and regular operations; stabilization of physiological parameters during work.

Thus, the results of space flight tests and model experiments justify the use on board, in the system of psychoprophylaxis, of such factors as controlled (in volume and content) flow of nonbusiness information, measured communication (direct and via the communication channel), purposeful effect on emotional sphere by means of functional music and television programs, which permits deliberate intervention in the process of psychological adaptation in order to optimize it.

PSYCHOPHYSIOLOGICAL RELIABILITY FROM THE STANDPOINT OF BIORHYTHMOLOGY

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 6-8

[Article by B. S. Alyakrinskiy and S. I. Stepanova]

[Text] Impaired coordination of rhythmic processes in the organism--desynchronosis--can presently be classified among the mandatory elements of the stress syndrome with full justification. Desynchronosis is the nonspecific reaction to any stress factor. Weightlessness, as a potent stress factor, has a desynchronizing effect on organisms. This was demonstrated with regard to lower organisms in experiments on the zone-forming fungus, Actinomycetes, which were conducted during the Soviet-American flight on the Soyuz-Apollo program. The results of analysis revealed that the periodicity of fungus growth was impaired in weightlessness, and these disturbances were manifested by an increase (less often a decrease) in duration of growth cycle, as well as appearance of local defects in circular structures, particularly phase-shifted segments. The desynchronizing effect of weightlessness was also observed during the flight of monkeys aboard the American satellite, Biosatellite-3: while the periodicity of sleeping and waking, arterial pressure and diuresis remained on a 24-h cycle, the rhythm of pulse rate acquired a 26-h period, the rhythm of temperature of the body and brain was on a 25.5-h cycle, while the rhythm of excretion of calcium in urine was on a 30-h cycle.

Humans differ in resistance to desynchronosis. This resistance is determined by the individual biorhythmological status, the most important feature of which--organization, orderliness of rhythmic processes--is ultimately determined by the quality of body functions as a system, including rhythms with the most diverse periods. At the present time, the problem of biorhythmological status of man is considered through the prism of circadian rhythms, since the system of circadian rhythms is the main rhythmic system of man.

Orderliness of circadian rhythms is characterized by the concept of constancy of the organism's circadian system. The constancy of the circadian system is the integral expression of the constancy of rhythms that form it. The constancy of circadian rhythm is determined by the degree of its resistance, stability, daily consistency of its quantitative parameters. The higher this constancy, the lower the variability of these parameters and the more constant the rhythm, and vice versa. The leading feature of rhythm constancy is stability of the position of its acrophases on the 24-h scale. A high degree of stability of the position of acrophases of vital rhythms provides for constancy of phasic

angles between different rhythms, i.e., a high degree of mutual synchronization of these rhythms.

In view of the hierarchic structure of the circadian system of the organism, the presence in this structure of controlling rhythms (pace setters) and subordinate rhythms (pace followers), it can be stated that proper function of the circadian system and proper interaction between all its levels, and between them and the system of exogenous timers is provided by high (but not excessive) constancy of pace followers and adequate (but also not excessive) lability of pace setters. Such a system is capable, on the one hand, of reacting rapidly to changes in the environment and, on the other hand, of rapidly and accurately transmitting control signals from pace setters to pace followers. Expressly such a system is the most resistant to desynchronosis.

Consideration of the individual distinctions of biorhythmological status of candidates for space flights makes it possible to screen individuals with optimum organization of circadian system of vital rhythms, and thereby to see to it that individuals who participate in space flight are the most resistant to the desynchronizing effect of weightlessness and other stress factors of space flights. Organization of biorhythmological screening is a pressing task for today, and it has been validated in conceptions of desynchronosis as a mandatory component of the stress syndrome and constancy of the body's circadian system.

CORRELATION BETWEEN PARAMETERS OF CIRCADIAN RHYTHM OF MUSCULAR STRENGTH

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 8-9

[Article by A. A. Koreshkov and V. I. Makarov]

[Text] After cosmonauts spend a long time in weightlessness, the following factors are rather significant in the acute period of readaptation to earth's gravity: loss of muscle mass, deconditioning of some muscle groups and diminished muscular strength. In administering readaptation measures, it is imperative to take into consideration the biological rhythms of functions. A 70-day auto-experiment was conducted to study the circadian (about 24-h) rhythm of muscular strength.

J. Aschoff (1964) observed the importance of such a parameter of circadian rhythm as a level, and at the same time he referred to the difficulty of defining it. W. Menzel (1968), who is one of the few authors who noticed a correlation between different parameters of the circadian rhythm--level and amplitude--with regard to arterial pressure. We do not know of any studies where such an approach was used to consider the circadian rhythm of muscular strength. We examined the question of correlation between parameters on the example of the circadian rhythm of muscular strength.

The experimental conditions did not involve changes in the subject's usual life style. Muscular strength of the right and left hands was measured during the period of scheduled wakefulness in odd hours of Moscow time, with discreteness of 2 h, i.e., 9 times a day. We used the DRP-90 dynamometer.

It was established that any deviation of amplitude of circadian rhythm of muscular strength from mean values, both in the direction of increase and decrease, was associated with elevation of the circadian level of this functional parameter ($p<0.02 \ldots 0.01$).

The maximum value for the circadian rhythm of muscular strength demonstrated a dependence on the position of the acrophase of the maximum on the time axis.

The probability of expression of the maximum circadian rhythm is a function of time of day. For the function of muscular strength, it was established that, for this subject, the maximum value of the parameter within a 24-h period is most likely ($p<0.01$) to occur after 1500 hours Moscow time.

In this subject, the position of the maximum of circadian rhythm of muscular strength on the time axis and 24-h level of this parameter were interrelated ($p<0.01$). Such are the data on the initial structure of circadian rhythm of muscular strength.

Elevation of daily level of some functions (for example, arterial pressure) is a symptom of classical stress (H. Selye, 1960). On the basis of the data we obtained, elevation of 24-h level of some functional parameter is associated with amplitude and phase shifts of circadian rhythm of this parameter. Thus, along with the symptoms of classical stress, we also observe symptoms of adaptive change in circadian rhythms. Desynchronosis is consistently a part of the general adaptation syndrome (B. A. Alyakrinskiy, 1973). Observation of circadian rhythm of muscular strength may also be useful in diagnosing stress states.

THE 'ISOLATED' BRAIN AS A MODEL FOR THE STUDY OF CORRELATION BETWEEN ENDOGENOUS AND EXOGENOUS FACTORS OF GENERATION OF CIRCADIAN RHYTHMS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 10-11

[Article by R. F. Makul'kin and Yu. F. Pedanov]

[Text] The problem of endogenous or exogenous generation of circadian rhythms is still debatable in biorhythmology. Diverse facts adequately substantiate the thesis of equal validity of these two approaches. Continued research is deemed important with regard to methodology, since it would solve the problem of relative importance of "external" and "internal" factors in the control of such adaptive reactions as circadian rhythms. We chose the "isolated" cat brain according to Bremer (transection of the mesencephalon on the boundary of the diencephalon) as a model for determination of some aspects of the genesis of circadian rhythms. In a chronic experiment (animals' life span of 35-40 days), starting on the 10th-14th day, we demonstrated high stability of parameters on daily tracings of the EKG and respiration, which were unrelated to time of day and did not change when there was constant illumination. Consequently, with neuronal isolation of the prosencephalon from stem structures, there is elimination of function of the "biological clock" that controls circadian rhythms in the cardiovascular and respiratory systems.

We recorded the function of the "isolated" prosencephalon electrophysiologically (EEG), reaction of alteration of rhythm and evoked potentials (EP) in response to light. For 7-14 days after total transection of the mesencephalon, the background daily EEG was represented by slow waves in the delta range and bursts of sleep spindles. This monotonous EEG was subsequently replaced (in the 3d-4th week) by significant alteration of rhythm, with alternation of long periods of desynchronization and synchronization. There was restoration of the brain's ability to generate typical EP with distinct positive, negative components and reaction of change in rhythm in response to flickering light. In the course of the day, we observed periods of widening of the range of reproduced frequencies, against the background of prolonged spontaneous desynchronization, which was indicative of improved lability of the cortical end of the visual analyzer and can be interpreted as an indicator of periodic (circadian) change in functional state of the cerebral cortex. This was also confirmed by the results of analysis of various EP parameters against the background of synchronization and desynchronization of the EEG of the "isolated" brain.

The above data suggest that structures of the organism that claim to play the role of regulators of circadian rhythms are apparently related to the function of such highly organized parts of the central nervous system as the forebrain.

METHOD OF APPLYING T TECHNIQUE OF FACTOR ANALYSIS TO THE STUDY OF PSYCHOPHYSIOLOGICAL COMPATIBILITY

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 11-12

[Article by A. B. Savvin, S. V. Kulikov, M. A. Novikov and A. F. Bystritskaya]

[Text] As we know, the essence of methods of factor analysis consists of going from the description of a certain set of studied objects, specified by a large volume of directly measured indirect signs, to description with a smaller number of deep variables with maximum informativeness reflecting the most important properties of a phenomenon. Factor analysis is generally used to study flat two-dimensional sections of a block [cube] of data, on the axes of which are the parameters, individuals and time. A distinction is made between R, Q, O, P, S and T techniques, depending on the section isolated (V. M. Zhukovskaya, I. B. Muchnik, 1976).

Let us discuss the time section of data (according to individuals and time). Such material can be used to analyze the nature of variation of tags in time and find factors as certain generalized parameters that describe this variation well. Factor analysis of such a presentation of data is called the T technique.

In our case, the curves of subjects' pulse rate were the indirect characteristics studied during verbally assigned work of the associative type ("paired word test") in an experiment, which was conducted to examine group behavior and the distinctions of emotional-autonomic reactions. The matrix of base data consisted of a set of curves of pulse rate of the individuals which changed in time. The area of factor analysis of dynamic tags has been little-studied, but it is feasible (Ya. Okun', 1974).

At the first stage, the studies were pursued on the basis of the hypothesis that there is a certain typical physiological component inherent in each individual. To solve this problem, we took several pairs of runs [realizations]. One of the distinctions of the first stage of the studies that we took expressly pairs of runs, i.e., the pulse frequency of two subjects participating simultaneously in an associative experiment. The second distinction was referable to the low or high values of the coefficient of coincidence of pulse increments (coefficient of sign correlation) between runs in pairs (M. A. Novikov, 1975).

The first results of analysis, with calculation of variance of the first, main factor and initial runs, enabled us to advance a more general hypothesis that

there are typical forms of physiological reactions of people. This was due to the fact that the first main component showed virtually no change when we analyzed a constantly diminishing number of pairs of runs. In the analysis of individual pairs contained in the several pairs taken initially, we noticed the strong influence of correlated pairs on the form of the main factor. Subsequent analysis of other sets of pairs and separate runs from the experiments confirmed the predominant effect of correlated pairs on the form of the main factor.

It can also be assumed, on the basis of the well-known circumstance that variables, which change identically in time, form bundles in the correlation matrix, that in this case one can use factor analysis to determine the main influences upon which these fluctuations and changes are based, which are inherent in individual distinctions of man. Moreover, the T technique makes it possible to obtain controlled changes in the process of change in circumstances. For this reason, it is very interesting to conduct relevant experiments aboard spacecraft in order to use this method for detection of the influence of the gravity factor on man's psychophysiological characteristics in space.

DYNAMICS OF SOME PSYCHOPHYSIOLOGICAL FUNCTIONS IN COMPLEX SIMULATION OF CONDITIONS OF A TEN-DAY SPACE FLIGHT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 13-14

[Article by A. A. Alelyukhin and M. L. Khachatur'yants]

[Text] At the present time, in the practice of psychophysiology of space work broad use is being made of methods of ground-based simulation of elements of professional activities of cosmonauts, several habitat factors and, in particular, weightlessness. For this purpose, such methods as long-term hypodynamia, hydro-weightlessness, support-free stands, flights in a laboratory aircraft over a Keplerian parabola are used the most often in the studies. The last model conforms best to real flight conditions, but because of its short duration it does not permit investigation of changes that occur during long-term flights.

In this study, for the first time in the practice of ground-based experiments, we used complex simulation of the conditions of a 10-day orbital flight. Our model of flight was based on long-term (10 days) hypodynamia in antiorthostatic position (-6°) and, against this background, we gave posthypnotic suggestions of altered sensitivity to gravity. Of the entire group of subjects, we succeeded in two cases of in the posthypnotic suggestion of weight loss (up to 4-5 kg) and in one, on the contrary, a weight gain of up to 300 kg. The fourth subject served as a control and was not submitted to any factors, with the exception of hypodynamia.

The subjects performed operator work following a specially developed cyclogram against the background of such simulation of flight conditions. Concurrently, we examined several psychophysiological functions (simple motor reaction, static endurance of the hands, tremor, tapping test, flicker fusion frequency) and dynamics thereof as related to the stage of the experiment and simulated states. Also, we recorded pulse, respiration and body temperature every 4 h of the entire waking period (from 0700 to 2300 hours).

Analysis of the obtained results failed to yield statistically reliable differences as a function of the simulated state, and this can be attributed to the distinctions of our experiment.

In our model, prolonged hypodynamia was of dominant significance, while the psychological models of states formed against its background could not be demonstrated sufficiently by the above-mentioned methods, since the subjects were

in a hypodynamic state during their work, and very small muscle groups participated concurrently in the work, mainly those of the forearms. As a result, there was extremely little afferent impulsation, and the created mental models of states could not be manifested distinctly enough in the operators' performance.

Evidently, when creating a complex model of orbital flight in the future, it is necessary to plan active operator activity in the course of the experiment, corresponding to real work, rather than strict hypodynamia, which would activate afferent impulsation, creating better conditions for demonstration of the distinctions of the simulated state. Thus, the model will conform better to real flight conditions, and this would permit more comprehensive studies in ground-based experiments of the distinctions of operator work with maximum approximation of the conditions of real orbital flights.

DYNAMICS OF WORKING MEMORY DURING OPERATOR WORK WITH COMMAND AND SIGNAL DEVICES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 14-15

[Article by L. A. Sivokon']

[Text] A study was made of the dynamics of working ["operative"] memory during operator work with combined systems of display, signaling and control in model experiments.

The importance of studying working memory in the course of an operators work with command and signal devices is related to the fact that the operator processes a large volume of information within a limited time, under extreme conditions.

For this purpose, we used a method of half-realistic simulation of professional work of a cosmonaut to control and monitor systems by means of regular command and signal devices and command-signal fields.

It was established that working memory plays the decisive role in successful performance of monitoring and control tasks by means of command-signal devices: determination was made of the correlation between efficiency of an operator's work with command-signal fields and level of operator training, knowledge of the logic of integrating commands in the system, ability to rapidly decode abbreviations, knowledge of algorithm for the implementation of different types of commands; it was established that command-signal matrix consoles with a two-step method of delivering commands, expanded field of signal and command devices, integrated in functional groups were the most effective for control and monitoring of systems by an operator; the efficiency of operator work to control and monitor systems diminishes with the use of a multistep method of delivering commands with different algorithms of control and addition of special distinctive tags in the signal cells of the command-signal field.

The following recommendations were formulated:

1. To achieve a standard [single type] control algorithm, the two-step method of control is recommended for command-signal fields.

2. Identical index require the same logic of turning on controls; for this reason, commands with different algorithms of control should have different indexes on the corresponding transparencies.

3. In the case of multistep control, in addition to a certain lay-out of keyboard system units and units of command keyboards, the additional controls must have a very specific, spatially distinct position on the console. Emergency commands should also have their own controls, i.e., they should not be included in the general unit of command keys.

4. In order to create in man a stable visual image of the meaning-related field of command-signal devices, it is recommended that initial training be conducted with expanded command-signal fields. It is recommended that emergency commands be displayed on a separate, expanded matrix panel.

ROLE OF NONINSTRUMENTATION SIGNALS IN PILOT WORK

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 16-17

[Article by S. A. Gozulov, R. A. Vartbaronov, F. A. Zubets and V. V. Grishchenko]

[Text] Researchers are being increasingly concerned with the question of the pilot's use of various sources of information to form an image of the flight and construct control movements. Least studied is the significance of noninstrument signals in pilot performance. In our studies, we demonstrated the important role in flight maneuvering of a set of exogenous visual signals, perception of angular and linear accelerations, change in force applied to the controls and pressure in the chambers of the G suit (GS). The obtained data made it possible to formulate the specifications, from the standpoint of engineering psychology, for adequate simulation of noninstrument flight signals in aviation simulators, to simulate the effects of high and prolonged accelerations on the pilot. On the basis of our studies, recommendations were developed on individual training of pilots in the skill of using acceleration signals and signals of concomitant factors in performing a maneuverable flight.

The informativeness of noninstrument signals was related to their physical intensity and duration, the pilot's ability to distinguish and evalute quantitatively the changes therein. Differential sensibility and psychometric evaluation of physical signals of flight were determined by the innate properties of analyzers to a greater extent than by the pilot's acquired skills. In the course of professional training, there is development and refinement of analyzer function, with formation of a "feeling" about the aircraft.

Individual accuracy of perception and evaluation of noninstrument signals determines the specifics of gathering instrument information by the pilot and the general structure of the sensorimotor flying skill.

It is recommended that there be purposeful organization of teaching skill in using their own sensations in performing training flights on an aircraft, as well as dynamic flight simulators, in order to solve effectively and well problems of pilot training.

Continued investigation of the role of noninstrument signals of flight in pilot performance is a very promising direction of aviation psychology.

EFFECTS OF PSYCHOTROPIC AGENTS ON MENTAL ACTIVITY AND AUTONOMIC FUNCTIONS OF MAN IN THE PRESENCE OF EMOTIONAL STRESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 17-19]

[Article by A. Vares]

[Text] For the past few years, increasing importance has been attributed to the study of the distinctions of man's functions under extreme conditions. The search for possibilities to avert and correct the functional disturbances in different organs and systems, which occur with emotional stress, is one of the important aspects of this problem. Use of psychotropic agents for this purpose may be effective in assuring the reliability of man's performance in stress-producing situations. In turn, this requires a clear idea about the nature of the effects of psychopharmacological agents on such processes and functions of higher nervous activity in essentially healthy man as thinking, attention, memory, psychomotor coordination, etc.

Our objective was to test the effect of the benzodiazepine tranquilizer, diazepam (seduxen), and the piperidine neuroleptic agent, thioridazine (mellaril), on some mental and autonomic functions in healthy people.

The situation of taking an important test by first-year students served as the model of emotional stress. In all we tested 120 people.

The following test methods were used: airthmetic test of the intellectual "numerical series" type and the MMPI test with the motor reflex (Saarma, 1970). In addition, we recorded some beha oral reactions, as well as several autonomic parameters.

Thioridazine (10 mg), diazepan (2.5 mg) and placebo were given 45 min to 1 h before the subjects entered the room were the test was given. All of the studies were conducted before the question cards were picked up. Background studies were conducted in the course of the semester, in a calm situation.

The obtained results were indicative of exclusively individual reactions of different subjects to the psychotropic drugs. For example, diazepam had a tranquilizing effect on 42% of the subjects, who reported that they felt calmer, indifferent, after taking it. Sedation, manifested by appearance of drowsiness, was observed in 17%, and in some cases drowsiness was associated with muscular weakness. A feeling

of inebriation, which the subjects compared to the effect of alcohol, was present in 7%. Thioridazine had a tranquilizing effect in 4% of the cases and a sedative one in 2%; 6% of the subjects reported that they became excited.

In the group of subjects given placebo, a statistically significant in mean time required for the "numerical series" test, as well as an increase in number of gross errors, was noted in the examination situation. We also recorded a longer latency time for the motor reflex in response to a photic stimulus, longer time of differentiation between photic stimuli and difference in latency periods. The obtained results are indicative of some degree of disorganization of mental activity in the presence of stress: poorer operative memory, operative thinking, diminished attention, as well as slowing of nervous process and prevalence of inhibition. With regard to autonomic indicators, the parameters of arterial pressure, pulse rate and tremor of the hands were elevated, while temperature and electrocutaneous resistance of the digits were diminished. The obtained data concerning the effect of emotional stress on performance and autonomic functions conform with the findings reported by other authors.

To sum up the data on the effects of diazepam and thioridazine on performance, behavior and autonomic functions in a situation of emotional stress, we can note that both agents have a definite anti-stress effect. Thus, there was a decrease in behavioral manifestations of stress, improved well-being of the subjects, faster motor reaction to a photic stimulus, lowering of systolic arterial pressure and rise of digital temperature under the influence of these agents. Under their influence, there was also a substantial decrease in number of statistically significant correlations between the indicators of anxiety and other parameters studied, which may be indicative of the beneficial effect of these agents on subjects who tend to have more marked manifestations of stress.

As for the distinctions of action of these agents, we observed deterioration of operational memory, operational thinking and attention in the group given diazepam. With intake of thioridazine, we observed faster mental activity, as well as faster generation of differentiated inhibition by the nervous system and improvement of its quality.

THE QUESTION OF EVALUATING DISPATCHER EFFICIENCY IN AIR TRAFFIC CONTROL

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 19-20

[Article by V. F. Onishchenko and O. N. Baklunova]

[Text] Quite often the air traffic controller works on a very tight schedule, which could lead to emotional stress under certain conditions. As a result, there is a decrease in psychophysiological capabilities and general reliability of dispatcher work. For this reason, it is of practical importance to study the efficiency of mental activity of air traffic controllers as related to the speed and amount of information delivered. For this purpose, studies were pursued using a special instrument, Rhythm ["Ritm"] , which enabled us to evaluate the subject's ability to solve problems of receiving and processing presented information. Photic (color) signals, delivered in an arbitrary order and at a different speed (from a minimum of 25 signals in 30 s to a maximum of 45 signals) served as the sources of information. The job for the subject consist of having him react to the color stimuli (green, red and yellow lights) by depressing a button of the same color. The work was done in three time modes. The first was characterized by presenting the subject with an "underload" of information, since the time of delivery of the color signal on the panel was extended, constituting 1.2 s (25 signals in 30 s). The second mode of work was characterized by "optimum" conditions of the work process by means of adequate signal delivery time on the panel--0.85 s (35 signals in 30 s). The third mode was under "extreme" conditions, i.e., a marked shortage of time. Signal delivery time constituted 0.7 s (45 signals in 30 s). This mode was characterized by "discomfort," which had a negative effect on the process of work activity, since it increased drastically the demands made of the subject's emotional sphere, requiring constant concentration of will and rapid operational analysis of the current state.

All of the controllers performed the first assignment well, and the results remained stable throughout the work shift. As a rule, the controllers did not have any erroneous responses. The second assignment (35 signals) in the optimum mode was also performed with rather good stability. In the third task (45 signals), none of the tested controllers could react to all of the signals, responding to an average of 30-35 signals, which constituted 70% of the total presented. It can be stated that performance of this task required utmost mobilization of psychophysiological capacities, thereby creating neuropsychological tension.

Older dispatchers [controllers] had some difficulty in performing the second task. This group of controllers did not have time to respond to even half the presented signals of the third assignment. Worsening of performance was observed after the third hour of work at the radar screen.

These studies revealed that this method can be used to detect early signs of developing fatigue.

PSYCHOPHYSIOLOGICAL VALIDATION OF METHODS OF CODING INFORMATION ON ELECTRONIC FLIGHT INSTRUMENTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 20-22

[Article by V. A. Ponomarenko, N. D. Zavalova, V. V. Lapa, A. N. Razumov and R. I. Brusnichkina]

[Text] The use in flying vehicles of new display systems using cathode-ray tubes [CRT] is substantiated by a number of potential advantages: maximum integration of information, feasibility of issuing the necessary information as related to flying mode, variation of principles types and forms of presentation, and others.

In view of the fact that such systems are called upon to replace the aggregate of usual flight and navigation instruments, they must furnish all information needed for flying and spatial orientation of the pilot, and in a form that will assure the effectiveness of his actions.

Our studies of interaction between the pilot and flight instruments based on CRT revealed that the change from the usual methods of coding flight signals (information presented on vertical and horizontal dials instead of round ones, change in scales of the dials, depending on flight mode, use of counters, different method of showing spatial position of the aircfart) leads to partial deautomation of sensorimotor coordination in piloting. Deautomation of the skill, which resulted in diminished precision of flying, was manifested by a change in parameters of information gathering (in particular, fixing the eyes longer on the main flight indicators) and in structure of control movements: increased frequency and amplitude of movements, with a distinct tendency toward increase in overall bioelectrical activity of muscles involved in their performance, and by the presence of trial and error movements. It was also found that it was particularly difficult for the pilot to make combined use of two information models (electronic flight indicator and the usual instrument panel).

We related the diminished piloting efficiency to difficulties in mental regulation of the pilot's actions, due to lack of concordance [matching] of operational images formed when using the CRT indicator and aggregate of traditional flight and navigation instruments. We also became convinced of this because the pilots did not experience any difficulty in using the CRT indicator for control in a directive mode, i.e., following command signals, which showed the pilot how he should make movements for the aircraft to hold accurately to the set trajectory.

When flying according to directive signals from the electronic indicator, piloting accuracy was high and the structure of performance did not undergo substantial changes. The fact of the matter is, in the first place, that the mode of presentation of directive signals on CRT is not appreciably altered and, in the second place, and this is apparently the main point, in the directive mode of flight, as previously shown by N. D. Zavalova and V. A. Ponomarenko (1973), the pilot uses a simplified operational image, and for this reason he depends less on the quality of the information model, type or mode of coding flight information.

The results of these studies prove the importance of taking into consideration the psychological distinctions of formation of operative images regulating pilot action in making the choice of principles, types and means of presenting flight information on new indicator equipment. In particular, these distinctions determined the degree of meaning-related and formal compatibility of new and traditional methods of coding it.

MEANS OF REFINING INDICATORS IN AIRCRAFT SIMULATORS TAKING INTO CONSIDERATION PSYCHOPHYSIOLOGICAL DISTINCTIONS OF PERCEPTION

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 22-23

[Article by Yu. V. Kamenshchikov and A. S. Kondrat'yev]

[Text] Visual information is a mandatory prerequisite in modern aviation simulators (AS) to work out a considerable number of tasks involving visual contact with the external situation.

Simulators of the visual situation (SVS) simulate patterns that differ from real ones in several respects. These differences are attributable, on the one hand, to the limited capabilities of SVS and, on the other, to the desire of simplifying their design.

Consideration of the psychophysiological distinctions of perception of space outside the cabin of an aircraft or simulator is the decisive factor in determining whether simplifications of a simulated image are admissible.

From the standpoint of psychophysiological perception, we can outline the following means of upgrading SVS: first, expansion of the field of vision of the simulated image; second, creation of the effect of quasi-three-dimensionality of the observed image; third, use of a color system of SVS.

Most modern SVS have limitations in angular dimensions of the simulated visual image. In a real fight, the pilot sees virtually all of the space outside the cabin. One could eliminate the restrictions on the angle of vision by installing additional film projectors, which project the image on the periphery of the information field of the SVS. It was shown experimentally that with such enlargement of the field of vision strict conformity of displacement of objects on the central and lateral screens does not necessarily have to be achieved.

Such factors of depth vision as physiological doubling, binocular parallax, which are inherent in vission using both eyes, are not involved in perception of a simulated visual space on SVS. This is due to the fact that the pilot takes information from a flat image of the SVS, which is projected on a screen that is at a finite distance.

The studies revealed that one can diminish the influence of such inconsistency by placing collimating optics in front of the screen. An experiment revealed that

viewing an image through a large positive lens creates the effect of quasi-three-dimensionality and the illusion of the real distance of objects.

Use of color images in the SVS creates an optimizing effect, which occurs because of the increased level of coding of the simulated situation and, as a result, decreased time of perception and processing of visual information.

In conclusion, it can be noted that it is mandatory to assess and analyze new SVS systems, from the standpoint of psychophysiological perception of the simulated image, before undertaking their development.

PERCEPTION OF COLOR-CODED AVIATION SIGNALS IN THE PRESENCE OF PHOTIC INTERFERENCE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA L979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 23-24

[Article by Yu. P. Petrov, L. N. Karelina and A. S. Kondrat'yev]

[Text] Pilot work in the system of aircraft control is among the most complex forms of operator work, due to the need to process a large amount of information, considerable shortage of work time during exposure to the diverse adverse flight factors. In particular, night flights involve discrimination of dim outside signals and landmarks which, in turn, requires a high level of light sensitivity. Under such conditions, even a slight photic factor, which disrupts the adaptation process, leads to diminished visual fitness.

We studied the time of restoration of light thresholds after use of photic factors in the situation of observing outside light signals (navigation lights, barrier lights, etc.). Determination was made of thresholds for white, green and red. It was experimentally demonstrated that there is considerable elevation of thresholds for discrimination of color point signals after exposure to light, as compared to initial data. For example, the threshold for a white light source was about 1000 times higher than the base level. The color of red and green point signals was identified after exposure to light only 44 and 55 seconds later, with threshold levels of light to the pupil 7-10 times above the initial threshold. These data indicate that there is not only impairment of sensitivity to light, but of color perception--achromatism, under the influence of an intensive photic stimulus. However, achromatism was inherent only in cases of of close to threshold discrimination, since the color was perceived instantly when presenting supraliminal levels of brightness. A study of discrimination of signals referable to the light panels in the cabin revealed that they were all identified virtually instantaneously after exposure to experimental photic stimuli.

Restoration of illumination thresholds to base levels depends on the color of the signal. According to data obtained in laboratory experiments, determination was made of the possibility of averting an aircraft collision in the air after blinding the pilot. The changes in threshold illumination after delivery of the photic stimulus demonstrated experimentally was used to calculate the range of visibility of lights in the collision prevention illumination system. It was shown that the range of visibility of signals after delivery of strong photic stimuli does not permit performance of the maneuver to restore a safe situation.

DISTINCTIONS OF VISUAL FITNESS OF PILOTS UNDER DIFFICULT FLYING CONDITIONS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 24-26

[Article by Yu. P. Petrov, Yu. V. Kamenshchikov and M. G. Kozyr'kov]

[Text] There are several factors that affect a pilot in flight, which lead to complication of flying conditions and diminish his visual fitness.

A change in lighting conditions during a flight is one of the powerful ambient factors, which is adequate to human vision.

When flying at night under difficult meteorological conditions and at high altitude, the pilot may experience the effect of considerable fluctuations of brightness, which lead to blindness. On the basis of the results of flight experiments, it was established that, even when a pilot is briefly blinded for several seconds, there could be loss of spatial orientation with development of an emergency situation.

When flying at high altitude there is a redistribution of levels of brightness, drastic increase in contrast and change in lighting climate in the cabin due to the change in correlation between the direct and scattered elements of natural illumination. As a result, after observing the brightly lit cloud layer, some time is required for the pilot to be able to again discern the instrument readings. To reduce this time, it is imperative to make optimum use of light filters, special gear and special illumination in aircraft cabins with "hurricane lamps."

There are no visible landmarks outside the cabin in the pilot's field of vision when he is at high altitude. Under such conditions, one observes a decrease in range of detection of airborne targets. "Empty field myopia" is considered the main cause of this. A display system developed on glass, in which the indexes are collimated to infinity, helps increase the range of detection of airborne targets by attenuating accommodation.

Flights at extremely low altitude have their own distinctions, which affect visual orientation. They include the great tension of the pilot, which is related to his closeness to earth, exposure to accelerations in different directions, limited time for observing objects on the ground, which move at high angular velocities.

Moreover, in low-altitude flights, we observe difficulties in visual estimation of altitude, particularly when flying over snow-covered areas and in calm weather

over water. These problems are related to the absence in the field of vision of individual discernible objects, from which the pilot gauges distance.

In view of the foregoing, along with development of special range finders, one should also train the pilot's visual estimating functions.

COMPLEX PSYCHOLOGICAL EVALUATION OF PILOTS WITH DIFFICULTIES IN SOCIOPSYCHOLOGICAL ADJUSTMENT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 26-27

[Article by Ye. N. Lobova]

[Text] At the present time, a complex psychological examination is made for psychological analysis of pilots as part of expert medical certification, and the main methods involved are: conversation, examination of records (medical chart, medical records, service and medical references, flight record [book]) and a set of experimental psychological methods including those used to examine the personality and dynamics of main mental processes.

In our study we tested the following functional psychological capacities of subjects: ability to perceive spatial relations, ability to retain and rapidly reproduce meaningful material, span, stability and productivity of active ["operative"] memory, ability to distribute and switch attention, stability of attention.

Character and temperament were studied by several personality methods: standardized personality testing method (SMIL), thematic apperception test (TAT, Heckhausen variant), 16-factor personality questionnaire (16 FLO). All of the methods were standardized on a large group of flight personnel.

We examined flight personnel who had shown poor sociopsychological adjustment to flight training or service, manifested by frequent conflicts and infraction of discipline, because of which they had been referred to the department of expert medical pilot certification at an aviation hospital.

All of the subjects had poor medical references, the conclusions indicating the desirability of limiting or removing them from flight work, although 20% had good professional skills. Constant alcohol abuse was recorded in 47%.

Analysis of the results of determination of dynamics of the main mental processes revealed high (42%) and average (58%) scores.

However, this group was homogeneously poor with regard to individual psychological traits. The psychological profiles of all patients, obtained from use of personality methods, were indicative of accentuations of the psychopathic type.

A high degree of pretentiousness, along with dissatisfaction with one's own status, excessive conflict (in 80% of the cases there were conflict situations both at work and at home), increased affectiveness, difficulty in social adjustment,

inadequate reactions to conventional social standards, cruelty and impulsiveness were inherent in all of them. As a result of constant alcohol abuse, all of these features were more marked in half the subjects.

Consequently, it is not enough to take into consideration only functional psychological capacities. A complex evaluation is needed, which also takes into consideration the distinctions referable to the individual's mental state and temperament, degree of susceptibility to emotional disorganization during professional activities, in medical certification of flight personnel presenting frequent conflict situations and poor sociopsychological adjustment, and this would largely determine the expert's decision.

SOME OF THE PATTERNS OF POSTFLIGHT DYNAMICS OF THE RECOVERY PERIOD FOR PILOTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 27-29

[Article by A. A. Krivonos]

[Text] Regulation of work and rest schedules occupies one of the leading places in the armamentarium of resources for actively affecting formation of an optimum functional state in pilots. First of all, proper conditions must be provided for normal occurrence of recovery processes in pilots, starting immediately after completing flights.

However, many theoretical and applied aspects of this problem have not yet been adequately resolved. For example, the absence of systematized data pertaining to the nature of "deferred" recovery, which takes place for many hours after a flight, does not enable us to offer a scientifically validated answer as to the physiological needs with regard to duration and alternation of rest (active and passive) and work.

Simple and instrumentation studies, measurements and complex recording of physiological functions, behavioral reactions and quality of performance of large groups of pilots, pursued for many years, and interrogation thereof made it possible to obtain additional information about some of the distinctions of their recovery processes after diverse flight work loads and to determine some patterns.

Thus, "deferred" recovery lasts up to 18-24 h after a maximum flight load. At first, for about 40 min, there is normalization of most of the altered physiological parameters. Then the number of altered parameters again increases. As a result, the state of the functional systems involved in maintaining the endogenous environment and systems determining the body's behavior in the exogenous environment undergoes fluctuating change during this time, with manifestation of a harmonious combination of direction and degree of change in the relevant parameters. The "wavy" pattern of change is of an extinction nature, and it occurs against the background of manifestation of circadian rhythm. Each half-wave lasts about 6 h.

Under the influence of this biologically determined undulant pattern, one observes phases during which there is a drastic decrease in number of altered physiological parameters in the subject, and in subsequent phases this number increases again.

We found that, at the start of the minimum and subsequent rise to maximum level of number of altered parameters, the body has a phsyiological need for passive rest and sleep, whereas in the next phase, when the number of altered parameters decreases, this need is manifested by active behavior and work.

If this need is not met under the influence of the social synchronizer, i.e., the prescribed schedule for the day of work and rest because rest (sleep) and waking state (work) are counter to the phase of normal dynamics of the recovery period, the attenuating process of fluctuation is impaired and overall duration of "deferred" recovery increases drastically (sometimes by 9 h or more). In turn, if alternation of psychophysiological activity (active rest, work) and passive rest (sleep) coincides with the duration of the demonstrated phases, the recovery process is drastically shortened. These patterns may augment the stock of initial theses referable to physiological validation of proper grouping, determination of order and duration of performance of educational and pedagogic tasks and official duties in the periods between flights so that the necessary conditions are provided for forming the optimum level of psychophysiological readiness of pilots for flight work over the period of the next flights.

DISTRIBUTION OF PILOT'S ATTENTION DURING LANDING WITH LOW WEATHER MINIMUM

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 29-30

[Article by V. V. Polyakov]

[Text] A study was made of distinctive features of information gathering by a pilot when making a landing approach as a function of degree of automation of aircraft control and difficulty of meteorological conditions.

Studies were pursued during flights aboard aircraft under real SMU [adverse meteorological conditions] with low weather minimum. The pilots made landing approaches in automatic, directive and positional modes of control. The direction fixed by the pilot's eyes was filmed to study the structure of information gathering.

Analysis of the motion pictures enabled us to demonstrate distinctions in the structure of distribution of attention, which must be taken into consideration when training flight personnel for flights under conditions of a low weather minimum.

In real SMU, even before coming out of the clouds, pilots start to search for landmarks. The share of attention given to examination of the space outside the cabin depends on the weather minimum and level of automation. The most time is devoted to outside space in the automatic control mode, and the pilot is distracted from instrument flying the least in the directive mode. The time spent looking at the space outside the cabin before coming out of the clouds constituted 0.5-4.5 s when flying in the automatic mode, 0.3-2.2 s in the directive and 0.4-2.6 s in the positional. Whatever the flying mode, the lower the weather minimum, the more time the pilot was distracted from instruments to search for landmarks.

After coming out of the clouds, the structure of distribution of attention differed markedly from a usual visual flight, and it was characterized by alternate monitoring of instruments and outside space. The share of time devoted to monitoring instruments was related both to the flying mode and conditions of horizontal visibility. In the automatic flight mode, there was prevalence of observation of landmarks on the ground, while the time spent on reading instrument information constituted 18-27% of the flying time after going out of the clouds until the runway was touched. In the directive mode, there was a substantial increase in attention given to instrument signals, monitoring of which occupied 42-64% of the time. With decrease in visibility of the runway, there is an increase in attention given by the pilot to instruments.

The principal implications of the obtained results is that a fact of practical importance was established: with low weather minimum, the change to visual flying is not a simple, instantaneous act; it takes time and has a complex structure. More favorable conditions for changing to visual flight are created in the automatic control mode.

THE PROBLEM OF STUDYING INDIVIDUAL PSYCHOLOGICAL DISTINCTIONS OF FLIGHT PERSONNEL

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 30-32

[Article by V. A. Bodrov, B. L. Pokrovskiy, N. F. Luk'yanova and V. P. Stupnitskiy]

[Text] The significance of individual psychological traits to professional work is determined by the difficulty and specifics of a concrete occupation. Pilot efficiency depends quite substantially on his individual traits, even more than the flying and tactical characteristics of the aircraft in the opinion of some authors. This is the reason why psychological screening began sooner in aviation than any other types of work, and it has gained the most dissemination all over the world.

Flying and combat use of new aviation technology are characterized by an ever increasing mediation of control action by partial automation of analysis of information and control processes, increased monitoring function and, accordingly, thinking, as compared to the purely motor elements of work. For this reason, greater demands are made of the intellect of pilots of modern flying vehicles. We used a special method, developed by Soviet authors, to study the level of development of intellect in flight school candidates. Analysis revealed that this method has broad possibilities and considerable potential with respect to refining psychological screening of various aviation specialists.

The chief cause of disqualifying flight personnel for health reasons are diseases in the etiology of which sociopsychological factors play an important role, which are largely related to individual personality traits. Investigation and deeper evaluation of these traits are aided by the use of a set of personality methods. Use of such a set of methods in examining older flight personnel (41-55 years) with diseases of the gastrointestinal tract, sequelae of closed cerebrocranial trauma, functional diseases of the central nervous system and essential hypertension, who were admitted to hospitals due to partially erroneous actions in flight or conflict situations at work and at home, enabled us to demonstrate in a number of cases--9 to 100% among these groups--adverse personality traits that were instrumental in onset or aggravation of disease and tense emotional states. Knowledge of such distinctions helps find a better expert decision and choose a system of adequate preventive measures.

The main principles of studying the human personality include duration and continuity. However, at the present time, there are no official forms in the

medical service that record the results of experimental psychological examinations and of the aviation physician's studies of individual psychological traits of pilots. This lowers the accuracy of evaluating such traits and does not permit analysis of the dynamics of their development; consequently, it does not permit prediction of behavior in a given situation, makes it difficult to institute preventive measures, and has the greatest effects when a pilot is transferred to a different place of work or medical certification in a hospital. It is a pressing task for aviation medicine today to make up a "psychological passport," a record that would systematically reflect the pilot's individual psychological traits throughout his period of service, as well as to develop practical ways and means of evaluating and recording these traits.

DISTINCTIONS OF PILOT'S SENSORIMOTOR COORDINATION WHEN PERFORMING DUAL DUTIES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 32-33

[Article by V. V. Davydov and A. B. Vasil'yev]

[Text] The pilot often has to combine the process of flying an aircraft with performance of a number of other tasks, the quality of which ultimately determines the effectiveness of his work.

Studies were made of some of the psychophysiological distinctions of pilot performance when working on two competing tasks, the piloting process with concurrent observation of other objects. Structural analysis of the direction in which the pilot looks and his controlling movements revealed that, in both actual flight and on a simulator, movements are performed not only during visual monitoring of flight parameters, but when attention is distracted to additional objects, i.e., without visual feedback. However, during "flight" on a simulator, virtually all of the operations with the controls start during periods when the pilot is looking at the instrument panel. In a real flight, when the sensory basis of activity is enriched by a set of noninstrument signals (angular and linear accelerations) which, as shown by studies, not only give a sensation of the body's position in space, but are included in the mechanism of formation of controlling movements, the pilot performs some of the movements in response to noninstrument signals. The number thereof depends substantially on stability of the aircraft. While there are about 12% on a stable aircraft (the An-12), there are almost three times more on one that is not very stable (helicopter). As a result of using a set of noninstrument signals, the time available to perform additional tasks that are not related to the flying process is 15-20% greater in actual flight than on a simulator with a stationary base, with the same dynamic characteristics of the controlled object.

The studies revealed that as flying skill improves there is expansion of the sensory input of information due to more adequate and complete utilization of the set of noninstrument signals. As a result, experienced pilots perform about 40% of the movements in response to noninstrument signals, whereas less experienced ones have only 25% such movements. This is one of the important factors that cause a 15-20% increase in reserve capacities of experienced pilots.

Thus, the psychophysiological distinctions of a pilot's sensorimotor coordination when performing dual duties are determined by the role of instrument and noninstrument signals in constructing controlling movements. The ratio between these signals in the mechanism of forming controlling movements depends on the type of aircraft, its aerodynamic characteristics and level of pilot training.

STATE OF THE NERVOUS SYSTEM OF AVIATION SPECIALISTS DURING PERFORMANCE OF THEIR DUTIES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 33-34

[Article by G. A. Akimov, V. S. Videnin and M. M. Odinak]

[Text] We used neurological clinical methods to study fatigue in flight personnel, as well as a number of psychophysiological tests: critical flicker fusion (CFF), electrical excitability of the eye (phosphene), digital tremor, motor reaction time in response to sonic stimulus, muscular strength and endurance, maximum speed of finger movement (tapping test) and electrical resistance of the skin (galvanic skin response).

Flight personnel were examined before flights and in the postflight period, after 1-2 h and every 12 h for 2 days.

It was established that a number of stereotype neurological changes are demonstrable in flight personnel in the postflight period. Signs of moderate asthenization were observed the most often at the early stages. The pilots reported insignificant fatigue, while neurological examination revealed dermalaxia disorders, accentuation of tendon and periosteal reflexes. Against the background of these rather sparse neurological symptoms, there was total worsening of psychophysiological parameters, which is pathognomic for asthenic syndromes of diverse genesis.

At the next phase of neurological changes, we observed diffuse organic symptoms. Neurological examination revealed signs of oral automatism, which were often associated with impairment of statics and fine coordination, with some instability in Romberg's position. There was further decrease in productivity according to the psychophysiological studies; however, the clinical data alone were sufficient to diagnose fatigue of this grade.

We then observed the syndrome of hemispheric asymmetry, which was manifested by microsymptoms of pyramidal deficiency. There was smoothing of the nasolabial fold, occasionally combined with deviation of the tongue, accentuation of tendon and periosteal reflexes with attenuation of plantar and abdominal reflexes on the same side. The pilots were inconsistent in the psychophysiological tests. These findings were indicative of marked fatigue.

All of the demonstrated changes were functional and reversible. Restoration of background neurological data and psychophysiological parameters usually occurred

within 24 h, but in some cases a longer period was required for them to regress (up to 24 h [sic]).

The data we obtained from clinical neurological and psychophysiological tests constitute objective criteria of fitness, and they can be used for the early detection of fatigue in flight personnel and better regulation of the work load.

PHYSIOLOGICAL EVALUATION OF FORMATION OF FLYING SKILLS WITH A CHANGE IN STRUCTURE OF THE PILOT'S WORK

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 35-36

[Article by N. I. Frolov, V. I. Zorile, A. B. Vasil'yev, A. L. Ivashchenko and V. A. Varfolomeyev]

[Text] Formation of flying skills when the work structure is altered is an important practical task for aviation medicine. This is related to the fact that pilots are periodically retrained for other types of aircraft. We conducted complex studies of the main elements of flight skills (sensory, motor and autonomic) and the correlation between them in the retraining process.

It was established that there are marked changes in physiological systems with a change in structure of pilot work, and they appeared before the flights, being related to the degree of novelty and difficulty of tasks; they diminished significantly (in both degree and, particularly, duration) when going on repeated flights.

The motor component of skill (studies during landing approaches) was characterized by a change in internal and external structure of controlling actions. As the skill of control was formed in the course of retraining on a different aircraft, we observed a decrease in overall number of movements (by 20-30%) and their amplitude, with less time spent on active manipulation of the control stick. In addition, in the course of forming a skill, there was a change in proportion between different types of movements (working, correcting, background). In particular, there was an increase in share of background movements, with relative decrease in working and corrective ones. In the structure of the pilots controlling actions, there was an increase in number of movements of a preventive [anticipatory] nature, which were performed on the basis of anticipation, and movements without visual feedback. Evidently, these changes reflect the change of regulation of some of the controlling movements from the exogenous to endogenous regulation system, and they are indicative of automation of control skills. As the retraining program was assimilated, there was a decrease in number of mistakes, increase in accuracy of holding the specified flight parameters, increase in attention reserve, decrease in tension of physiological systems in both the period before take-off and in flight. The parameters characterizing the quality of flight performance stabilized before the physiological ones.

Thus, one can make a rather complete evaluation of flying skill after retraining by using a set of parameters that characterize the following: level of tension of physiological systems in the period before take-off, in flight and after flight; structure of pilot's controlling movements; quantity and quality of erroneous actions; level of reserve capacities and quality of performance of the flight assignment.

This paper validated the feasibility and formulated the principles of using psycho-physiological parameters as an objective criterion for evaluation of flying skill for the purpose of further improvement of flight training.

SOME PSYCHOPHYSIOLOGICAL ASPECTS OF THE PROBLEM OF IMPROVING EFFICIENCY OF OPERATOR PERFORMANCE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 36-37

[Article by V. K. Martens, A. N. Medvedev, V. Yu. Sheblanov, V. I. Il'in and A. A. Talalayev]

[Text] Development of aviation and cosmonautics is posing with particular urgency the question of the means of enhancing efficiency (reliability) of the "pilot-flying vehicle-environment" system.

Investigation of mechanisms of an operator's adjustment to the conditions of his professional work, using the principles of the systems approach, appears to be the most promising.

It should be assumed that investigation of pilot performance, with close correlation between his information load and professional working conditions, psychophysiological state and structural distinctions of the operator's personality will enable us both to increase the efficiency [effectiveness] of the "man-machine" system, and to lower neurotic and related somatic diseases among operators of ergodic ["ergatic"?] systems.

The consistent increase in incidence of such diseases is presently considered to be one of the important problems according to Soviet and foreign literature.

Fitness, psychophysiological state and the mechanism of operator adaptation to brief and prolonged stressors were studied for several years in both the laboratory and at work referable to different types of operator activities, including real and simulator flights.

The data we obtained revealed that examination of the functional state of an operator using a set of physiological methods makes it possible to determine the effectiveness of regulation and function of different physiological systems during work and degree of tension of the body as a whole, i.e., the "physiological price" of the work. At the same time, under standard conditions of operator work, the subjects revealed dissimilar and, in some cases, contradictory responses. It is difficult to explain these differences solely on the basis of physiological parameters.

In our experimental work, we made extensive use as well of psychological personality tests. The psychodiagnostic methods we used (MMIL [MMPI?], 16-RG-Kettel and SAN) enabled us to identify the distinctions of personality structure and current mental state of the operators surveyed.

Analysis of the experimental data from the standpoint of the systems approach revealed that the "physiological price" and success of operator performance, as well as overall psychophysiological adaptation to stressors, were largely determined by the personality traits and, first of all, level of anxiety. There was convincing experimental confirmation of this. Use of psychopharmacological and psychotherapeutic measures to lower anxiety improved the parameters of operator performance and increased the effectiveness of adaptation.

The results of our studies enable us to outline the means of evaluating, predicting and optimizing psychophysiological adaptation of operators to brief and prolonged stressors, as well as the related success of operator performance; one should make broader use of psychodiagnostic methods of testing the personality in the traditional system of professional screening of operators.

FORECASTING FLIGHT ACHIEVEMENT ACCORDING TO RESULTS OF TESTING ON A SIMULATOR

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 38-39

[Article by V. A. Bodrov, V. F. Zhernavkov and A. A. Vorona]

[Text] With the development of aviation, there are greater demands on a pilot's mental qualities, and for this reason intensive work is under way in aviation to refine the system of screening individuals with adequate capacities for this profession. There are no objections to the view, according to which the "capacity" for this form of work should be tested (N. I. Mayzel', V. D. Nebylitsyn, B. M. Teplov, 1964). For this reason, one of the main tasks in predicting flight achievement is to demonstrate capacity for flight training.

Thus, prediction of one of the most important features of fitness for a profession or achievement in future flight work of a cadet should be based on the results of the dynamics of formation of the skill (set of skills) on a model that is as close as possible (adequate) to the real work. It is known that aviation simulators are presently the best model of pilot work, and they include some working elements of flying operations on the corresponding aircraft.

The principle of evaluating capacity for learning as it relates to flying is followed rather well by means of training and check flights on an aircraft, when the final decision is made as to the professional fitness of the student. However, for many reasons, it is necessary to pick out earlier the individuals with poorer capacity for flight training.

We studied the possibility of predicting flight achievement of first-year cadets at a flying school according to the results of "flights" on simulators before starting to perform training flights on a training aircraft. The characteristics of formed skills in flying in the simulator and aircraft were equated with flight capacities and graded on a nine-point scale by experienced instructors. It was established that none of the cadets with low marks (1-3) on the simulator was among the best (with a score of 7-9) according to the results of real flights, whereas none of those rated as excellent had a low score when graded in an aircraft.

The cadets who were dismissed for poor flight achievement made reliably more piloting mistakes on the simulator and were notable for slower advancement through

the training program, as well as greater variability of indicators of quality of control. It may be assumed that they were not able to assimilate the correlation between changes (deviations) in flight parameters and required controlling movements within the time scheduled for training on the simulator.

Increasing use is being made in training practices of objective psychophysiological monitoring of pilot (cadet) performance on the simulator. Apparently, this could become the main regular system for checking and assessing the ability to acquire new skills and functions inherent in this profession. Practice sessions, which serve as a means of predicting capacity for learning, should also include a test of the pilot's (cadet's) traits related to reliability of actions under special (extreme) flying conditions.

PHYSIOLOGICAL AND PSYCHOLOGICAL REACTIONS OF PILOTS WHEN LANDING IN WATER AFTER ABANDONING THEIR AIRCRAFT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 39-40

[Article by V. L. Marishchuk and B. S. Stravinskiy]

[Text] We know of instances when crews did not act effectively after emergency abandonment of their aircraft above water, and they did not take proper steps to save themselves. Interrogation of pilots warrants the belief that psychological stress is one of the causes, which develops because of the difficulty and uniqueness of the situation, as well as lack of necessary practical skill for actions after landing in the water.

In order to assess the physiological and psychological cost of some elements of pilot action after finding themselves on the water after abandoning their aircraft, we provided similar models (inflation of lifeboat in water, getting into it, handling the raft with a helicopter overhead so as to hook up with the cable, being lifted by the crane on the helicopter out of the water). Before and after these procedures, we measured several autonomic reactions and conducted psychological tests. A total of 40 flight personnel were submitted to these tests.

We found that the procedures with the lifeboat were quite difficult and highly emotional for pilots without the necessary skill, particularly when handling it to come closer to the cable dropped from the helicopter (because of the wave generated by the propeller movements).

Thus, among the subjects submitted to the tests, 35% presented an increase by more than 32 beats per min in pulse rate (in some cases it more than doubled), 33% had elevated maximum arterial pressure (by 30-50 mm) and 37.5% elevated minimum arterial pressure (by 10-25 mm). In one young pilot, the hypertensive type of arterial pressure reaction (+60 mm systolic and +35 mm diastolic) was discovered for the first time. In 25% of the participants in the experiment, there was a substantial decline after the test of parameters of the step test (by more than 10 units).

In some cases, there was also an appreciable decrease in number of lymphocytes and eosinophils in blood, which was an indirect indication of development of a stress reaction.

The psychological tests revealed that 30% of the subjects presented a significant decline of parameters of mental productivity and visual memory; 30% of the pilots also had poorer results in the modified Romberg test.

One of these authors (B. S. Stravinskiy) organized training of several groups of pilots on how to act on water after abandoning their aircraft. The training was conducted on a special program, with organization of active rest for the flight personnel. We found that pilots who had undergone such training performed all specified actions much more effectively and better. Psychological testing after joint actions with the crew of the rescue helicopter (rowing to the cable, attaching oneself to it and being lifted) showed that they had a feeling of confidence in their abilities and they had higher parameters of stability of mental processes. Their autonomic reactions were less wasteful.

The foregoing indicates that even relatively brief training on the program we tested helps adapt to the conditions of such action and form confidence in their success.

CHANGES IN VENTILATION PARAMETERS OF CIVIL AVIATION HELICOPTER CREWS UNDER THE INFLUENCE OF FLIGHT FACTORS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 41-42

[Article by Yu. N. Kamenskiy]

[Text] A study was made of the crews of cargo helicopters in the course of flights in order to examine the changes referble to external respiration, as a system that integrally reflects the functional state of the body. The ventilation parameters were recorded in the base state before the flight, at the climbing, horizontal and descending stages of flight.

In the base state, the parameters of respiratory rate (RR), tidal volume (TV) and minute breathing volume (MV) constituted 11±0.9 cycles/min, 660±40 mℓ and 6.6±1.4 ℓ/min, respectively. During the climb, there was significant elevation of all ventilation parameters. These changes were more marked in the crew commander than other crew members. Thus, there was a 28% increase in the commanders' RR, 23% increase in TV, while MV changed similarly. This indicates that there is relatively less increment of MV in commanders, which was largely attributable to faster breathing. Evidently, nervous and emotional tension of pilots at the most important phases of the flight--take-off, climb and descent--played the leading role in these changes. For expressly this reason, the greatest respiratory changes were noted in crew commanders.

However, one should not rule out the effects of flight factors on the pilots, in particular, vibration. In the opinion of N. S. Molchanov et al. (1972), vibration can have an appreciable effect on respiratory function of helicopter crews. Our findings also suggest such a correlation. During horizontal flight, when the process of flying the helicopter was much simpler and even switched to the automatic pilot, there was no normalization of respiratory parameters. While the RR was close to base values, TV increased and MV showed virtually no change, as compared to the climbing period. Probably, in this case, hyperventilation could have been the pilot's reaction to vibration. The mechanisms of these reactions were apparently related to both reflex increase in tonus of postural muscules and resonance phenomena in anatomical structures of the thoraco-abdominal region (Ye. Ts. Andreyeva-Galanina, 1956; W. Lange, 1974). Nor can we rule out reflex hyperventilation due to mechanoreceptors of the lungs and airways (T. Lamb, S. Tenney, 1966).

In the light of the data of N. S. Molchanov et al. (1972), the results of our studies may be indicative of the fact that vibration plays a part in development of lung and upper respiratory tract diseases in helicopter pilots. On the other hand, these data must be taken into consideration when assessing the energy expended by helicopter pilots, particularly in cold weather, for the purpose of developing a better work, rest and nutrition schedule.

SIMULATION OF INJURIES SUSTAINED IN CABINS OF CIVIL AVIATION AIRCRAFT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 42-43

[Article by A. V. Klyuyev]

[Text] At the present time, experimental modeling is used extensively in scientific research referable to different branches of science. There is also wide use of modeling in medicine, particularly in aviation medicine (for example, simulation of special flight situations in aircraft simulators with recording of physiological parameters of crew members, etc.).

In virtually every investigation of an aircraft incident, the question rises of determining the position and actions of crew members at the moment the aircraft collides with an obstacle, and the proper answer to it is important to retrospective analysis of the emergency situation as a whole. There are some theoretical conditions that permit unequivocally answering this question. As we know, at the time of collision of an aircraft with an obstacle the crew is subject to deceleration overloads, and the body hits the parts of the equipment and cabin interior located in front. As a result, primary injuries of a specific localization are formed, and they characterize the position of the body in the work place at the moment of impact.

In order to solve this problem properly one must have experimental models of formation of injuries in crew members in the cabin of different types of aircraft.

We determined the parts of objects presenting the potential hazard of trauma in the cabins of complex mockups of certain aircraft with simulation of deceleration overloads on the X and Z axes of the aircraft and their components.

We took into consideration the typical anthropometric features of the pilots, the system of immobilization in the work place and direction of deceleration overloads. [accelerations?]. During such overloads, produced by assuming a simulated position, the subjects performed specific work actions with the controls. Determination was made of the possibility of localizing injuries on the crew's body, as well as the parts of the pilot's cabin presenting a trauma hazard. Concurrently, we examined the results of investigations of aircraft incidents in order to detect the clues indicative of position and work actions of the crew under specific circumstances of the accidents. Analysis of these data demonstrated the validity of the experimental approach to settling the complex question of position and action of the crew when investigating very serious aircraft incidents.

The results of our studies are submitted in the form of an atlas of the human body, showing the location of mechanical trauma inherent in specific positions and work operations.

The obtained experimental data can be used to determine the position and work actions of crews when investigating serious flight incidents, with consideration of the direction and magnitude of deceleration overloads, type of seat belt system, nature of deformation and destruction of an aircraft cabin.

USE OF PSYCHOTHERAPY ABOARD OCEAN NAVIGATION VESSELS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 43-45

[Article by M. S. Denisyuk, G. V. Rozhkovskiy, M. V. Batyuk, S. N. Koval'chuk, N. V. Motnyak, A. A. Rudenko and A. S. Slyn'ko]

[Text] Methods for regulation of the general condition of the body, optimization of daytime rest after a watch, faster induction of natural sleep and activation of the body prior to a night watch are included in the adapted self-regulation system (ASS), which was developed to optimize purposeful correction of adaptive processes.

The ASS was tested at sea on 4 cargo vessels with crews totaling 177 people and average duration of voyage of 3.5 months. A set of tests characterizing the condition of the central, autonomic and cardiovascular systems was used to examine the dynamics of the process of learning the ASS and effects of ASS on the organism.

ASS was used for 129 out of the 177 crew members, which constitutes 72% of the total number. The program was completed with a total positive effect by 97 people (175% [sic] of the total trained) and partial positive effect by 22 (17%). This training had no effect on 10 people (8%). These studies confirmed the hypothesis that conscious self-regulation can affect adaptation processes, and led us to the following conclusions: the beneficial effect of using ASS during a voyage is manifested by a regulatory influence on several of the vital systems of the body, faster reorganization of cyclic rhythms of the body, stabilization of emotional background of the crew and fewer visits to the ship physician; the factors that limit the efficacy of ASS at sea are: degree of training of the ship physician, lack of desire on the part of the crew to learn the proposed technique and sea disturbances rated at over 4 points.

Concurrently with ASS, hypnosis was used in some cases to correct deadaptation signs and treat some diseases. The following are the important limiting factors for use of hypnosis at sea: lack of adequate method of determining susceptibility

to hypnosis and of a hypnotizing method that would be effective enough and conform with the prevailing conditions. A method was developed to determine hypnotizability, which makes it possible to use data obtained during hypnosis to develop hypnotization formulas, in order to optimize the use of hypnosis at sea.

Hypnosis was used in 24 cases (neurotic signs, seasickness, algetic syndrome). Functional disturbances or lack of response to drug therapy served as indications. In 20 cases there was a complete beneficial effect, in 2 a partial one and in the remaining 2 hypnosis was ineffective (1 case of seasickness and 1 reactive neurosis). It is desirable to train ship physicians extensively in methods of psychotherapy and, in particular, hypnosis. Indications were formulated for prescribing different types of psychotherapy.

ELECTROPHYSIOLOGICAL CRITERIA FOR EVALUATING THE QUALITY AND INDIVIDUAL DISTINCTIONS OF OPERATOR FITNESS AS RELATED TO COMPLEX TESTING OF LIFE SUPPORT SYSTEMS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 45-46

[Article by G. P. Doronin, A. A. Antonov, V. N. Chernyakova, E. B. Petrova and V. S. Dyundina]

[Text] A set of electrophysiological criteria for evaluation of the quality and individual distinctions of operator work was developed and tested, as it applies to long-term studies and on the basis of modern methodological principles.

The following are proposed as the main criteria: parameters of integrative activity of the central nervous system, obtained from analysis of individual correlations between frequency characteristics of the EEG in the frontoparietal and parieto-occipital regions of the cerebral cortex; indicators of distinctions referable to autonomic regulation of cardiac function, obtained on the basis of variation analysis of time and amplitude parameters of the EKG; indicators of individual distinctions of sensory sensations in studies of tactile and nociceptive thresholds for electrocutaneous stimulation.

Operator performance is evaluated on the basis of analysis of formalized operator activity in sensorimotor reactions, cancellation test and results of examining the emotional and mental state according to MMPI data.

Use of the proposed set of objective electrophysiological criteria,along with data obtained by psychophysiological methods, enables us to study the individual distinctions of formation of the functional system of a behavioral act in examining operator work. This approach is considered to be the most promising for evaluation of operator fitness and mechanisms of possible change therein in the course of prolonged and complex tests of life support systems.

SCREENING, EXPERTISE AND METHODOLOGICAL ASPECTS IN AEROSPACE MEDICINE

EXPERIENCE IN ORGANIZING AND MAKING EXPERT PREDICTIONS OF HEALTH STATUS OF THE CREW ABOARD THE SALYUT-6 ORBITAL STATION

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 49-50

[Article by Ye. V. Khozyainova]

[Text] A number of specific difficulties arise in predicting the health status of an individual in the course of a long-term space flight, such as the limited amount of medical information, lack of direct contact with the object of study, uncertainty of expected deviations in health status of cosmonauts, etc. Under such conditions, the method of expert evaluation may be quite useful; it is currently in wide use for solving many problems that cannot be formalized in various branches of science and practice. In our opinion, the collective opinion of a group of qualified specialists, without loss of the individual opinion of each of them, is the advantage offered in this case by the method of expert forecasting, as compared to other methods.

We used the method of expert forecasting of health status of an individual participating in a long-term space flight during the missions aboard the Salyut-1 orbital station and two missions aboard the Salyut-4 orbital station (R. M. Bayevskiy, V. I. Kudryavtseva, Ye. V. Khozyainova, 1978). Because of the increased duration of the missions, there was some modification of the methods of prognostic studies described in the above-mentioned work.

The purpose of expert forecasting of the health status of the crew of the Salyut-6 orbital station was to determine the probability of development in the course of the flight of one of the following adverse states: 1) physical deconditioning; 2) general asthenization of the body; 3) impairment of cardiac automatism; 4) impairment of myocardial contractile function, systemic and regional hemodynamics; 5) diminished mental fitness; 6) impairment of psychoemotional status; 7) vestibular disturbances; 8) impairment of fluid-electrolyte metabolism; 9) development of orthostatic instability. Each of the probable states was rated on specially developed 10-point scales, which were refined, as compared to those used in previous flights. The group of experts consisted of 15 highly qualified specialists in different fields, with much experience and tenure in the field of space medicine.

The experts made three types of forecasts: short-term (up to 2 weeks), intermediate (to 1 month) and long-term (for the entire period of flight and period of readaptation).

After each discussion of the experts' findings, mathematical analysis was made of the obtained data, with consideration of the experts' competence. To determine the experts' competence, there had been prior appropriate interrogation. The results of this analysis constituted the group evaluation of each of the adverse states.

Comparison of the forecasts to objective data concerning the health status of the crew, obtained during and after the flight, enabled us to assess the accuracy of the forecasts. The collective expert forecast corresponded quite accurately to the actual physical condition of the crew. For example, the forecast made by the first meeting of the team of experts during the second mission conformed entirely with the actual health status of the cosmonauts. On the whole, the experts did not expect significant deviations in health status of the crew of the second mission during flight or the readaptation period, and this was entirely confirmed by objective data. It must be noted that the accuracy of the forecasts improved from flight to flight.

Thus, the proposed modified method of expert evaluation was found to be quite effective in forecasting the health status of cosmonauts during long-term space flights. In the future, the method of interrogating the experts and mathematical processing of the findings must be further refined.

SIGNIFICANCE OF COMPLEX EVALUATION OF BICYCLE ERGOMETER TEST IN DETECTION OF LATENT CORONARY INSUFFICIENCY IN FLIGHT PERSONNEL

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 51-52

[Article by G. I. Dorofeyev, V. A. Maksimov, S. N. Akimov, V. T. Ivashkin, N. M. Leshchenko, Yu. P. Monastyrev and N. T. Sverdlina]

[Text] Use of functional tests and, in particular, bicycle ergometer, has expanded significantly the possibility of early detection of chronic cardiac ischemia. For expressly this reason, the bicycle ergometer test soon gained recognition, and it is presently in broad use by experts. However, one cannot consider the criteria for evaluating this test to be definitively established.

Most researchers consider a 1 mm or more decline of the ST segment during or after the test to be the main criterion for a positive test. Some authors tend to evaluate other EKG changes--inversion or versal of T wave, giant T, impairment of rhythm and conduction--as functional. For this reason, it is necessary to determine the nature of these "nonspecific" EKG changes and their significance to the solution of questions of expertise.

A total of 300 men in the flying professions were studied; they had no clinical or electrocardiographic (at rest) signs of ischemia. Impaired repolarization (shift of ST segment and changes in T wave) was demonstrated in 49 subjects, and in 24 of them these changes were grounds to stop the test. In 65 subjects, the following signs appeared under the influence of the physical load: impairment of rhythm and conduction (extrasystole in 29 cases, widening of PO [or RO?] in 13 cases); partial block of the right and left branches of the bundle of His (in 7 cases) and giant T wave (in 16). A complex study was made of 55 men with the use of the bicycle ergometer. In addition to the electrocardiogram, we evaluated hemodynamics, external respiration and a number of biochemical parameters of metabolic processes (lactic and pyruvic acid, nonesterified fatty acids, lactate dehydrogenase, AST [aspartate transaminase?], ALT [alanine transaminase?], KFK [creatine phosphate?], cyclic AMP and others). Upon demonstration of EKG changes indicative of latent coronary insufficiency (including indirect ones), there were adverse changes in hemodynamic (reduced stroke volume) and spirographic parameters, as well as biochemical tests (for example, there was a 2.5-3-fold elevation of cAMP level, versus 1.5 in the control).

Complex evaluation of the results of the bicycle ergometer test, with consideration not only of clinical, but hemodynamic, spirographic and biochemical tests, permits detection with greater reliability of latent forms of chronic ischemia.

COMPLEX EVALUATION OF SOME PARAMETERS OF CENTRAL AND REGIONAL HEMODYNAMICS BY MEANS OF TETRAPOLAR RHEOGRAPHY

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 52-53

[Article by V. F. Turchaninova and M. V. Domracheva]

[Text] There has still been no practical confirmation of the theoretically validated hypothesis of redistribution of blood when men is in weightlessness. To settle this question, we used tetrapolar rheography with quantitative analysis of the rheographic curve in order to determine the stroke volume of the heart (SV), minute volume of circulation (MV) and parameters of delivery of blood to regional vessels according to magnitude of the ratio between variable and constant components of impedance in the examined region.

Our objective was to make a complex evaluation of parameters of central and peripheral circulation by means of an onboard tetrapolar rheography under conditions that caused any degree of redistribution of blood in man.

In this report, we submit the results of examining 50 essentially healthy men 30 to 40 years of age, submitted to an ortho-antiorthostatic [sic] factor and application of negative pressure to the lower half of the trunk (LBNP). In all, we conducted 92 studies. In addition, we examined nine cosmonauts who participated in space flights of different duration.

In antiorthostatic [head down] position wth an angle of 30°, there was insignificant (7-16%) but often reliable ($P<0.01$) increase in SV and MV at the start of the test followed by restoration of base levels by the 15th-20th min of the test. The changes in delivery of blood to the forearm corresponded essentially to the dynamics of SV and MV, whereas delivery of blood to the lower leg increased by 22-30% and remained high to the end of the test. Movement of the subjects into vertical position (+70°) caused 38-47% decrease in SV and 26-37% decrease in MV ($P<0.001$).

Delivery of blood to the lower leg decreased to about the same degree, with somewhat less marked changes in parameters characterizing blood levels in the vessels of the forearm.

LBNP caused a decline of MV and particularly SV, by 16-56% and 10-25%, respectively, depending on the mode of rarefaction ($P<0.05$, 0.001). Yet there were distinctions

in delivery of blood to the forearm and lower leg. In the former case, it did not differ from the base level or even exceeded it somewhat, and in the latter it diminished.

Thus, it was demonstrated that each of the functional tests we used differed in mechanisms of influence on man and was associated with specific vascular reactions. They were reflected in the dynamics of circulatory parameters obtained by the rheographic method. This enabled us to recommend this technique for use aboard spacecraft in order to examine the cardiovascular system in weightlessness.

The hemodynamic changes during the flight were characterized by the following signs of redistribution of blood in the vessels of the upper half of the body: increased pulsed and minute filling of head vessels, which was noted in most cosmonauts; decreased delivery of blood to crural vessels in all cosmonauts, starting on the first day; prevalent increase in delivery of blood to the forearm, mainly during the first month in weightlessness.

These changes were apparently due to several factors, including reflex reactions. It is important to study these reactions in order to solve the main problems of physiology of circulation during space flights.

USE OF INFORMATIONAL CHARACTERISTICS OF THE HEART RATE OF MAN FOR INVESTIGATION OF AUTONOMIC REACTIONS TO CORIOLIS FORCES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 54-55

[Article by N. L. Borunov, V. N. Artishuk, V. N. Alekseyev, S. I. Kasatkin and I. K. Tarasov]

[Text] A method of integral evaluation of cardiac intervals was used to examine the possibility of using changes in information characteristics of the heart rate in the presence of seasickness, since they are a gauge of rate of creation of diversity, which are determined by the following formula:

$$C = fc \log_2 \frac{\sigma e^2}{\sigma D^2}$$

where fc is the significant spectrum of heart rate, σe^2 is variance of the cardio-interval process and σD^2 is variance characterizing the measurement error factor.

A decline in value of C corresponds to a more stable cardiac rhythm, and vice versa.

A total of 20 people participated in our studies. Of these, 12 (first group) had a good level of vestibular stability since they exercised regularly; the second group of subjects--8 people--did not exercise, and most of them had a satisfactory level of vestibular stability. The cumulative test with Coriolis accelerations according to I. I. Bryanov (1963) was used as a vestibular load.. We recorded the EKG on tape during 15 cycles of rotation lasting 1 min. The EKG was decoded by means of a device that measured cardiac intervals and transferred them to punched tape for subsequent processing on a computer, in order to obtain the information characteristics of the heart rate. The obtained data enabled us to assess the individual dynamics of informational characteristics. The obtained data were standardized in relation to background values, followed by approximation with a first degree polynomial by the least squares method, in order to demonstrate tendencies of change in information characteristics. The coefficient reflected the degree of change in this tendency.

After processing the data, we found that there was virtually no change in heart rate of the first group of subjects (α = +0.001) and in the second group there was a marked tendency toward diminished stability of heart rate (α = -0.011).

The quantitative characteristics obtained of changes in stability of cardiac rhythm in subjects who were susceptible and insusceptible yo seasickness enabled us to determine the range of changes in cardiac rhythm and degree of vestibular stability of the subjects.

Thus, these mathematical methods of processing information yield standardized evaluations of stability of the heart rate of subjects during vestibular training. The software developed for use with the M-220 computer makes it possible to gain more current information about the heart rate of subjects during vestibular training.

COMPLEX RHEOGRAPHIC EVALUATION OF REGIONAL CIRCULATION

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 55-56

[Article by D. G. Maksimov]

[Text] The change in gravity conditions during manned space flights is associated with redistribution of blood and body fluids, and this is apparently one of the triggering mechanisms of development of processes of adaptation to new living conditions (O. G. Gazenko, B. S. Alyakrinskiy, 1970; Ye. D. Kovalenko, 1974). Rheography may be a promising method of noninvasive evaluation of redistribution of blood and regional circulation. One usually assesses arterial influx to the examined region on the basis of the amplitude of the rheographic wave and its relation to the calibration signal, and tonus of arterial vessels according to the slope of elevation of systolic wave, duration of elevation and depth to which the systolic wave drops; venous vessels are evaluated according to the ratio of amplitude of diastolic wave to maximum systolic wave (Kh. Kh. Yarullin et al., 1972, 1977; D. G. Maksimov, M. V. Domracheva, 1976). In addition to volume plethysmography, several authors recommend rheoplethysmography to assess changes in general delivery of blood (L. G. Terekhova, Ye. S. Titkov, 1971; V. V. Orlov, 1976; D. G. Maksimov, M. V. Domracheva, 1978).

We proposed (D. G. Maksimov et al., 1978) a rheographic modification of the method of Mellender (1960) in order to further refine evaluation of regional circulation without taking blood. The method of Kubichek (1970), intended for calculation of stroke output of the heart, is recommended to determine pulsed delivery of blood and minute arterial influx. The total blood volume in the region under study (V_b) is calculated on the basis of the formula for determining resistance of a homogeneous cylindrical conductor to electric current:

$$R = \rho \cdot L/S;\ R = \rho \cdot L \cdot L/S \cdot L = \rho \cdot L^2/V;\ V_b = K_2 \cdot \rho \cdot L^2/R,$$

where K_2 is the correction coefficient, ρ is specific resistance of blood, L is the distance between electrodes and R is electric resistance of the region under study. Correction factor K_1 is also added to the formula of Kubichek. Both factors are determined empirically. According to our data, $K_1 = 0.75$ and $K_2 = 0.25$. Venous efflux is determined from the difference between minute arterial influx and changes in blood volume per minute in the region studied. It is expedient to relate the blood volumes to 100 ml tissue so that comparison can be made of data for different parts of the body.

Testing under clinical conditions of the bloodless modification of Mellender's method yielded positive results; in particular, consistent differences were demonstrated in regional vascular reactions to orthostatic tests in health individuals and patients with essential hypertension.

EXPERIENCE IN COMPUTER PROCESSING OF TETRAPOLAR RHEOCARDIOGRAMS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 56-58

[Article by Yu. A. Glazkov, G. K. Derimarko, Yu. S. Miroshnikov and V. G. Samokhin]

[Text] Stroke and minute blood volumes (SV and MV) when breathing at excess pressure (EP) are informative indicators characterizing central hemodynamics, and probably the most promising bloodless method of determining them is tetrapolar rheocardiography (RKG). The following formulas were used in a trial of computer processing for ongoing receipt and analysis of these parameters according to the RKG:

$$SV = \frac{\rho}{2} \times \frac{l^2}{Z^2} \times \int_{t_1}^{t_2} \Delta Z(t)dt \quad (1)$$

and

$$MV = \frac{30\ \rho}{(t_2-t_1)} \times \frac{l^2}{Z^2} \times \int_{t_1}^{t_2} \Delta Z(t)dt \quad (2)$$

where ρ is specific resistance of blood (150 Ω•cm), l is mean distance between internal edges of circular potential electrodes (cm), Z is the constant component of impedance of a segment of the thorax (cm), $\frac{1}{2} \int_{t_1}^{t_2} \Delta Z(t)\ t = \Delta Z$ is the variable component of impedance per cardiac cycle (corresponding to SV, mℓ), t_1 is the starting time and t_2 the ending time of the cardiac cycle, 1/2 is the coefficient due to the assumption of difference in effects of function of the left and right heart on electric conduction in the segment per cardiac cycle and $\Delta Z(t)$ is the immediate value of the variable component of impedance as a function of time (on the tracing--the RKG curve).

In the series of experiments breathing at EP in an oxygen mask, up to 60 mm Hg, RKG was recorded simultaneously on automatic recorders (Multiscriptor: V = 25 mm/s, 0.1 Ω = 10 mm and Watanabe: V = 10 mm/s, 0.1 Ω = 10 mm and a tape recorder SDR-813 type: V = 10 mm/s). The RKG tracings were processed in both the traditional way (according to Kubichek) and on a computer (using formulas 1 and 2 above).

Computer processing consisted of the following:

1. Determination of SV and MV on an analog-digital ATAS 501-20 computer with magnetic recorder and external magnetic memory on SDR-813. Hemodynamic parameters were transferred to a two-coordinate plotter--XY-Recorder, Watanabe--in units of volume (mℓ and mℓ/min). The time per address was 20 ms. This complex enabled us to do the following: select typical segments and individual RKG curves for analysis and to alter, virtually without limits, the scale of the SV and MV graph.

The following are among the flaws of this computer: necessity of strict stability of zero line of RKG tracing (in integration mode); need for manual adjustment of zero line of the computer to the zero line of the RKG tracing; no possibility of arbitrary change in program for processing the input signal; and presence of only one input channel.

2. Determination of MV on the Dnepr-1 digital computer with output of data in the form of tables on a teletype, or graphs (similarly to the ATAS (XY-Recorder). The RKG was integrated by the Euler method with 20-ms spacing [steps]. The special program we developed (volume of about 600 cells) inputted in the immediate access memory of the computer enabled us to do the following: automatically match the start of counting with the start of the arbitrarily selected RKG complex; processing for a 6-s RKG interval; consider in subsequent processing of changes in level of the constant component of the RKG.

The flaws of this computer are: practical limitation of immediate and permanent memory; absence of output on displays.

Modern computers do not have these flaws.

A comparison of the preliminary data obtained with a computer and by the traditional method (after Kubichek) revealed a good coincidence between the computer processing. data in the literature and the results of traditional calculations. The delivery of our paper will include illustrations and comparative data, as well as the flowchart for digital processing of the RKG, the program and its structural diagram.

Refinement of the program for processing RKG's will make it possible to obtain immediate information about both the SV and MV, as well as changes in delivery of blood to a thoracic segment in the course of exposure to a factor.

DETERMINATION OF STROKE AND MINUTE BLOOD VOLUMES BY MEANS OF FOUR-ELECTRODE RHEOCARDIOGRAPHY WHILE BREATHING AT EXCESS PRESSURE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 58-60

[Article by V. G. Samokhin]

[Text] Increasing interest is being displayed in four-electrode rheocardiography (RKG) as a bloodless and convenient practical method of recording stroke and minute blood volumes (SV and MV). The following formula is the basis for current methods of quantitative evaluation of the RKG:

$$\Delta V = \rho \times \frac{l^2}{Z^2} \times \Delta Z \qquad (1)$$

where ΔV is stroke volume (mℓ), ρ is specific resistance of blood ($\Omega \cdot$cm), l is the mean distance (cm) between internal margins of circular potential electrodes, Z is resistance (Ω) of a segment (base impedance or constant component of impedance), ΔZ is the change in resistance (Ω) of the segment (variable component of impulse). Determination of ΔZ corresponding to SV involves the greatest difficulties. Numerous attempts to find ΔZ on RKG tracings are in essence different modifications of the Kubichek-Nybower method, and ΔZ is used only for the systolic phase of the cardiac cycle, which requires concurrent registration of moments of opening and closing of ventricular valves to determine this phase.

The method that we empirically propose for determining SV and MV when breathing under excess pressure (EP) is based on the following assumptions:

1. The function of the entire heart is the primary cause of changes in electric conduction of the interelectrode segment of the thorax.

2. In the absence of changes in volume of pulmonary reservoir of blood, there is a difference in effects of function of the right and left heart on change in impedance of the segment.

3. Changes in impedance of the segment are attributable both to fluctuations of delivery of blood (volumetric factors) and changes in distribution and movement of blood (spatial factors) in the interelectrode space.

4. The aggregate of changes in volumetric and spatial factors affects ΔZ throughout the cardiac cycle, i.e., systole and diastole.

Proceeding from these premises, in formula (1) ΔZ will equal:

$$\Delta Z = \frac{1}{2} \int_{t_1}^{t_2} \Delta Z(t)dt \qquad (2)$$

where ΔZ is the variable component of impedance as a function of time (on the tracing--the RKG curve for the cardiac cycle), t_1 is the start and t_2 is the end of the cardiac cycle, 1/2 is the coefficient ensuing from the above-mentioned assumption 2.

With consideration of equation (2), the formula for determining SV acquires the following appearance:

$$\Delta V = f_2 \times \frac{l^2}{Z^2} \times \int_{t_1}^{t_2} \Delta Z(t)dt \qquad (3)$$

and for calculation of MV:

$$MV = \Delta V \times \frac{60}{(t_2-t_1)} \qquad (4)$$

where (t_2-t_1) is the duration of a given cardiac cycle.

The proposed method of determining SV and MV does not require simultaneous registration of additional parameters and involves no basic difficulties in immediate processing on a computer.

Analysis is made of comparative data on determination of SV and MV when breathing under excess pressure by traditional methods and the proposed one.

ULTRASONIC MONITORING OF BLOOD SUPPLY TO THE BRAIN

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 60-61

[Article by V. Ye. Panfilov and Ye. B. Shul'zhenko]

[Text] Ultrasonic detection of blood flow in superficial vessels of man, based on the Doppler effect (Rashmer et al., 1966), makes it possible to assess on a real time scale the state of local blood flow to the extent of total arrest thereof.

These features served as the basis for the ultrasonic method of evaluating blood flow in the temporal artery of man, which was developed by S. Rositano et al. (1972-1975).

An experimental unit was developed on the basis of the Soviet type IPK-1 clinical instrument, which consists of a high-frequency oscillation generator, miniaturized sensor (emitter-receiver of ultrasonic signals), as well as a system for securing the sensory on the subject's head.

This unit was tested in more than 50 experiments involving 14 male subjects.

In these experiments, we assessed blood flow in the superficial temporal artery as a parameter of blood supply to the brain (S. Leverett, Jr; V. Voge; Sandler et al.). Concurrently we recorded the EKG (in the Neb leads), parameters of external respiration and sphygmogram of the ear lobe.

The studies were conducted with the use of lower body negative pressure of up to 50 mm Hg, lasting up to 40 min, or longitudinal head-pelvis accelerations of up to +5 G_z (grad = 0.2 g/s).

These experiments revealed the high efficacy of ultrasonic monitoring of blood flow in the superficial temporal artery for rapid diagnosis and prognosis of the state of a man exposed to extreme conditions. The method was also found to be useful in rapid [operative] determination of whether an experiment should be stopped (continued).

POSSIBLE USE OF A NEW RHEOGRAPHIC COMPLEX TO STUDY THE PARAMETERS OF THE CARDIOVASCULAR SYSTEM OF COSMONAUTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 61-62

[Article by V. V. Murashko, A. I. Osinovskiy and A. K. Zhuravlev]

[Text] According to current conceptions, it is necessary to analyze as many hemodynamic elements as possible in order to assess the efficiency of the circulatory system as a whole when preparing for work in space, as well as directly in the spacecraft and during subsequent adaptation to earth. They include determination of stroke, minute volumes of blood and total peripheral resistance, evaluation of functional state of the left and right heart, delivery of blood to organs and blood flow in the arterial "compression chambers." These parameters present a wide range, as shown by medical monitoring and evaluation of cardiovascular function as a whole.

At the present time, studies of hemodynamic parameters of cosmonauts by means of rheography, with subsequent processing of its results, are gaining increasingly broad significance during space flights.

The known rheographs do not have sufficient sensitivty, and their operation is not always stable. For this reason, we have proposed a new "Unit for recording active electrical resistance of biological tissues," which is more sensitive, stable, consumes less power and has the capabilities of multichannel rheography (more than 20 channels), which precludes interference of adjacent channels, and it is also electricity-safe.

One can use the method of integral rheography of the body according to M. I. Tishchenko (1970) and tetrapolar rheography in the modification of Yu. T. Pushkar' et al. (1977) to study the main parameters of central hemodynamics. But, in our opinion, the fact that manual processing is time-consuming is an obstacle to studies of hemodynamics referable to mass scale, prolonged and continuous medical studies and monitoring.

For this reason, we developed several types of instruments to determine the parameters of central hemodynamics: "Instrument for automatic determination of stroke volume" and "Instrument for automatic determination of main parameters of central hemodynamics," which are based on the easy and biophysically validated rheographic method. In addition to the above-mentioned advantages, the new equipment proposed

for examining the hemodynamic system can be readily combined with the operation of the computer that processes the results. It is easy to code the rheogram parameters for direct retranslation to the center, and they can also be processed back to base parameters on the onboard computer.

Thus, the solution we propose to the problem in question is promising for medical monitoring in space.

ACCURACY OF MEASUREMENT OF PARAMETERS DESCRIBING REDISTRIBUTION OF THE COSMONAUT'S BODY MASS IN WEIGHTLESSNESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 62-64

[Article by S. Yu. Kas'yanov and A. B. Savvin]

[Text] There is redistribution of mass between different organs of the human body during space flights, and information about this is an important physiological criterion. Moreover, the mass of the entire body changes as time passes.

Certain quantitative parameters must be measured to monitor these processes. Mass, position of mass center and central moment of inertia of the body are convenient to use and they describe well the distribution of masses.

At the present time, body mass is already being measured during space flights, as well as the approximate position of mass center; mass is determined by means of linear elastic fluctuations and position of mass center by visual observation of angular movements of the cosmonaut.

This paper deals with the possibility of concurrent determination, in weightlessness, of mass, coordinates of mass center in any plane and central moment of inertia of the human body. It was demonstrated that these parameters can be determined by means of the moment of inertia. If one knows the moments of inertia in relation to four different parallel axes and coordinates of points of intersection of these axes with the perpendicular plane, one can construct a system of nonlinear algebraic equations for determination of the parameters sought.

The required parameters cannot be determined for any location of the measurement points. Investigation of the location of measurement points enabled us to find the conditions, under which the obtained system of equations can be solved for the entire set of sought parameters. These conditions determine the geometric place of points with complex form, and the measurement points should not belong to it. In particular, the measurement points should not be on the same line or circle. As the points draw closer to this geometric place, accuracy of determination of the parameters diminishes.

It was learned that one should select measurement points as far as possible from one another to improve the accuracy of measurements. If there are restrictions on

the distance between points, it is expedient to select points at the apices and center of an equilateral triangle, the length of each side of which equals the specified restriction on the distance.

As a rule, the approximate values of some of the sought parameters are known in advance. The existence of some a priori information determines the desirability of a particular choice of measurement points. For example, if the location of mass center is known, the measurement points should be so chosen as to have one of them in the mass center and the others at the apices of the equilateral triangle with the center at this point.

In measuring the moments of inertia for the frontal and sagittal planes, one can determine the corresponding central moments of inertia and spatial location of the mass center of the cosmonaut's body.

CORRECTED ORTHOGONAL EKG LEADS IN THE SYSTEM OF MEDICAL MONITORING OF COSMONAUTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 65-65

[Article by V. D. Turbasov, V. A. Talavrinov, V. R. Lyamin, V. I. Luk'yanchikov and Z. A. Golubchikova]

[Text] Addition to medical monitoring during space flights of electrocardiographic examination using the 12 conventional leads has expanded appreciably our knowledge in the area of the effects of space flight factors on cosmonauts.

However, the flaws of the 12 EKG leads become obvious as the duration of space flights increases and their programs become more complex, with expansion of the set of medical tests and use of automatic analysis of the EKG, which requires as few communication channels and leads as possible, less variability of parameters and as few duplicating parameters as possible. Moreover, this method is rather time-consuming and complicated, and it has low noise stability.

These flaws are eliminated by using corrected orthogonal leads according to Frank. Moreover, these leads provide more detailed information about the spatial characteristics of the electric field of the heart, which is very important in weightlessness, whereas the conventional leads are inadequate for vector electrocardiography.

Medical monitoring with the use of the corrected orthogonal leads of Frank was performed for the crew of the Skylab orbital station; however, primarily the vector correlations of the heart's electric field were evaluated and analyzed.

The question of replacing conventional leads with a system of corrected orthogonal leads according to Frank for clinical evaluation of the cardiovascular system has not yet been definitively answered.

We tried to do so in a study of 18 subjects, each of whom had spent 182 days in bed rest, with the head end of the bed tilted down at an angle of 45°. We took EKG's in the 12 conventional leads and orthogonal leads (X, Y, Z) on each subject once a month.

Comparative evaluation of the results of this study revealed that there was the same direction of changes in several of the main electrocardiographic parameters, depending on duration of the experiment. These changes consisted of an increase in

heart rate, longer atrioventricular conduction, decreased amplitude of T waves, increased R/T ratio and increased amplitude of QRS.

None of these deviations exceeded the range of normal fluctuations and they were not statistically significant; however, this does not rule out the clinical implications of the demonstrated changes. A comparison of the EKG data with the use of 12 leads and the X, Y and Z leads failed to demonstrate disagreement of electrocardiographic conclusions. On the whole, the dynamics of EKG parameters referable to leads with identical axes (X and $V_{5,6}$, Y and aVf, Z and V_2) presented the same direction.

Thus, corrected orthogonal EKG leads make possible a clinical evaluation of the condition of the cardiovascular system, and they have a number advantages over the 12 conventional leads; they can be recommended for the standard variant of clinical monitoring of cosmonauts.

USE OF INDICATORS OF FUNCTIONAL ASYMMETRY OF PHYSIOLOGICAL FUNCTIONS IN MEDICAL MONITORING OF FLIGHT PERSONNEL

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 65-66

[Article by V. A. Yegorov and V. K. Shirogorov]

[Text] Because of the increased complexity of flight training, which is related to development of aviation technology, it is necessary to constantly upgrade the methods of medical monitoring of flight personnel to assure flight safety.

One of the directions of studies that yield additional information about the functional state of the body is to determine asymmetry of functions. Functional asymmetry is related to the patterns of paired function of the cerebral hemispheres (B. G. Anan'yev, 1968). Changes are observed in parameters of functional asymmetry under the influence of activity, including that of flight personnel (V. A. Yegorov, V. K. Shirogorov, 1975, 1976).

Criteria, which can be used as additional signs for evaluation of individual reactions of pilots to flights, were developed on the basis of statistical processing of results of examining flight personnel on days when they do not fly and after completing different numbers of flights. The most informative ones here were the indicators of systolic and diastolic blood pressure and skin temperature in the region of the elbow, when measured on both sides of the body.

According to our data, most healthy pilots presented asymmetry of arterial blood pressure not exceeding 10-12 mm Hg and asymmetry of skin temperature not exceeding 0.3°C. Higher asymmetry values could be indicative of deviations of functional state of the organism and require additional, more thorough examination.

An increase in asymmetry of arterial blood pressure in excess of 20 mm Hg and of skin temperature of more than 0.8-1.0°C in studies made between flights can be interpreted as one of the signs of pilot fatigue.

More significant asymmetry (more than 25 mm Hg for blood pressure and more than 1.2°C for skin temperature) is apparently indicative of marked discoordination of autonomic functions on both sides of the body. This should be interpreted as a sign requiring investigation of the causes of the body's unusual reaction to the flight work load.

These criteria apply to pilots with relatively equal physiological parameters on the right and left, asymmetry of which does not exceed the above indicators when measured in the background period. The magnitude of asymmetry diminishes under the influence of flights in pilots with distinct right or left-sided asymmetry initially (11-21% of the examined pilots with reference to different functions). For this reason, it is imperative to have background data on the correlation between physiological parameters on both sides of the body in order to use indicators of functional asymmetry in medical support of flights.

VESTIBULAR ASYMMETRY AND POSSIBLE USE OF ITS PARAMETERS IN CERTIFICATION OF FLIGHT PERSONNEL

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 67-68

[Article by E. V. Lapayev and O. A. Vorob'yev]

[Text] In recent years, several authors have expounded the hypothesis that one of the causes of development of vestibular disorders could be bilateral vestibular asymmetry, occurring under the influence of aerospace flights (B. B. Yegorov and G. I. Samarin, 1970; Benson, 1963, and others). However, the question of distinctions of vestibular asymmetry as they relate to medical certification of pilots had not been submitted to comprehensive experimental investigation.

This work was done in order to examine the correlation between right- and left-sided vestibular reactions of flight personnel, as compared to individuals in other professions. We studied the illusion of counterrotation, rotatory and postrotatory nystagmus with the use of electronystagmography during rotation to the right and left at a velocity of 180°/s. The walking in place test, with the eyes closed, was used to study vestibulospinal reactions. Vestibulovascular reflexes of cerebral vessels were tested by means of rheoencephalography.

These studies revealed that there is dynamic asymmetry, with regard to magnitude and nature (direction), of the tested vestibular reactions under normal conditions, in pilots, cadets and flying school graduates. There were marked individual fluctuations of asymmetry in all groups examined, but in most cases healthy individuals presented moderate prevalence of vestibular reactions on side or the other.

We demonstrated a decrease in asymmetry in pilots, as compared to individuals in other professions. We also found an increase in vestibular asymmetry--appearance of spontaneous unilateral reactions--in some individuals after fights and after long-term exposure to intensive noise. Equivalent dominance (according to incidence and degree) of right- and left-sided vestibular reactions was observed in all groups examined; for this reason, evaluation of vestibular asymmetry on the basis of the mean values of these reactions was not effective. It was proposed to determine the correlation between reflexes in opposite directions by means of the asymmetry index, which takes into consideration in each subject the difference between values of right and left vestibular reactions and intensity thereof.

It was shown that it is necessary to assess asymmetry of nystagmus (in caloric and rotation tests) on the basis of two or more of its indicators characterizing

amplitude, frequency and time properties of this reaction. Determination was made of the range of normal fluctuations of asymmetry of different vestibular reactions for pilots and flight school candidates.

The results of these studies suggest that vestibular asymmetry in healthy individuals is based on fluctuation of the constant of spontaneous activity of receptor structures, but the degree of asymmetry is determined, to a significant extent, by the level of activity of central structures of the vestibular analyzer.

STUDY OF PROFESSIONAL FITNESS FOR THE PURPOSE OF FORECASTING ITS STATE UNDER REAL CONDITIONS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 68-69

[Article by G. G. Sekunov, N. A. Fedanova and O. P. Yakovlev]

[Text] To date, the question of professional fitness of flight personnel has been based on evaluation of physical condition. However, it is not in all instances that a correlation is found between health status and the pilot's ability to perform extremely complex operations related to flying.

These circumstances make it imperative to study flight work and search for the means of quantitative evaluation of professional fitness of flight personnel. The necessity of direct evaluation of professional fitness was first raised in a monograph by our compatriot, N. M. Dobrotvorskiy, "Flight Work" (1930). Numerous studies were conducted in recent years for practical implementation of this theoretical conclusion (K. K. Platonov, 1957, 1960; A. M. Pikovskiy, 1964; M. B. Zabutyy, 1969, 1970; K. K. Ioseliani, 1971, 1975; G. L. Komendantov et al., 1975; N. A. Razsolov, O. P. Yakovlev, 1976; N. A. Fedanova, 1978, and others).

We submit here data obtained from a study of professional fitness pursued to make a quantitative evaluation thereof using various methods.

Methods were developed for quantitative evaluation of professional fitness at different stages of medical certification of pilots. The methods were based on the photographic mockup method of K. K. Platonov and A. M. Pikovskiy (1960) and data obtained by M. B. Zabutyy (1970). Determination was made of 10 criteria, which rendered the method simple, available to every aviation physician and quite informative. It was used to evaluate professional fitness of pilots flying different types of aircraft. The lack of reliable differences in the results of our studies is indicative of the universality of the method.

This method enables us to demonstrate early stages of fatigue after actual flights. A survey of a group of pilots suffering from varous neurological diseases also revealed a decrease in professional fitness. This trend was particularly manifest in patients with cerebral atherosclerosis ($M = 4.08$, $\delta = \pm 0.24$, $m = \pm 0.05$, versus $M = 4.35$, $\delta = \pm 0.20$, $m = \pm 0.05$ and $t = 3.86$ in the control, $P < 0.01$). The lower score was attributable to impaired differentiation and diminished lability of nervous processes.

Investigation of the capacity to perform a series of work operations during exposure to adverse flight factors is another method of assessing professional fitness. A quantitative estimation is made of the range of effects of the simulated factor, within which it begins to affect pilot fitness, up to the time of its maximum decline of fitness.

Studies and quantitative estimation of professional fitness in order to forecast the quality of performance of flight assignments are among the effective directions of medical support of flight safety.

STUDIES OF CEREBRAL HEMODYNAMICS OF CIVIL AVIATION PILOTS AND CADETS WITH HISTORY OF ONE EPISODE OF IMPAIRED CONSCIOUSNESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST'II in Russian 1979 (signed to press 7 May 79) pp 69-71

[Article by L. I. Dmitriyev, K. I. Demekhina and E. G. Yanovskaya]

[Text] It is relatively rare for flight and cadet personnel to have a single episode of impaired consciousness (SIC), but this is still a serious threat to the safety of flights. Of all cases of SIC, 10% occur while directly involved in controlling flying vehicles (in the air, at take-off and during landing).

Chronic and acute diseases, as well as excessive physical and psychoemotional factors (gravity loads, pain, etc.), are the chief causes of SIC.

Syncopes and epileptoid seizures, each of which has a different pathogenesis, are the main clinical forms of SIC in pilots and civil aviation cadets.

In expert determination of SIC among pilots, it is sometimes very difficult to differentiate between a syncope and epileptic seizure, since primary information about the nature of impaired consciousness may be incomplete and contradictory. For this reason, retrospective diagnostics, i.e., determination of the clinical nature of impaired consciousness, is based essentially on determination of health status using paraclinical methods (EEG, rheoencephalogram, EKG, functional tests, biochemical analyses, etc.).

Rheoencephalography (REG) was used to study cerebral hemodynamics of 175 pilots and cadets who had had SIC, in young people 18-23 years of age and civil aviation flying school cadets and older pilots, 30-37 years of age. In 55% of the group of cadets who had had a syncope, the REG was indicative of diminished tonus of great vessels of the brain. In 22% of the cases, hypotension was associated with labored venous efflux.

In 41% of the group of cadets who had a history of impaired consciousness with a convulsive component the REG was of the venous dystonia type. This apparently caused deeper and longer SIC.

In flight personnel with a history of syncopic states, the REG was of the hypotensive type in 26% of the cases, hypertensive type in 24% and venous dystonic in 23%. In 27% of the cases, the REG showed no deviation from normal. In the group of flight

personnel with a history of epileptiform seizures, almost half (46%) showed signs of increased tonus of cerebral vessels and relatively high percentage (33%) of normal REG's.

The REG taken during an orthostatic test with standing for 30 min revealed that, already in the 1st min after moving from "seated" to "standing" position, there was a decline in amplitude of the main REG wave, in both health subjects (control group of pilots) and individuals with history of SIC. However, the amplitude of the REG wave diminished much more (by 15%) in the group with a history of syncope than in the group with a history of epileptiform seizures (10%). During the 30 min of standing, there was gradual decrease in delivery of blood to cerebral vessels of individuals who had had syncopes, and by the end of the orthostatic test it diminished to 25% of the base level. There was only a 13% decrease in amplitude of the main REG wave in subjects who had had a convulsive seizure.

The REG data obtained for individuals with a history of SIC revealed that there is greater stability of retention of background blood flow to cerebral vessels in the presence of gravitational loads, due to insignificant hypertonus, in the case of a tendency toward epileptic seizures. Those with a tendency toward syncopes were characterized by the hypovolemic type of reaction of cerebral circulation, to the extent of acute anemia of the brain (syncopes) with significant (prolonged) orthostatic loads.

DYNAMICS OF ORTHOSTATIC STABILITY AND SOME BIOCHEMICAL PARAMETERS OF MAN FOLLOWING A WATER LOAD

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 71-72

[Article by I. G. Dlusskaya]

[Text] Along with other functional tests, the water load test, whose physiological and biochemical effects and mechanisms have not yet been sufficiently investigated, is used in examining spacecraft crews.

In healthy man, the water load activates the volume regulating systems, and it is associated with increased diuresis, as a result of which 60% or more of the water ingested is eliminated within 2 h. Since intake of one or more liters of fluid at one time should lead to rapid changes in volumes of liquid secretions of the body, it was interesting to study the reactions of the cardiovascular system within the first 10 min after a water load, and to compare them to the changes in circulating blood hemoglobin level and rate of elimination of fluid.

We evaluated the reaction of the cardiovascular system by means of a series of 5-min active orthostatic tests: before the water load, three times at half-hour intervals and 4 h after the load. The orthostatic tests were performed at the same times on the control days. Orthostatic stability was evaluated using the formula proposed by Burkhart and Kirkhoff:

$$OI = \frac{\text{AP max supine}}{\text{AP max stand.}} \times \frac{\text{AP min standing}}{\text{AP min supine}} \times \frac{\text{HR standing}}{\text{HR supine}} \times \sqrt{S^2APmax+S^2APmin+S^2HR}$$

where OI is the orthostatic index, AP is arterial pressure and HR is heart rate.

The results of experiments with 1.5% water load test conducted on 12 healthy men established the following: there was significant improvement of orthostatic stability and a direct correlation between AP max (in "supine" position) and level of diuresis for the 90 min immediately following the water load; 1 h after the load there was no change in hemoglobin on the average for the group, but individual change in the range of +2 to -2 g% hemoglobin was noted, the nature of which showed a link with reactions of the cardiovascular system; plasma renin activity and aldosterone excretion in urine diminished during the period of the water loads.

The possible mechanisms of the effect of increased orthostatic stability after the water load test are discussed.

CURRENT METHODS AND CRITERIA FOR DETERMINING MAN'S ENDURANCE OF IN-FLIGHT ACCELERATIONS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 72-73

[Article by D. Yu. Arkhangel'skiy, V. I. Babushkin, A. V. Kondakov, L. S. Plakhotnyuk and M. A. Tikhonov]

[Text] Numerous studies of the effects of head-pelvis accelerations on man established generally recognized criteria for reaching the individual range of endurance of this factor (impairment of vision, disorders referable to cardiac rhythm, respiration, general physical fatigue and others). These criteria are used extensively in experimental practice and medical certification of pilots (P. M. Suvorov, A. R. Kotovskaya et al.). However, we still do not have a standard method for determining maximum endurance of accelerations, which is needed for comparative evaluation of the efficacy of diverse antigravity gear and methods. In recent years, exposure of man in a state of deliberate muscular relaxation (M. Parkhurst, M. Ericson) is used, in addition to traditional diving and "ploshchadochnyy" [plateau?] modes of accelerations, for this purpose.

This method makes it possible to determine man's background endurance, particularly in the case of slow gradients of velocity of change in accelerations, and with special reference to the functional reserves of his cardiovascular system.

In our studies, we determined endurance of G forces according to maximum value of n_y at build-up velocities of 0.1 unit/s in a state of voluntary relaxation of the subjects, with and without the use of G suits. We demonstrated a positive correlation, $r = +0.63$ ($P<0.05$) between these two parameters and determined the antigravity effect of the G suits. At the same time, no correlation was demonstrated between the acceleration reached in a relaxed position in a G suit and time of endurance of acceleration of 9 units, which is indicative of the substantial influence of muscular tension on endurance of accelerations. We also demonstrated the prognostic value of the time of endurance of 9 unit acceleration to evaluation of endurance of the subjects to complex G forces ($r = +0.84$, $P<0.05$).

In a special series of studies, we compared the time of endurance of 9 unit G forces with different angles of inclination of the back of the seat. We demonstrated a correlation between the subjects' endurance and angles of 30, 45 and 55°.

Thus, the method we used to evaluate integral resistance of man to n_y G forces enabled us to differentiate between the specific significance of its components: compensatory reserves of the cardiovascular system, muscular tension and anti-gravity equipment.

SPIROERGOMETRY IN THE PRACTICE OF EXPERT MEDICAL CERTIFICATION OF FLIGHT PERSONNEL

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 74-76

[Article by A. S. Turetskaya]

[Text] Spiroergometry is one of the most valuable investigative methods, which permits quantitative evaluation of physical fitness and functional state of the respiratory and cardiovascular system. The method is also valuable because it permits evaluation of the functional correlation between these systems of the body (U. K. Shkhvatsabaya, 1978; Bruce, 1971; Patterson, 1972).

We were interested in exploring the possibility of using this method in the practice of expert medical certification of flight personnel.

Our objective was to study the distinctions of pulmonary ventilation, exchange of gases, gas composition of blood during physical exercise in individuals with early forms of diseases of the respiratory and cardiovascular systems, in order to detect signs of latent respiratory insufficiency and evaluate the functional reserves of the cardiorespiratory system.

We conducted 167 studies, of which 67 were referable to health flight personnel, 34 to individuals with incipient forms of chronic nonspecific diseases of the lungs (CNDL) and 66 to individuals with early signs of atherosclerotic lesion to the heart. Examination of external respiration at rest by means of standard spirographic tests failed to demonstrate appreciable deviations from normal in these groups.

The load on a bicycle ergometer was increased in steps to a maximum level. During the test, we recorded pulmonary gas exchange (oxygen uptake, carbon dioxide output), pulmonary ventilation (minute volume, respiration depth and rate) continuously, and we determined the gas composition of blood at rest and with the peak load.

The studies to determine maximum oxygen uptake revealed that there was marked decrease in maximum oxygen uptake in 38% of the patients with early forms of CNDL and 33% of those with signs of atherosclerotic pathology of the heart; according to a rating scale we had developed previously, this was indicative of limited functional capacity of the cardiorespiratory system.

We compared the depth of respiration to vital capacity and minute volume to maximum pulmonary ventilation in order to assess the utilization of ventilation reserves.

We found that healthy subjects expended an average of 50% of their ventilation reserve when submitted to the maximum physical load. The highest utilization was 70% of the reserve with a load of 1200 kg-m/min. There was considerably greater strain on compensatory mechanisms of ventilations in the patients. Thus, in the presence of CNDL, a maximum load of lesser intensity required an average of 57% of the reserve. Individual analysis revealed that some patients used 95% of the maximum volume of ventilation when submitted to a small exercise load, i.e., virtually their entire reserve. In such cases, the diminished ventilation capacity of the system of external respiration was probably the principal factor in limiting physical fitness. These individuals also presented the greatest decline of gas-exchange efficiency of ventilation. The coefficient of oxygen uptake with the maximum load dropped to 22-27 in these subjects (this coefficient constituted a mean of 38 for the CNDL group, versus 42.4 in the healthy subjects; $P<0.05$).

The test involving the maximum physical load conducted on the patients with atherosclerosis also demonstrated greater strain on compensatory mechanisms of the system of external respiration and decline of gas-exchange efficiency of ventilation, as compared to the healthy subjects. These changes were less marked than in the CNDL group. This is probably due to change in pulmonary hemodyanmics, as a result of inadequately effective function of the heart during exposure to intensive physical loads.

Analogous findings were made in the studies of parameters of ventilation and pulmonary exchange of gases with standard loads (500, 1000 kg-m/min). While the healthy subjects expended 26% and 47% of their ventilation reserve with loads of 500 and 1000 kg-m/min (respectively), the patients with CNDL expended an average of 40 and 55% with analogous loads (the differences between them and healthy subjects were reliable; $P<0.001$). With these loads, minute volume of respiration was substantially above normal values observed in healthy subjects in 30% of the CNDL group and 25% of patients with atherosclerosis.

In order to determine the extent to which the strain of compensatory mechanisms of the external respiration system maintains normal gas composition of blood, we studied the acid-base balance and gas composition of blood during exercise. Gas composition was in the range of the physiological norm in most patients with CNDL and atherosclerosis. The changes in acid-base equilibrium of blood were more marked in these cases than in healthy subjects, and they reflected marked metabolic acidosis. They did not exceed the range of compensated and subcompensated forms; however, they were indicative of greater involvement of anaerobic processes.

Thus, these studies revealed that 30% of the flight personnel with incipient forms of respiratory and cardiovascular pathology presented excessive increase in volume of ventilation during exercise, greater utilization of ventilation reserves than healthy subjects and diminished gas-exchange efficiency of ventilation. According to conventional interpretation, such changes may be indicative of latent respiratory insufficiency. In most cases, the increased tension of compensatory mechanisms of the external respiratory system maintained blood gases within the physiological range. In such cases, spiroergometric studies yielded important additional information for validation of the functional diagnosis and they are of substantial aid in solving complex problems of expert medical certification of flight personnel.

STUDY OF PHYSICAL CONDITION OF FLIGHT PERSONNEL WITH FUNCTIONAL EKG CHANGES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 76-79

[Article by N. B. Makarova and B. L. Gel'man]

[Text] Catamnestic studies are very important in experiment medical certification of flight personnel. They make it possible to refer to the dynamics of health status in the group under study, aid in verifying diagnoses and establishing a better substantiated prognosis in the course of an illness. These matters are of particular importance to flight personnel with functional changes in the repolarization phase of the EKG. It is a known fact that nonspecific changes in the ST segment and T wave could be a manifestation of both functional, reversible diseases of the heart and organic ones, including latent, "asymptomatic" cardiac ischemia.

In our prior studies (1970), it was demonstrated that patients without organic heart disease present changes in the terminal part of the ventricular complex of the EKG due to impaired regulation of the heart and its heightened sensitivity to sympathetic influences. An electrocardiographic syndrome was singled out, the main features of which are spontaneous lability of the shape of the EKG. Sympathetic stimulation (orthostatic test, physical exercise test, hypoxic test, administration of glucose, nitroglycerin and epinephrine) aggravated the EKG changes. Blocking the sympathetic influences (state of emotional rest, administration of adrenalytic agents--potassium, ergotamine, inderal) normalized the EKG.

These EKG changes were evaluated as neurocirculatory dystonia [NCD] of the cardiac type. The set of tests we developed made it possible to validate acceptance for flight work of 107 individuals with such EKG pathology.

To determine the course and prognosis of NCD, as well as the link between EKG changes and cardiac ischemia, dynamic observation of this group of patients was set up. To date, we have data pertaining to dynamic observation of 52 patients with NCD of the cardiac type.

Observation time ranged from 1-2 to 15 years. Mean observation time was 6 years, and 6.6 years from the time of appearance of the first EKG changes. A total of 12 individuals have been under observation for 10 to 15 years. They were examined in the hospital 2 to 7 times.

Only 4 out of the 52 patients were excused from flight work for medical reasons over the observation period. One of them complained of cardiac pain without irradiation, which was unrelated to exercise, as well as neurotic signs (fatigue, irritability, headaches). Two were excused from flying work due to a change in EKG dynamics, and the fourth patient developed serious rhythm disorders after exercise.

The remaining 48 people continued to feel well when they resumed their flight work.

With reference to objective signs, there were no appreciable changes in physical, roentgenological or biochemical parameters. Thus, only 12 people presented a tendency toward gaining weight, 7 who previously had arterial pressure of up to 150/100 mm Hg subsequently reverted to normal. In nine subjects who previously presented signs of autonomic dysfunction, they became less marked upon re-examination.

With reference to the dynamics of the EKG, it must be noted that the changes had not been demonstrated for the first time in the life of 19 out of the 52 subjects. In time, the EKG reverted to normal in three cases, both at rest and with the use of various factors. In 45 cases, rechecks revealed that the EKG changes remained just as inconsistent as in the first examination, both at rest and with functional tests. It must be stressed that reproducibility was not always complete for all tests, and "normalizing" agents did not always have the same beneficial effect. This indicates that the EKG changes may remain unstable in NCD patients over a long period of time, without being associated with worsening of health status. In three subjects, the EKG changes became persistent. Administration of sympatholytic agents had no positive effect on the EKG. Evidently, in these cases, the functional changes in the myocardium progressed into sclerotic changes. The changes in the EKG and persistence thereof served as grounds to revise the diagnosis. Two years later, one of the patients with "static" form of EKG developed myocardial infarction with the typical attack of pain and EKG dynamics.

In spite of the fact that there was only one such case, it is felt that the course of NCD of the cardiac type is favorable so long as lability of the EKG is retained. The stability of the EKG signs is indicative of development in these patients of organic disease, and the risk of cardiac ischemia is unquestionably greater.

Thus, dynamic observation of flight personnel with functional EKG changes confirmed the validity of EKG interpretation and established diagnosis; it revealed that, in most cases, NCD has a good prognosis for a long period of time, which indicates that it is expedient to allow pilots with such EKG pathology to fly.

The changes in EKG dynamics in these patients, i.e., appearance of persistent, "static" changes, should serve as grounds for revising the diagnosis and, in some cases, the expert opinion.

SOCIOCLINICAL PROGNOSIS FOR CIVIL AVIATION FLIGHT PERSONNEL WITH A HISTORY OF PSYCHOTIC STATES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 79-81

[Article by S. G. Svininnikov]

[Text] According to our data, mental diseases among flight personnel in the civil aviation require a differentiated approach to questions of their fitness for continued flying or ground-based work with the use of professional skill and knowledge about the CA [civil aviation] system.

The psychotic states we observed among flight personnel in 1970-1977 were not notable for wide diversity, and we classified them in the following groups: psychogenic and other neurotic reactions; psychopathies (reactive states and decompensation); paroxysmal consciousness disorders in the presence of epilepsy and other neurological and mental diseases; cerebrovascular diseases (atherosclerosis of cerebral vessels with mental disturbances).

These groups of mental diseases had their own specific distinctions with regard to socioclinical prognosis.

The clinical and occupational prognosis was good in the group of psychogenic (neurotic) reactions and incipient neurosis-like stage of cerebral atherosclerosis, as well as in part of the group of intoxicational disorders and mental disorders. Individuals who have experienced brief psychotic episodes or pathological reactions, with rapid and complete recovery of mental health and in the absence of residual vasovegetative and asthenic manifestations, with stable compensation of the neuromental state for at least 2-3 years can be allowed to engage in flight work (copilot, piston-engine aviation, air-borne crop dusting and others).

The socioclinical prognosis was relatively good in cases of virtual recovery, profound remission and stable neuropsychic compensation in patients who had suffered from infectious and endogenous psychosis, protracted psychogenic reactions and states of marked decompensation in psychopathic personalities, as well as the neurosis-like stage of cerebral atherosclerosis, paroxysmal consciousness disorders related to episodic intake of excessive amounts of alcohol. After treatment and a vacation, this group of individuals was allowed to work on the ground, in areas requiring the use of their professional skills. The question of fitness for controller work, in the aircraft traffic control service, must be settled on a strictly individual basis with due consideration of catamnestic data.

Patients who presented residual psychopathological symptoms (critical deficiency, intellectual and mnestic disorders, marked personality changes, severe asthenization of the mind, various psychopathic manifestations, etc.) after suffering from psychosis were deemed unfit for work on the ground at airports and airfields. Such patients must be referred to a VTEK [expert medical commission] for determination of disability group and optimum job placement in accordance with the general regulations.

Medical expertise concerning flight and other work must include determination of personality distinctions and social-occupational sets of the subjects, the level of their professional training and qualifications, relations in groups and evaluation of their professional performance by their superiors, in addition to in-depth clinical psychopathological, anatomical and catamnestic analysis.

Experimental psychological studies occupy a special place in expert evaluation and socioclinical prognosis of CA flight personnel.

Our study enabled is to outline the criteria for socioclinical prognostication referable to different nosological forms of mental illness, as well as to single out factors that may be significant in the prevention of loss of professional fitness and fitness of CA flight personnel as a result of neuropsychological diseases (consideration of personality distinctions, screening for CA schools, continued scientific development of work and rest schedule, refinement of psychohygienic and sanitary-hygienic measures, as well as more thorough neuropsychological examination in the course of annual medical check-ups in the CA, and others).

This study demonstrated the benefits of examining a separate occupational group (CA flight personnel) in the clinical and applied (practical) aspect, as well as the theoretical one.

INTERPRETATION OF THE RESULTS OF QUANTITATIVE ANALYSIS OF PSYCHOPHYSIOLOGICAL PATTERNS OF HUMAN PERFORMANCE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 81-82

[Article by M. B. Gurevich and G. F. Nevskaya]

[Text] For specialists in aerospace medicine, the problem of evaluating the psychophysiological (PP) patterns of man's activities has a direct bearing on questions of professional screening of pilots and cosmonauts, as well as determination of their efficiency [fitness] when exposed to deleterious flight factors. The reliability of quantitative estimates of PP patterns is characterized by the reliability factor (RF), defined as the coefficient of correlation (CC) between repeated measurements of parameters for each of the subjects in the group under study.

It was found that the reliability of the results of some tests may change in the presence of adverse factors. This can be explained if we submit the result X_{ij} of a certain test for the ith subject in the jth measurement, in the form of a sum:

$$X_{ij} = X_{Ti} + X_{\varepsilon ij}$$

where X_{Ti} is the value characterizing the ith subject, regardless of number of measurement, $X_{\varepsilon ij}$ is the parameter describing the influence of random (uncontrollable) factors. In the presence of an adverse factor, the scatter of X_{Ti} and $X_{\varepsilon ij}$ may change dissimilarly, and this leads to a change in RF.

The concept of parallel tests and parallelism factor (PF), which is defined as the CC between the results of two tests for the same group of subjects, enables us to track the change in value of X_{Ti} common to both tests, which reflects the influence of different PP patterns on the test parameter:

$$X_{Ti} = \sum_{m=1}^{M} Tim$$

where X_{Tim} is the contribution of the mth PP pattern to PP parameter of the test (the X_{Ti} part).

Examination of changes in RF and PF under the influence of a factor, indicative of a change in relative contribution of value of X_{Tim} to X_{Ti}, X_{Tj} to $X_{\varepsilon ij}$ and X_{ij} enables us to demonstrate the PP patterns that are the most susceptible to the studied factor.

Since the size of the groups of subjects is small at the first stages of the study and the number of tests and methods checked for suitability is large, the evaluation of RF and PF is not very accurate. By singling out parallel tests before and after exposure to adverse factors it will be possible, in the first place, to lower the number of PP tests and methods used and, in the second place, to increase the reliability of parameters with the use of the Spearman-Brown formula for RF in parallel tests. As it was shown, use of this formula not only increases the RF of the parameters, but narrows the confidence range for them.

It is particularly important to examine the parallelism of tests when exploring the diagnostic value of new PP methods, since a partial parallel between them and known methods, and change in CF and PF under the influence of an adverse factor facilitates interpretation of the parameters and enables us to ascribe a meaning to them with regard to a specific PF.

STABILOGRAPHIC EVALUATION OF MAN'S EQUILIBRIUM IN VERTICAL POSITION

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 83-84

[Article by R. R. Galle, L. N. Gavrilova, F. Glavachka, A. R. Kotovskaya and Ya. Kubichkova]

[Text] The ability to maintain equilibrium in vertical position is one of the important prerequisites for active interaction between man and the environment.

Progressive disturbances may occur when the exogenous influences are addressed to systems involved in regulation of posture. Thus, several cosmonauts presented impairment of equilibrium function after returning to earth (V. M. Mikhaylov et al., 1971; Yu. N. Purakhin et al., 1972; Homick et al., 1974, and others).

The method of stabilography (V. S. Gurfinkel' et al., 1965; Baron, 1973, and others) has gained wide popularity for quantitative estimation of man's ability to retain equilibrium in vertical position. There is rather disparate information about quantitative changes in stabilographic indexes when an influence is exerted on various sensory system, and sometimes it is difficult to compare due to methodological differences in examination systems and method of recording and analyzing the experimental data.

This work deals with the characteristics of stabilographic parameters of equilibrium in healthy subjects, as well as evaluation of changes therein under the influence of various factors.

These studies were conducted on essentially healthy men 20 to 40 years of age.

During the study, the subject stood on the sensitive platform of the stabilograph with the eyes open at "attention." We used the following as additional conditions to make more difficult the task of maintaining equilibrium: closing the eyes, change in sensation of support, which was done by using a porolon [plastic] mat 10 cm in thickness; rotation of the head (10 active rotations in 20 s).

The following were used as parameters describing equilibrium: area of vector-stabilogram, oscillations per minute, mean and maximum amplitude of oscillations and index of rate of oscillation--integral of the first derivative of the stabilogram.

The ability to maintain equilibrium in vertical position is characterized by certain values of the stabilographic parameters of oscillation of the human body.

Exclusion of visual control of vertical stability led to a reliable increase in mean amplitude and index of rate of oscillation. There was somewhat more increase in stabilographic parameters under the influence of circular head movements. The most marked impairment of stability was observed with the use of a soft mat. Under this condition, there was a reliable increase in all recorded parameters.

Exclusion of vision during graded head movements and, particularly, with the use of the soft mat had a significantly greater effect than when standing on a hard surface without movement.

Of the parameters we used in this study, the area of the vector-stabilogram, mean amplitude and index of rate of oscillation were found to be the most informative.

The additional factors used can be ranked as followed according to degree of influence on equilibrium: closing the eyes, moving the head and a soft mat. These factors, which addressed themselves to the visual, vestibular and motor analyzer, can be recommended to evaluate the mechanisms of equilibrium disturbances in various extreme situations.

THE QUESTION OF CHANGES IN HEMATOLOGICAL AND BIOCHEMICAL PARAMETERS OF BLOOD AS A FUNCTION OF PHASE OF DEVELOPMENT OF THE ADAPTATION SYNDROME DURING EXPOSURE TO ACCELERATIONS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 84-85

[Article by L. G. Yelkina, A. M. Klochkov, P. A. Yelkin, G. G. Sekunov and S. I. Stroganova]

[Text] According to existing conceptions, adaptive changes in blood are among the manifestations of the general adaptation syndrome, and they can be used as an informative criterion of stress. However, the large number of factors that affect the severity and nature of blood changes (type of autonomic reaction, endocrine regulation, higher nervous activity, conditioning, etc.) cause diverse hematological and biochemical reactions to the same stressor. For this reason, the nonspecific manifestations of the adaptation syndrome studied under concrete conditions could lose their practical significance for evaluation of endurance of an extreme factor present under other conditions. For this reason, when evaluating adaptive changes, the distinctions of compensatory changes merit special attention, with due consideration of regulatory influences prevailing in the body.

It is important to know the general dynamic patterns of adaptive changes and individual reactivity, which affects the intensity and duration of a stress reaction, to comprehend the nature of changes.

The phasic nature of development of the adaptation syndrome is generally recognized. The overall dynamics of compensatory changes are characterized by phases of build-up of sympathetic activity of blood and decline thereof. Maximum sympathetic activity of blood may be reached either at the height of action of the stressor, or after it and, less often at earlier times, depending on individual distinctions of the organism.

For this reason, isolated readings of biochemical and hematological parameters taken before and after exposure to the stress factor may not necessarily correspond to the same phases of the adaptation syndrome in different individuals.

According to prevailing conceptions, the build-up of sympathetic activity may be associated with an increase in levels of glucose, calcium, leukocytes, neutrophils, etc., while an increase in parasympathetic activity can be associated with increase

in eosinophils, lymphocytes, potassium and others. Investigation of the correlation between these parameters in blood enables us, with some degree of arbitrariness, to define the phase of development of the adaptation syndrome.

Thus, the state of the human body can be evaluated by determining hematological and biochemical parameters, with consideration of the distinctions of the dominant form of autonomic regulation. This approach was used to evaluate the state of a man during long-term rotation, brief accelerations and when flying in complex modes.

EXPERIENCE IN DEVELOPMENT AND OPERATION OF THERMOSTATICALLY CONTROLLED DEVICES FOR BIOMEDICAL EXPERIMENTS DURING SPACE FLIGHTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) p 86

[Article by Ye. K. Iordanishvili and E. A. Izupak]

[Text] Thermostatic control [use of incubators] of objects of research at different phases of biomedical experiments, for the purpose of demonstrating quantitative changes under the influence of space flight factors, is one of the main conditions in a number of cases for obtaining reliable scientific data.

On the examples of specific development of thermostatically controlled systems of the Biotherm and Thermocont types, and experience with use thereof aboard the Cosmos artificial earth satellites, Soyuz spacecraft and Salyut orbital research stations, analysis was made of the results of using existing scientific equipment to support various biomedical studies, and recommendations are offered for further expansion of technical and methodological capabilities of thermostatically controlled systems on the basis of the latest developments in this area of technology.

HYGIENIC RESEARCH IN FLIGHT AND MODEL EXPERIMENTS

STUDY OF AIR ENVIRONMENT IN A MOCKUP OF THE SALYUT-6 ORBITAL SPACE STATION

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 89-90

[Article by G. I. Solomin, V. D. Yablochkin, A. I. Gorshunova, N. Ye. Ostasheva, M. A. Vytchikova and V. I. Grachev]

[Text] Several stages are involved in the sanitary-chemical study and toxicological evaluation of nonmetal materials used for equipment in manned, sealed compartments, in particular, the modules of spacecraft.

Mockup tests are the most important of these stages, on the route of selecting materials to be used aboard spacecraft. For this reason, a sanitary-chemical study was made of the atmosphere in a mockup of the Salyut-6 orbital space station, for demonstration of volatile toxic impurities. The mockup was equipped with the main nonmetal materials and instruments that it was planned to use in a real flight. Air samples from the airtight compartment were collected 7, 29 and 125 h after it was sealed, by means of a special console developed for this purpose. Analysis of the air was made using highly sensitive methods of gas and fluid chromatography, with methods of equiponderant concentration of volatile substances (sensitivity of 0.01 mg/m^3 according to the standard). The list of chemicals for which the mockup of Salyut-6 was tested included agents referable to different classes of compounds. Most attention was devoted to the volatile substances that had been demonstrated in highest concentrations in the course of self-contained or bench studies of materials and instruments. The results of testing the atmosphere of the Salyut-6 orbital station are submitted in the Table.

The results of this study revealed that the demonstrated concentrations of volatile substances did not exceed the appropriate maximum permissible levels, so that we were able to give a positive toxicological rating for the entire set of materials and equipment used on the Salyut-6 orbital station.

Concentration of trace impurities in the atmosphere of the mockup of the Salyut-6 orbital station

No	Volatile product	Concentration, in mg/m³, demonstrated in analysis of air after sealing mockup of station		
		7 h	29 h	125 h
1	Ethanol	0.32	2.56	4.70
2	Acetone	0.24	0.72	1.68
3	n-Propanol	0.44	0.90	3.70
4	Ethyl acetate	0.52	3.82	7.10
5	Isobutanol	ND*	0.50	1.20
6	n-Butanol	ND	1.00	4.85
7	n-Heptane	0.50	1.20	2.90
8	Toluene	ND	0.35	0.88
9	n-Butyl acetate	0.64	0.77	1.87
10	m, p-Xylenes	0.21	0.63	0.71
11	O-Xylene	ND	ND	Traces
12	Isoamyl alcohol	ND	ND	0.03
13	n-Amyl alcohol	ND	ND	0.06
14	Formaldehyde	ND	ND	0.03
15	Ammonia	ND	0.50	0.91

*None demonstrated.

PHYSICOCHEMICAL MICROFACTORS DETERMINING THE BIOLOGICAL QUALITY OF CABIN ATMOSPHERE IN MANNED SPACECRAFT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 90-92

[Article by B. V. Anisimov]

[Text] New experimental data confirm the findings made in the 1930's, that air which has passed through a purification and air-conditioning system is not the biological optimum. Malaise, rapid fatigability and increased morbidity among individuals who work in rooms without natural ventilation are related to two factors: deionization and deozonation of the air (A. A. Minkh et al., 1975; N. N. Kokorev, 1972; F. Abel, 1974; Yu. D. Gubernskiy et al., 1975, 1976). Artificial ionization of the air (V. P. Kolokolov et al., 1975: "Instructions on Compensation for Aeroion Deficiency, No 1601-1977," USSR Ministry of Health) and addition of trace concentrations of ozone (Yu. D. Gubernskiy et al., 1977, 1978) restore to a significant extent the sensation of fresh air and partially remove the adverse effects.

During a space flight, the concentration of light aeroions must be 20-30 times higher than in the near-earth atmospheric layer, with prevalence of positive ions, because of the constant radiation background. According to our data, prolonged breathing with positively ionized air in a sealed chamber led to decline of physical fitness, worsening of parameters of natural immunity, slowing of sensorimotor reactions and poorer well-being. Breathing with negatively and, particularly, bipolarly ionized air had a beneficial effect on the subjects (Yu. G. Nefedov, S. N. Zaloguyev et al., 1966; B. V. Anisimov, 1975, 1977). The results of these experiments made it possible to recommend the "Svezhest'" [freshness] system of regulating aeroion composition, installed on the Salyut-6 station, as one of the onboard preventive measures. This system is designed to hold the coefficient of unipolarity of aeroions in the range of 0.7-1.0.

The quantitative patterns of effects of aeroions on man have not been sufficiently investigated. In our opinion, at this stage it is the most urgent to study the effects of aeroions on the nervous and endocrine systems, behavior, emotional stability and mental fitness (operator performance), as well as resistance to extreme factors. It is of basic importance to determine the role of ozone as a factor of habitability and the patterns of combined effect of ozone and aeroions.

There are data in the literature that warrant the assumption that there may be other microfactors, in addition to aeroions and ozone, causing the sensation of

fresh air and its biological quality: volatile organic compounds discharged by plants and some oxidants in microconcentrations.

Maintaining the optimum composition of atmospheric microfactors, which have a stimulating effect on man, may become one of the means of maintaining fitness and lowering morbidity both during space flights and under industrial conditions on earth.

EMISSION OF DELETERIOUS TRACE IMPURITIES IN THE AIR EXHALED BY MAN

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 92-93

[Article by T. I. Kuznetsova, V. P. Savina, V. Ye. Ryzhkova and K. N. Mikos]

[Text] The study of chemicals emitted with the air exhaled by man enables us to determine the composition of end metabolic products. Data in the literature and our studies indicate that the quantitative and qualitative composition of air exhaled by man differs, depending on a number of factors: individual distinctions and general condition of the organism, environmental conditions, level of exercise, diet, etc. It is known that the composition of exhaled air changes when there are significant metabolic disturbances. The existing literature indicates that there is 2-3 times more acetone in the air exhaled by diabetics than healthy individuals. There is a somewhat higher level of ammonia and amino compounds (1.5-2 times more) and considerably less carbonmonoxide and hydrocarbons in patients with lung cancer than healthy people. Studies of the composition of the air exhaled by man could serve as an additional method of diagnosing certain pathological states related to metabolic disturbances.

For our studies we selected volunteers who had undergone a medical examination and were deemed to be essentially healthy. The subjects were put in a pressure chamber, under standard conditions with respect to diet, exercise, work schedule and microclimate.

We analyzed air samples by methods of colorimetry, nephelometry and gas chromatography. We used the mean volume of pulmonary ventilation, which constituted 6.97 m^3/day for this group of subjects, to calculate the absolute levels of discharge of trace impurities per day in exhaled air. The obtained experimental data were submitted to statistical processing by the method of Student, and they are listed in the Table.

The results of this study can be used to design systems for removing toxic impurities from the atmosphere of confined areas and for development of diagnostic methods for a number of diseases related to impairment of different elements of metabolic processes.

Table

No	Assayed substances	Number of cases	Absolute emission, mg/day
1	Ammonia and amino compounds	35	0.96±0.08
2	Carbon monoxide	36	70.80±8.4
3	Fatty acids	37	5.30±0.48
4	Ethanol	93	27.20±3.12
5	Methanol	41	14.20±7.7
6	Acetaldehyde	44	2.40±0.1
7	Acetone	65	16.10±1.2
8	Methane	84	326.00±21.1

RECOVERY OF OXYGEN FROM THE ATMOSPHERE OF MANNED SPACECRAFT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1968. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 93-94

[Article by S. V. Devyatov and V. N. Fedorov]

[Text] There are several ways in which the problem of recovery [reduction] of atmospheric oxygen of manned spacecraft can be solved. The use of electrochemical methods is a promising direction in this field.

One of the best developed methods of obtaining oxygen for such purposes is electrolysis of aqueous solutions of electrolytes. In spite of its seeming simplicity, this method has the following flaws: impossibility of immediate use of obtained oxygen for breathing by the crew due to significant contamination of the gas by electrolyte aerosol; difficulty of organizing gas-liquid separation during a space flight.

While the second flaw could be elimited by technical means, the first has an effect, even if equipment is available for fine purification of oxygen, due to the inevitable accumulation in the cabin's atmosphere of electrolyte aerosols, which is inadmissible from the standpoint of crew hygiene.

The system we examined for recovering oxygen, which is based on the use of electrochemical equipment with solid electrolyte oxide, for example, ZrO_2-Sc_2O_3, is free of the above flaws. By nature, such materials have unipolar electric conductivity. It occurs only by means of oxygen ions in the working range of temperatures for this formula. For this reason, transfer of charge in electrochemical systems with solid electrolyte oxide involves transfer of the substance, in this case, oxygen.

When using gas-proof solid electrolyte, transport of substance through the system occurs only through an electrochemical mechanism, and from the cathode cavity of the eletrolyzer with solid electrolyte oxide only oxygen is transported to the anode. This circumstance makes it possible to recover very pure oxygen, which does not require additional treatment and meets all hygienic requirements.

Analysis of the obtained results revealed that the low expenditure of energy, small size and low weight of equipment, simplicity of using it and the high quality of the obtained oxygen may be decisive factors in determining the competitiveness of the described method of recovering oxygen, as compared to other known methods.

INVESTIGATION OF ELECTROCATALYTIC METHOD OF REMOVING CARBON DIOXIDE FROM THE ATMOSPHERE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 94-96

[Article by B. G. Grishayenkov and I. A. Smirnov]

[Text] One of the practical hygienic tasks referable to cosmonauts is to clear CO_2 from the spacecraft atmosphere, and the difficulty of purification increases with increase in duration of the flight and distance from supply bases on the ground, when it is impossible to replace CO_2 absorbers delivered by cargo craft.

We have examined the electrocatalytic method as a possible variant for this purpose, which consists in essence of electrochemical conversion of CO_2 on catalyst electrodes to liquid or solid organic compounds.

The main advantages of this method are: feasibility of converting CO_2 to substances that are convenient to store on board; combination of the process of CO_2 utilization and recovery of oxygen in the same piece of equipment; no need to have a supply of chemical reagents on board; feasibility of the process under normal conditions (pressure and temperature).

In this case, metabolic CO_2 and H_2O are the reagents, while oxygen and organic compounds are the reaction products.

The overall process is expressed by the following reaction in its general form:

$$nCO_2 + mH_2O \rightarrow C_nH_{2m}O_1 + qO_2 \qquad (1)$$

One can obtain various organic compounds by selecting the appropriate conditions for the process: electrode material, potential level, electrolyte composition, pH and type of solvent.

We made an experimental study of electrocatalytic conversion of O_2 into formic acid.

Experiments were conducted in a two-compartment fluoroplastic cell 400 ml in size, with a platinum grid anode and tin cathode, the working surface of which constituted 100 cm^2. We used an MK-40 cation-exchange diaphragm [membrane] to prevent migration of products of the cathode reaction to the anode. An 0.2 N (K_2CO_3 + K_3PO_4) aqueous solution served as the catholyte. We passed current of 0.5 to 3.5 A through the

cell with a constant charge level (18000 C). Analysis of reaction products for formic acid, formaldehyde and methanol was performed on a gas-liquid chromatograph. In all of the experiments, we demonstrated only one organic product, formic acid.

We calculated the rate of conversion of CO_2 into an organic compound from the results of quantitative analysis of formic acid. It was established that, with increase in current density from 5 mA/cm^2 to 20 mA/cm^2, the rate of conversion of CO_2 into the organic compound increases from 0.037 ℓ/h to 0.32 ℓ/h, and with further increase in current density it decreases. Maximum yield of 50.4% was obtained with current density of 15 mA/cm^2. This mode corresponds to a rate of CO_2 conversion into the organic compound of 0.315 ℓ/h.

According to our data, the optimum range of current densities is from 15 mA/cm^2 to 20 mA/cm^2, and this must be taken into consideration when developing atmosphere purification systems in the future, which are based on the electrocatalytic method of converting CO_2 into liquid organic compounds.

HYGIENIC EVALUATION OF AEROSOL POLLUTION OF SPACECRAFT ATMOSPHERE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 96-97

[Article by T. I. Fedorova and G. N. Kuz'menko]

[Text] Pollution of the atmosphere with aerosol particles is one of the hygienic factors that determines man's living conditions in spacecraft cabins. To date, little attention had been given to investigation of this question. Yet, there can be a drastic increase in concentration of aerosols in weightlessness, since there is no gravitational precipitation of large particles.

We studied the intensity and sources of aerosols, determined the concentration and size distribution of aerosol particles as related to microclimate in model experiments in manned pressure chambers. Concurrently, we perfected methods of studying aerosols for use in confined spaces.

The aerosol particles were identified by means of microscopic examination of sediment under a scanning electron microscope and an optical microscope. We found that vital functions of man (sloughing off of epidermis, emission of microdroplets when talking and coughing, accumulation of refuse, discharge of dust from clothing and bedding, etc.) were the chief cause of aerosol formation.

In order to determine the intensity of dust formation related to the subjects' activities in the chamber, we carefully collected the dust with an onboard vacuum cleaner. Concurrently, we assayed the mean daily concentration of aerosols with a piezoquartz scale.

At the present time, it is a pressing task to develop on-board instruments to measure the concentration by weight and size of aerosol particles in the cabins of manned spacecraft.

HYGIENIC REQUIREMENTS OF SYSTEMS TO BE USED TO REMOVE TOXIC IMPURITIES FROM THE ARTIFICIAL GAS ATMOSPHERE OF SEALED HABITABLE COMPARTMENTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 97-98

[Article by A. V. Sedov, N. A. Surovtsev, G. Ye. Mazneva and O. N. Shevkun]

[Text] The problem of forming the artificial gas atmosphere of habitable sealed compartments, including insulated individual protective gear, is presently a rather important one.

Toxic trace impurities, the sources of which are man, as well as emission of gas from construction materials, are consistently demonstrable in the gas environment of confined spaces.

Estimates made, with due consideration of the rate of emission into the gas atmosphere of insulating gear of products of human functions, revealed that carbon monoxide, aliphatic hydrocarbons, amino compounds, phenols, ammonia and ketones are of the greatest toxicological and hygienic significance (in addition to carbon dioxide).

Since man's work in confined areas involves exposure to a set of specific factors, which could lead to biological transformation of the toxic effects of deleterious impurities, it became necessary to pursue experimental studies to set hygienic standards for levels thereof in an artificial gas atmosphere.

We obtained experimental validation of maximum permissible concentrations with due consideration of the specific conditions of the insulating gear: 5 mg/m^3 for ammonia, 300 mg/m^3 for aliphatic hydrocarbons scaled to C, 1 mg/m^3 for amino compounds, 50 mg/m^3 for aceton, 150 mg/m^3 for oxidized organic compounds, 0.3 mg/m^3 for phenol and 15 mg/m^3 for carbon monoxide.

The maximum permissible concentrations that we recommend for carbon monoxide are 30 mg/m^3 for 4 h, 60 mg/m^3 for 2 h, 100 mg/m^3 for 1 h and 300 mg/m^3 for 30 min.

Recommendations are offered for toxicological hygienic evaluation of the gas atmosphere of confined spaces containing several toxic substances.

These standards were approved in 1978 by the USSR Ministry of Health in the "Temporary Physiological and Hygienic Requirements for Individual Protective Insulating Gear."

TOXICOLOGICAL EVALUATION OF MIXTURE OF VOLATILE PRODUCTS OF COMBUSTION OF LUBRICANTS USED IN CONFINED HABITABLE SPACES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 98-99

[Article by G. D. Yukhnovskiy, M. F. Obukhova, K. P. Bugar', T. A. Lekareva, N. N. Khomutova and N. D. Gnezdilova]

[Text] Experiments were conducted on 600 male white mice, with initial weight of 20-24 g, to study the effect on the animals of a mixture of volatile products of combustion of synthetic lubricants VNIINP-502, VNIINP-279, VNIINP-223, VNIINP-270 and VNIINP-284 at temperatures of 600 and 850°C.

The white mice were exposed to the mixtures of combustion products in a 5-liter chamber for 5 min by the static method, with subsequent follow-up observation for 14 days.

The animal death rate served as a criterion of toxicity of the mixture of products of polymer lubricant combustion.

We determined that the mixture of combustion products from the above types of grease contained soot mixed with aerosol, carbon monoxide, carbon dioxide, nitrous oxides, volatile organic compounds, oxygen-containing products of oxidative decomposition (aldehydes, ketons, esters, alcohols, etc.), haloid-containg and fluorine-containing compounds.

The studies revealed that, with combustion of 1 g or larger batches of VNIINP-223, VNIINP-270 and VNIINP-284 lubricants at temperatures of 600 and 850°C, the formed mixture of volatile products caused 100% death of the white mice. A 50% death rate was observed with combustion of 0.89 g VNIINP-223 at a temperature of 600°C and 0.72 g of the same lubricant at a temperature of 850°C.

This effect was obtained with combustion of 1 g and 0.5 g VNIINP-270 lubricant and 0.88 and 0.7 g VNIINP-284 at temperatures of 600 and 850°C, respectively.

No deaths were recorded among the white mice exposed to mixtures of volatile products of combustion of VNIINP-502 (600°C combustion temperature) and VNIINP-279 (600 and 850°C) lubricants in amounts of 3 g.

Thus, analysis of experimental data obtained with consideration of the same biological effect of mixtures (on the level of Cl_{50}) obtained from combustion of different batches of the tested lubricants enables us to rank their toxicity as follows: VNIINP-270, VNIINP-284, VNIINP-223, VNIINP-502 and VNIINP-279.

EXPERIMENTAL VALIDATION OF MAXIMUM PERMISSIBLE CONCENTRATION OF DIMETHYLAMINE IN THE GAS ATMOSPHERE OF INDIVIDUAL INSULATING PROTECTIVE GEAR

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 99-100

[Article by A. V. Sedov, N. A. Surovtsev, G. Ye. Mazneva and O. N. Shevkun]

[Text] The gas atmosphere in the space within suits worn as individual insulating protection is polluted by products of human vital functions, among which amino compounds emitted from the body with exhaled air and perspiration are consistently demonstrable.

Dimethylamine is of the greatest toxicological significance in the group of aliphatic amines discharged from the human body, and its level in exhaled air is up to 25%. For this reason, when setting hygienic standards for levels of amino acids in the space within suits that are used as insulated protection, dimethylamine was chosen as the integral indicator.

In experiments conducted on subjects, we simulated the set of conditions inherent in working in insulated individual gear with a self-contained air source.

We conducted three series of experiments. In the first (control), the subjects breathed with pure oxygen. In the second and third series, they inhaled oxygen with an admixture of dimethylamine in concentrations of 1 and 3 mg/m^3. The subjects inhaled gas mixtures containing dimethylamine for 6 h a day, for 5 days.

As a result of these experimental studies, it was established that there was a tendency toward decline of whole blood catalase activity and tendency toward elevation of blood serum cholinesterase activity when inhaling oxygen with 1 mg/m^3 dimethylamine. We failed to demonstrate any other changes in the parameters studied.

Inhalation of oxygen with 3 mg/m^3 dimethylamine elicited hemodynamic changes, as well as functional changes in the central nervous system. With this concentration of dimethylamine, we observed both a decrease and increase in whole blood catalase activity, substantial increase in blood serum cholinesterase activity and decrease in blood ascorbic acid concentration.

These experimental studies enabled us to recommend that 1 mg/m^3 should be the maximum permissible concentration of dimethylamine in the gas atmosphere of insulated protective gear.

HYGIENIC CHARACTERISTICS OF MICROCLIMATE AND AIR ENVIRONMENT OF MODERN COMMERCIAL AIRCRAFT, AND MEDICOTECHNICAL REQUIREMENTS FOR THE LATTER

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 100-102

[Article by T. A. Drobyshevskaya]

[Text] The development of aviation technology puts a number of problems to specialists in aviation medicine, the solution of which is directed at assuring the safety of aircraft flights and transportation of passengers under comfortable conditions. On the basis of many years of research, medicotechnical specifications for different systems and aircraft equipment, which provide optimum conditions, to some degree or other, for man's function aboard aircraft, were developed and included in the "Standards for Flight Fitness of Civil Aviation Aircraft" (SFFCAA). One of the main life support systems aboard aircraft with pressurized cabins of the compressor ventilation type is the air conditioning system (ACS).

When the medicotechnical requirements are met, starting with the drawing board design and ending with aircraft testing, optimum microclimate conditions and air atmosphere are provided in the cockpits and passenger cabins ["saloons"]. As shown by numerous studies conducted at the stage of testing new equipment, the microclimate and air atmosphere of Il-62, Tu-154, Tu-134, Tu-124, Yak-40 and An-24 meet in essence the hygienic specifications for them. The only exception is relative air humidity. Relative humidity drops to 5-10% during flights lasting 7-8 h (Il-62 aircraft) and at altitudes of 17-19 km (Tu-144 aircraft).

Studies conducted at the stage of aircraft testing are indicative of the efficacy of the ACS and sufficient frequency (20 times) of air exchange, with up to 30 kg/h air expended per person. The demonstrated concentrations of carbon monoxide, nitrous oxides, hydrocarbons, epichlorohydrin and other chemicals were significantly lower than the levels allowed by SFFCAA and GOST 12.1.005-76.

Studies conducted during the period of operating the aircraft made it possible to demonstrate a correlation between chemical composition of the air and engine operating hours (Tu-154, Il-62, Il-62M, Yak-40 aircraft). It was also established that pollution of the air environment increases during take-offs, when gaining altitude and descending.

Use of construction, ornamental and finishing polymers makes it necessary to work out hygienic requirements to regulate their safe use. In model experiments, using

polymers with low self-extinguishing properties, high concentrations of hydrogen cyanide, carbon monoxide, acrylonitrile, acrolein and carbon dioxide were found in the air.

Development of new types of aircraft (the supersonic Tu-144, Il-86 air bus) makes it necessary to set hygienic standards for the new, specific conditions on the inside. Thus, flights of the Tu-144 aircraft, performed at altitudes of up to 20 km, where the concentration of atmospheric ozone ranges from 03 to 0.6 mg/m^3, made it necessary to measure the ozone concentration in cockpits and passenger cabins. Studies at the testing stage covering the Moscow--Alma-Ata flight route revealed that there was ozone in the cockpit, but its concentration was below the permissible level. It is known that the temperature in the air-injection engine of this aircraft is above 500°C, so that one can assume there is a possibility of dissociation of atmospheric ozone. With lower temperatures in air-injection engines of subsonic aircraft, there is less breakdown of ozone, so that there are higher concentrations thereof in the atmosphere of cockpits and passenger cabins, in some cases above the permissible levels. The latter circumstance advanced the need for developing measures to prevent ozone from affecting flight crews and passengers.

STUDY OF BIOCHEMICAL PARAMETERS FOR SETTING HYGIENIC STANDARDS FOR ACETONE LEVELS IN THE GAS ATMOSPHERE OF INSULATING GEAR

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 102-103

[Article by G. Ye. Mazneva]

[Text] Acetone is consistently demonstrated among the toxic impurities in the gas atmosphere of protective gear worn by man. According to the data of V. P. Savina et al. (1978), the concentration of acetone in the artificial gas atmosphere of the Soyuz-22 spacecraft constituted 7.8 mg/m^3.

Special studies were conducted to determine the effect on man of a gas mixture consisting of oxygen and acetone when wearing insulating gear.

Experiments were conducted in a pressure chamber at low barometric pressure, 308 mm Hg, air temperature of +20±2°C and relative humidity of 40-60%. The subjects performed cyclic exercise on a special stand, energy expenditure constituting 400 kcal/h, and they inhaled mixtures of oxygen and aceton in concentrations of 50, 100 and 200 mg/m^3. The tests were conducted for 6 h with 1-week breaks between inhalations, as well as with daily inhalation (6 h/day for 5 days).

We assayed the following biochemical parameters during the experiments: acetone and acetoacetic acid in blood and urine, blood serum cholinesterase activity, blood catalase activity and blood ascorbic acid content.

We failed to demonstrate reliable changes in the parameters studied in the tests using acetone in a concentration of 50 mg/m^3 in the inhaled air, in the case of either single or numerous inhalations, as compared to the results of control tests.

As a result of these experimental studies, it was established that there was no accumulation of ketone bodies in the blood and urine of the subjects after inhalation of a mixture containing 100 mg/m^3 acetone for 6 h. In the case of numerous inhalations of a mixture containing the same concentration of acetone (6 h/day for 5 days), β-hydroxybutyric acid levels in blood and urine began to rise, starting on the second experimental day.

With 200 mg/m^3 acetone used with oxygen, all subjects showed an increase in acetone and acetoacetic acid content of blood and urine at the end of one 6-h period of inhalation thereof. Inhalation of a gas mixture containing the same concentration

of acetone for 5 days (6 h/day) led to accumulation of ketone bodies (in blood and urine), starting on the second day.

There was no change in blood serum cholinesterase activity, blood catalase activity or blood ascorbic acid content after a single 6-h session of inhalation of gas mixtures containing 100 kg/m^3 acetone. However, with numerous inhalations of this mixture, there was a decline in blood serum cholinesterase activity from day to day, as well as a decrease in blood ascorbic acid content.

There was virtually no change in activity of the enzymes tested or blood ascorbic acid content after 6 h of inhalation of a mixture containing 200 mg/m^3. Inhalation of oxygen containing this concentration of acetone for 5 days (6 h/day) led to a decline in blood serum cholinesterase activity and ascorbic acid content of blood at the end of the experiment.

The experimental data obtained served as grounds for setting hygienic standards of acetone levels in the gas atmosphere of insulating gear.

DISTINCTIONS OF THERMAL STATE OF MAN WEARING INSULATING GEAR, CAUSED BY THE USE LOCAL HEAT-REMOVING SYSTEMS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 103-105

[Article by G. V. Bavro, N. G. Lando and A. Yu. Nefedov]

[Text] Questions related to the study of possibility of maintaining man's temperature-related homeostasis with the use of thermal insulation by means of local heat-removing systems are of some interest with respect to solving the problem of assuring the safety of space flights.

Cooling jackets, vests, trousers, as well as different cooling panels situated over different parts of the human body--head, back, chest, extremities--are referable to local heat-removing systems.

Use of local heat-removing systems involves significant changes in temperature topography of the body, which is an indirect indication of changes in distribution of heat in the body. Even when there is virtually complete removal of all excess heat from man under conditions of thermal insulation, by means of local heat-removal systems, there is significant increase in skin temperature in regions that are not cooled. The temperature gradient between cooled and uncooled parts of the body may constitute 10°C or more. However, when the temperature elevation of the skin in parts of the body that are not involved in heat transfer is compensated by a corresponding drop of temperature of the cooled parts of the body there are no signs of heat discomfort.

In our studies, we used a liquid-cooled garment (LCG) with tubular heat exchangers placed on the anterior surface of the thighs and arms, as well as forearms, legs and feet. The overall area of the cooling panels constituted 0.5 m^2.

When coolant at a temperature of 15°C was delivered to the heat exchangers, all heat produced by the subjects while performing moderately heavy work [exercise?] under heat-insulating conditions was removed. Sensations of thermal comfort were recorded when skin temperature in the cooled areas was 25-27°C and in the uncooled areas--35.5-36.5°C. CVT [mean air temperature?] was of the order of 31.5°C. Rectal temperature was on the level of 37.0-37.1°C. Moisture loss constituted 180 g/h.

The obtained data indicate that man endures rather well significant changes in distribution of heat in different parts of the body when his heat balance is retained.

The results of this study lead us to recommend the LCG, which removes heat only from the extremities, for use in insulating gear, the design or operating conditions of which do not make it possible to place heat-exchange elements of a heat-regulating system over significant areas of the body surface.

DYNAMICS OF PARAMETERS OF MAN'S THERMAL STATE IN THE CASE OF PROVIDING FOR THERMAL BALANCE WITH THE USE OF A LIQUID-COOLED SPACE SUIT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 105-106

[Article by A. S. Barer, Yu. G. Konakhevich, S. N. Filipenkov and A. A. Sheykin]

[Text] Studies were conducted on 16 subjects (25-40 years of age, weight 60-90 kg, height 163-185 cm). In all, we performed 36 experiments lasting up to 5 h in a heat chamber at a temperature of 40°C; mean energy expenditure constituted 220-340 W (maximum 840 W). The space suit, worn over a full liquid-cooled garment (LCG), virtually ruled out passive heat exchange with the atmosphere, and heat removal by the ventilation system of the space suit did not exceed 70 W. The subjects adjusted active heat removal in accordance with subjective sensations of change in water temperature at the input of the LCG in the range of 5-30°C, at the constant delivery rate of 2-3 ℓ/min. In all modes of physical activity, overall heat sensations were held at the level of "comfortably warm" or "comfortably cool."

We demonstrated significant correlation between the established temperatures of different parts of the body and water temperature at the input of the LCG and heat production. This correlation is well-described by equations of linear regression, the parameters of which were given in the paper.

It can be demonstrated that, in this system, transient processes can be described satisfactorily with close to exponential functions. The time constants of these processes are 5.8-15.7 min for mean skin temperature, 12.7-22.1 min for rectal temperature, 4.5-5.3 min for temperature at the input of the LCG and 1.6-4.2 min for heat production determined from gas exchange parameters. For each of the parameters, the time constant increases with increase in difference between initial and end levels of physical activity. The actual figures for the time constants were quoted in the paper.

The obtained data can be used to model thermal reactions of the body under the conditions studied, as well as in developing heat-regulating systems for insulating gear, since the structure of heat exchange when wearing a space suit differs substantially from the structure of man's heat exchange under ordinary conditions, primarily because of the high specific significance of the conductive component.

USE OF GAS CHROMATOGRAPHY FOR PRELIMINARY SANITARY AND CHEMICAL EXAMINATION OF GASSING FROM POLYMERS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 106-107

[Article by A. I. Gorshunova, G. A. Gaziyev and N. F. Sopikov]

[Text] Gas chromatography is one of the principal methods used for sanitary-chemical and toxicological studies of polymers used in sealed compartments. A gas chromatographic method is proposed for preliminary choice of materials with the least gassing, which permits prediction of the degree of toxicological hazard. It was demonstrated that total discharge of organic volatile substances from polymers and total levels thereof in the tested samples scaled to the weight unit can be determined, and residual amounts of unpolymerized monomers can be studied. The permissible levels of overall gassing required for sanitary and toxicological evaluation were set for two groups of polymers (rubber, paint and varnish). A chromatograph with flame ionization detector and pyrolytic attachment was used in this study.

Quantitative and qualitative analysis was refined for 34 of the main volatile components discharged by 70 polymers referable to the groups of rubber, paint and varnish, putty, glue, fabrics, etc., using two chromatographic columns filled with 15% polyethylene glycol 2000 in Celite 545 (0.117-0.25 mm granules) and 15% di-2-ethylhexyl sebacinate on Celite 545. It was demonstrated that the main components of gassing from the tested materials are: monomers, vulcanizing agents and products of their dissociation, plasticizers, vulcanization accelerator and antioxidants for rubbers; monomers, solvents and impurities [admixtures] in the initial solvent for varnish, lacquer, paint and varnish materials, adhesives and putty.

The results of the studies conducted by the recommended methods make it possible to use polymer materials in sealed compartments following a toxicological and hygienic evaluation.

MAIN DIRECTIONS OF RESEARCH ON THE PROBLEM OF BIOSTABILITY OF POLYMERS USED IN CABINS OF SPACE VEHICLES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 107-108

[Article by N. D. Startseva]

[Text] The destruction of polymer materials in a manned space vehicle, under the influence of microorganisms that multiply on them, presents a significant hazard, and this compels us to pay attention to various aspects of the problem of biostability of polymers.

On the one hand, this hazard is attributable to the possibility of reproduction of microorganisms on polymers, which was established by several authors (N. F. Belokon' et al., 1972; N. P. Yelinov, 1977), which is associated with change in the physicomechanical properties of polymers and consequent malfunction of diverse equipment. On the other hand, there may be pathogenic specimens among the microorganisms that can grow on polymers, and the role of the former as pathogens of human diseases has been established.

In view of the foregoing, as well as the wide use of polymers in spacecraft cabins, it is of great scientific and practical interest to study the possibility of reproduction of the main representatives of human automicroflora on polymers.

Laboratory experiments demonstrated that microorganisms contained in the human microflora can reproduce on various samples of polymer materials, with impairment of their physicomechanical properties.

The obtained experimental results, as well as data in the literature, enable us to formulate the main directions of research on biostability of polymers used in the cabins of space vehicles.

First of all, one must identify the microorganisms capable of accumulating on polymers in sealed compartments. In assessing the conditions that enhance this process, special attention should be given to investigation of the effects of ambient temperature and relative humidity of air, chemical composition of the polymer, species of microorganism and its initial concentration.

In view of the probability that condensation moisture, capable of building up in life support systems, can settle on polymers and the demonstrated possibility

of reproduction in it of representatives of human microflora (Yu. G. Nefedov et al., 1975), it is deemed desirable to investigate the conditions that favor survival of these microorganisms in the condensate of atmospheric moisture. It is imperative to assess the effect of the chemical distinctions of the condensate, which may vary, depending on individual distinctions of the people in the confined compartment, as well as to examine the effects of various temperatures on survival of conditionally pathogenic microorganisms.

In view of the fact that some of the reactions of microorganisms aimed at utilization of new sources of nutrition are usually adaptive (Yu. V. Galayev, 1968), it is particularly important to investigate enzymatic activity of representatives of human automicroflora growing on polymers.

The obtained data will make it possible to formulate the principal criteria for evaluating biostability of materials, with due consideration of technical and medical aspects, and to offer scientifically validated recommendations for the sanitary and hygienic conditions for using polymers in spacecraft cabins.

THE PROBLEM OF TOXICOLOGICAL HAZARD OF PRODUCTS OF POLYMER COMBUSTION IN CONFINED COMPARTMENTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 108-110

[Article by G. M. Gorban', Yu. P. Bizin, N. F. Sopikov, L. V. Marchenko, T. P. Tikhonova and Z. I. Pilipyuk]

[Text] Several hundred nonmetal materials are presently used to equip manned vehicles. The large amount of polymers used in spacecraft, including highly inflammable [combustible] ones, presents the danger of chemical poisoning in case of fire within the pressurized compartment. The products formed as a result of combustion of polymers are gas-smoke-aerosol mixtures that are complex in chemistry and little-studied from the standpoint of toxicology. The fact that they consist of many components harbors the danger of enhancement of the toxic effects of the different chemicals in such a complex. The conditions prevailing in a confined space of limited size are instrumental in rapid accumulation of chemicals in the air, up to toxic levels, as well as occurrence of an oxygen shortage. The toxic effects of products of polymer combustion could also be enhanced due to elevation of ambient temperature.

All these circumstances make it imperative to gather information about the degree of toxicity of products of combustion of materials used in spacecraft building, in order to select inflammable and, consequently, nontoxic specimens from the many nonmetal materials. Studies of sanitary-chemical and toxicological aspects of products of polymer combustion constitute a pressing task, which is important to the national economy.

Bearing the above in mind, methodological approaches were developed to examine the toxicity of products of polymer combustion; an experimental unit was developed for laboratory bench studies of combustion products, which permits working under safe conditions, and a study was also made of the toxicity of combustion products of a number of polymer samples based on polypyromellitimide and tetrafluoro-ehtylene using laboratory animals (combustion temperatures +600°C and +850°C, exposure time 5 min). Determination was made of parameters of acute toxicity (WCL_{50}, WCL_{16} and WCL_{84}) and threshold of acute effects of combustion products. The results of testing four samples of materials of these groups enabled us to define the amounts thereof that caused 50% animal mortality with combustion thereof and indicated exposure time (Table 1).

Table 1. Amounts of materials eliciting 50% animal death upon combustion (WCL_{50}), mg/ℓ

Name of polymer	at +600°C WCL_{50}	at +850°C WCL_{50}
Polypyromellitimide film, PM-1	112±5.5 mg/ℓ	32.3±1.85 mg/ℓ
Polypyromellitimide varnish, PAK-1	15.3±0.24 mg/ℓ	24.4±1.42 mg/ℓ
Fluoroplastic, F-40p	121±9.76 mg/ℓ	115.5±13.2 mg/ℓ
Fluoroplastic, F-40	130.3±15.4 mg/ℓ	126.6±5.72 ,g/ℓ

The results of these studies revealed that a marked toxic effect is demonstrable upon combustion of rather small amounts of the tested materials (15 to 130 mg/ℓ air volume), with 50% animal death. The toxic products of thermal destruction of the materials is related to formation of highly toxic compounds, in particular, HCN, CO, NF, organofluoric substances, etc. Changes in functional and morphological parameters, as well as temporary decline of physical endurance of animals, were observed under the influence of nonlethal concentrations of combustion products.

The results of these experiments, as well as analysis of data in the literature, indicate that several polymers, including polypyromellitimides and polytetrafluoroethylenes, cannot be allowed for use for equipment in sealed compartments because of the toxicity of products of their combustion. If such materials are used in the above-mentioned areas, the possibility of ignition thereof must be ruled out, the reliability of operation of life support systems must be increased, and a highly effective system of fire-extinguishing equipment must be developed.

VALIDATION OF THE SET OF MEASURES REFERABLE TO SANITARY AND HOUSEKEEPING CONDITIONS DURING SPACE FLIGHTS LASTING UP TO TWO YEARS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 110-113

[Article by S. N. Zaloguyev, V. V. Borshchenko, A. N. Viktorov, A. G. Prishchep and G. A. Shumilina]

[Text] Sanitary-housekeeping support of space flights is presently used to refer to the set of measures aimed at meeting the requirements of the crews of spacecraft or orbital stations with regard to personal hygiene and maintaining optimum living conditions in manned compartments. The importance of these matters increases significantly when space missions will increase to 2 years in duration (O. G. Gazenko et al.).

In our studies, we proceeded from the well-known thesis that man is exposed to a specific set of conditions during space flights, which are inherent in both the manned pressurized compartment, as well as other factors. As a result of such exposure, there are changes in some functional parameters of several systems and organs of man. Of particular interest are the changes observed in quantitative and species composition of automicroflora of the human integument. The role of staphylococci and other representatives of the automicroflora as potential pathogens may increase.

Studies pursued under simulated and actual space flight conditions, in the case of rather long missions, established that there is increase in extensiveness of a microbial site on the human integument and, as a result, more intensive discharge of microorganisms into the environment. This circumstance is one of the causes of accumulation of microorganisms in the environment of sealed compartments and greater role of air, internal surfaces and life support systems as the main factors of transmission of pathogenic representatives of human microflora.

Physiological and hygienic studies resulted in determination of the supplies for oral hygiene of cosmonauts. It was demonstrated that, when people are confined in space vehicles, a rather marked deodorizing and cleansing effect can be obtained with the combined use of viscose knit cloths soaked in BBS-III lotion, containing hexachlorophene, which separates in a measured amount, and an optimum regimen of chewing Kalev type chewing gum.

Under simulated and real conditions of space flight aboard the Salyut-6 orbital station, it was demonstrated that one can use water in a flow of air with items

made of absorbent textiles, which retain in the absence of earth's gravity and provide for measured dispensing of KABOAG, a detergent and disinfectant contained in them, upon contact with water, with satisfactory physiological and hygienic efficacy, and it is compatible with the technology of recycling liquid wastes by means of sorption, with filtration through ion-exchange resins and activated carbon.

The average consumption of water per procedure constituted 8±1 ℓ on the ground and 5±1 ℓ during flight aboard the Salyut-6 orbital station. In view of the distinctions in behavior of liquids in weightlessness and other conditions of long-term space flight, these figures should be considered quite acceptable in the support of flights lasting up to 2 years.

In ground-based tests of an experimental shower system, the temperature of water of 40°C was defined as optimum for these conditions. In orbital flight aboard Salyut-6, the cosmonauts wanted to use hotter water for showering. The ambient temperature in the shower was also in the range of the above figure.

The characteristics of water recovered after showering and subsequent long-term (up to 1 year) storage, as well as at different stages of regeneration with the use of physicochemical and bacteriological indicators, were obtained in order to investigate the possibility of using for washing oneself water regenerated a second time in future space vehicles. The obtained data enabled us to define the list of indicators of water quality and permissible levels thereof for use during long-term space flights.

One of the important measures referable to sanitary and housekeeping support is preventive disinfection, performed at different stages of preparations for and participation in manned space flights. Sanitary and bacteriological studies revealed that the chemical method of disinfection, using a 1% aqueous solution of katamin AB and 1% aqueous solution of hydrogen peroxide for mechanical pretreatment of surfaces in the manned compartments of space vehicles in the preflight period could have a pronounced antimicrobial effect.

During the time man spends in the cabin of a space vehicle, it is imperative to use a set of physical and chemical disinfection methods, the most important of which are the use of scattered ultraviolet radiation, with generation of a bactericidal flux of at least 100 mbar/m^2 and treatment of inside surfaces with 0.1% aqueous solution of katamin AB.

The medicotechnical specifications for equipment used for periodic monitoring of level of microbial contamination of the atmosphere of manned compartments of space vehicles operating for up to 2 years were developed successively in several stages. The experience in supporting manned space flights made it possible to define the list of the most probable pathogens of human diseases under such conditions.

Determination was made of the list of elective and differential diagnostic nutrient media that would permit detection of these microorganisms when present in relatively small amounts in the air of a space vehicle. The results of comparative evaluation enabled us to select 5% blood agar, mannitol-sodium agar, bromthymol blue agar and Sabouraud agar for demonstration of these microorganisms, and the aspiration-sedimentation and filtration methods for trapping microorganisms in air.

Bacteriological tests revealed that periodic monitoring of bacterial contamination of the air environment, with the combined use of the aspiration-sedimentation and filtration methods and the above-mentioned media, yields data that permit evaluation of the sanitary and epidemiological conditions in manned compartments of space vehicle simulators. The obtained experimental data enabled us to validate the medicotechnical specifications for a device to monitor microbial contamination in the cabins of space vehicles.

In conclusion, we should mention the desirability of expanding research on sanitary and housekeeping support of long-term space flights, in order to increase the share of information gained directly from space flights aboard orbital stations of the Salyut-6 type and analogous vehicles. Such data help with further refinement of ways and means of personal hygiene of crews of space vehicles, the duration of operation of which is constantly increasing.

CHOICE OF CRITERIA FOR EVALUATING COSMONAUTS' TOILETRIES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 114-115

[Article by V. P. Gorshkov]

[Text] When people spend time in space vehicles, there is a significant increase in the role of representatives of their microflora as potential pathogens of diseases. In evaluating the means of personal hygiene, which are being developed, the following indicators must be taken into consideration: overall microbial content and species in different parts of the human integument, intensity of discharge of microorganisms from the integument into the environment.

Experimental studies involving exposure of man to the specific set of conditions inherent in sealed areas demonstrated that there is 2 to 40-fold increase in microorganisms present on the subjects' integument. With regard to composition of automicroflora, we observed changes in amounts mainly of staphylococci and coryne-bacteria, by 10-60%, as compared to the total number of microorganisms, due to an increase in amount of streptococci, Gram-positive sporulating bacilli and appearance of Gram-negative cocci referable to the genus of nonpathogenic Neisseria and Gram-negative rod-shaped microorganisms of the Enterobacteriazeae, Acinetobacter and Acrhomobacter familes, general Serratia, Pseudomonas and Proteus.

It was also established that the extent of limitation of the volume and means of personal hygiene, which were determined with consideration of power and water supply, weight, dimensions, distinctions of life support systems used, duration of flight and nature of the crew's work, were among the main factors determining the nature and severity of changes.

Temperature elevation and increase in relative humidity in the sealed chamber led to more marked dysbacteriotic changes in composition of automicroflora and drastic increase, by 30-200 times, in microbial contamination, and occasionally to skin diseases of a bacterial nature in the subjects.

The increase in size of a microbial site on the human integument led to significant intensification of discharge of microorganisms into the environment. In a sealed compartment, there was a 10-150-fold increase in intensity of discharge, as compared to ordinary living conditions. It was established that migration of microorganisms into the environment was directly related to the amount of microorganisms on the integument ($P<0.01$). This circumstance is one of the causes of

accumulation of microorganisms in the atmosphere of a confined space and increase in role of air and environmental surfaces as one of the main factors of transmission of conditionally pathogenic representatives of human microflora. For this reason, when selecting toiletries it is desirable to use bactericidal agents with antimicrobial activity against various representatives of human automicroflora, precluding development of dysbacteriosis.

Clothing may play a significant part in accumulation of microorganisms in the environment of a sealed space. The results of our studies revealed that 63±9% of the microorganisms are discharged from the integument per hour, and that 3.2±0.4% of the total microorganisms of the skin pass into the environment. A significant part (59.8±8.9%) of the discharged microorganisms is retained by clothing. As time passes, there is gradual contamination of underwear by microorganisms, as a result of which it may become the source of contamination of the air environment by bacterial aerosol.

Thus, the results of these studies revealed that it is imperative to take into consideration, when choosing and evaluating toiletries, not only their cleansing properties, but degree and nature of change in automicroflora of the human integument.

EVALUATION OF FUNCTIONAL STATE OF THE HUMAN VESTIBULUM ORIS AND EFFICACY OF TOILETRIES DURING EXPOSURE TO SPACE FLIGHT FACTORS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 115-117

[Article by R. I. Volkova]

[Text]It is necessary to obtain data about the functional state of the human buccal cavity when exposed to the factors inherent in space flight in order to work out scientifically validated toiletry supplies for people spending long periods of time in space craft.

To investigate the effects of some space flight factors on the functional state of the vestibulum oris of man, as well as to assess toiletries, a study was conducted in the form of pressure chamber experiments lasting 30 to 120 days, and with 7 and 182-day antiorthostatic [head down] hypokinesia.

We used biochemical methods, including determination of pH of fasting saliva, amount of sediment, concentration of sulfhydryl groups, and quantity of ammonia nitrogen and nitrites in washings from the mouth. Samples were taken from the mouth before and 10 min after using toiletries. We also used the method of individual interrogation of subjects, with subsequent analysis of the obtained answers.

The series of pressure chamber experiments using various climate modes revealed that there were significant changes in the functional state of the mouth during periods of high temperature (33°C) and humitiy (90%) and a combination of these factors; the changes consisted of a statistically reliable increase in ammonia nitrogen and nitrites in washings from the buccal cavity ($P>0.001$), decrease in sulfhydryl groups and pH of mixed saliva ($P>0.001$). Such changes were demonstrable in the subjects during periods of simulation of emergency situations in the course of their 90-day stay in a sealed chamber.

An increase in overall sediment ($P>0.01$) in saliva toward the end of the experiment associated with some shift of pH in the direction of acidity was demonstrated in the series of 7-day experiments under close to real conditions.

The study of parameters of functional state of the vestibulum oris is very important to prognosis of stomatological diseases. An increase in ammonia nitrogen and nitrites in washings from the mouth is indicative of increased intensity of processes of breakdown in parodontial tissues, accumulation of products of vital

functions of microorganisms in dental deposit and start of the process of formation of tartar. It is known that a decline of pH of buccal fluid is one of the prognostic symptoms of actively progressive dental caries (T. F. Vinogradova, 1978).

A decrease in sulfhydryl groups of saliva is also an adverse sign, since it leads to loss of enzymatic activity and elicits various pathological disorders in parodontial tissues leading to stomatological diseases.

Accumulation of large amounts of deposits in the mouth, with their inherently high metabolic activity could have a direct relation to some elements of etiology and pathogenesis of caries.

Evaluation of several means of hygiene established that a combination of chewing gum and lotion-saturated cloth is an acceptable variant for oral hygiene of people who are exposed to special conditions.

Analysis of the results of our study of the functional state of the buccal cavity exposed to some space flight factors revealed that wise use of appropriate ways and means of personal hygiene maintains a high level of fitness and prevents appearance of stomatological diseases.

COSMONAUTS' DIET OF CANNED AND DEHYDRATED FOODS DURING LONG-TERM FLIGHTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 117-118

[Article by I. G. Popov, V. Ye. Potkin, A. A. Latskevich, I. A. Romanova, L. I. Kolesnikova, P. A. Lozinskiy and R. Kh. Khisyametdinova]

[Text] The problem of optimum nutrition of crews is growing increasingly complex with the increase in duration of space flights. Along with the need to provide complete nutrition consistent with energy expenditure and metabolic distinctions, there is an urgent need to lower the weight of food initially stowed aboard and prolong shelf life of foodstuffs in flight.

The task of enriching the space diet with large amounts of dehydrated foods, which weight less at the start and retain their nutrient value, as well as flavor, for a rather long period of time is quite justified.

The wide use of diets consisting of mixed canned [preserved] and dehydrated foods is hindered, to some extent, by the fact that long-term intake thereof has not been sufficiently investigated. In this study, we made a physiological and hygienic evaluation of experimental diets consisting of assortments of canned foods and mixed diets, which included canned and dehydrated foods.

The average assimilable caloric value of the first type of diet constituted 2980 kcal/day, with 98.3 g protein, 137 g fat and 317.3 g carbohydrates. Average (gross) weight of the diet constituted 1606 g. The main nutrients contained in the mixed diet were: 121.9 g protein, 120.1 g fat and 335.7 g carbohydrates. Mean daily caloric value was 2993 kcal and mean weight (gross) of the diet was 1221 g.

This study was conducted on 12 healthy men who stayed on these diets for 30 days, while on strict bed rest. The nutritional status of the subjects was evaluated by using parameters of nitrogen, amino acid, fat, carbohydrate, vitamin and fluid-electrolyte metabolism.

On the basis of analysis of the results, the diet that contained dehydrated foods was given a higher rating than the one consisting only of canned foods.

With both diets, the biochemical parameters of nutritional status were in the normal range set for healthy man who takes good nutrition, and they were virtually

the same, since the rations were ingested completely in both cases. The appetite remained rather good. There were no deviations from normal with regard to parameters of gastric function.

The obtained findings warrant the conclusion that diets containing dehydrated foods processed by the method of freeze-drying can be used with success in the daily rations of cosmonauts.

At the same time, these studies revealed that the existing freeze-dried foods require serious additional refinement to improve flavor, broaden the assortment, good reconstitution and convenient packaging.

DIGESTIVE SYSTEM REACTIONS TO SPACE FLIGHTS DIFFERING IN DURATION

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 119-120

[Article by K. V. Smirnov, L. G. Goland, I. L. Medkova and N. M. Nikolayeva]

[Text] K. V. Smirnov et al. (1973, 1976, 1977) studied secretory and peristaltic function of the gastrointestinal tract before and after space flights lasting 2 to 63 days. Changes were demonstrated in digestive system function, and they were related to duration and conditions of the space flights.

In this work, we studied hydrolytic and motor function of the digestive tract of the crew of the first mission aboard the Salyut-6 orbital station before and after a 96-day flight and in the crews of two visiting expeditions (7-day space flights). A study was made of activity of digestive enzymes in blood, urine and feces, i.e., of incretory and excretory pathways of enzyme secretion, which characterized adequately the functional activity of the glandular system of the stomach, pancreas and small intestine, and a study was also made of electrical activity to assess peristaltic function of the stomach.

We assayed gastric proenzyme, pepsinogen, and measured the activity of pancreatic enzymes--amylase and lipase--in blood and urine. In addition, we assayed trypsin and trypsin inhibitor levels in blood. Motor function of the stomach was evaluated by the electrogastrographic method, with plotting of curves of distribution of amplitudes of gastric contraction.

We examined 4 people after 7-day space flights and 2 after the 96-day space flight.

An increase in blood pepsinogen content was noted in 2 cosmonauts after 7-day orbital space flights.

With reference to secretion of pancreatic enzymes, we should mention only a tendency toward increased incretion of lipase in the crew of the second visiting expedition.

Analysis of the activity of intestinal glands revealed some decrease in excretion of invertase in the crew of the first mission.

Thus, there were negligible changes in excretion of digestive enzymes after the 7-day orbital flights, associated with increase in activity, mainly of the most labile digestive hydrolases, which were individual in nature.

More substantial and longer changes in function of the digestive system were demonstrated after the 96-day orbital flight. Both cosmonauts presented a drastic increase in pepsinogen content of blood, with intensified excretion of this enzyme from the body.

The study of excretion of pancreatic enzymes revealed a decrease in blood amylase activity in both cosmonauts, and increase in blood lipase activity in the flight engineer.

On the 31st postflight day, we found an increase in activity of trypsin and its inhibitory in blood, while there was some normalization of the above-mentioned parameters.

Studies of motor function of the stomach revealed depression of rhythm of gastric contractions in both cosmonauts.

The changes demonstrated after the 96-day space flight in secretory and peristaltic functions of the gastrointestinal tract reflect the patterns that we previously demonstrated for long-term space flights. However, in addition, we demonstrated the influence of longer weightlessness, as compared to 30- and 63-day space flights.

EFFECTS OF FREEZE-DRYING, PROLONGED STORAGE AND PROTON RADIATION ON BIOLOGICAL VALUE OF PROTEIN IN DEHYDRATED FOODS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 120-122

[Article by V. N. Gryaznova]

[Text] In the opinion of most authors, it is desirable to use foods dehydrated by the freeze-drying (lyophilization) method for long-term space flights. When stowed aboard spacecraft during long-term flights, the foods will be subject to irradiation due to solar bursts and galactic radiation.

We conducted this study in order to determine the effect of long-term storage and radiation on biological value of protein in dehydrated foods.

On the basis of analysis of the expected radiation situation, the dehydrated foods stowed for 2-year storage were exposed to divided doses of protons, at the rate of 6000 rad, every 6 months. As a result, the foods were exposed to a total of 12,000 rad radiation per year and 24,000 in 2 years.

We determined the biological value of protein in the foodstuffs by studying their vulnerability to proteolytic enzymes in vitro. For this purpose, we used the method proposed by A. A. Pokrovskiy and I. D. Yertanov. We tested the following foods: beef Stroganov, meat patties, meat [ground, or sausage[stuffed foods, pike perch, cottage cheese with pureed fruit and acidophilus paste. We tested the vulnerability of protein in unadulterated foods, freshly prepared freeze-dried foods, freeze-dried foods after 1 and 2 years of storage, and combination thereof with proton irradiation. Unadulterated foods served as a control for the freeze-dired, freshly prepared foods and freshly prepared freeze-dried foods served as a control for the others. The studies revealed that freeze-dried foods are digested somewhat worse than unadulaterated ones: by 3-6.8% in the case of hydrolysis with pepsin and by 2.4-6.6% with trypsin hydrolysis. Storage retards somewhat the rate of digestion: by 1.5-2.4% with pepsin hydrolysis and 1.0-3.0% with trypsin hydrolysis after storage for 1 year; 2.3-3.5% with pepsin hydrolysis and 1.8-4.9% with trypsin hydrolysis after storage for 2 years.

Irradiation of freeze-dried products during storage in doses of 6000, 12,000, 18,000 and 24,000 rad increases the rate of digestion proportionately to the radiation dosage. This increase was in the range of 2-11.9% with pepsin hydrolysis and 2.4-9.8% with trypsin hydrolysis.

These studies revealed that freeze-drying and storage diminish somewhat the rate of digestion of proteins by proteolytic enzymes in vitro, while radiation accelerates digestion.

The studies also revealed that there was negligible change in biological value of protein in dehydrated foods under the influence of freeze-drying, long-term storage and storage combined with radiation, which enables us to recommend such foods as a source of complete protein to be included in the rations of crews of space vehicles operating for long periods of time.

EFFECT OF DIET, AGE AND SOME FACTORS SIMULATING SPACE FLIGHT CONDITIONS ON HUMAN LIPID METABOLISM

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 122-123

[Article by O. S. Khokhlova and A. G. Kasatkina]

[Text] A study was made of lipid metabolism in healthy men deemed fit for participation in tests of life support systems. Total blood serum lipids were assayed by the turbidimetric method, cholesterol by the Huang method, while percentile levels of α- and β-lipoproteins were estimated by the method of electrophoresis on paper. In 36 men ranging in age from 19 to 49 years who stayed on the usual diet, mean total lipids constituted 603±10 mg% (M±m), cholesterol was 185±2 mg%, α-lipoproteins 28.2± 0.6%. The figures were 548±29, 170±8 and 29.9±1.2, respectively, for subjects 19-25 years old (22 men), 598±15,182±3 and 28.6±0.9 for those 26-30 years of age (59 men), 610±18, 194±6 and 28.8±1.5 for those 31-35 years of age (34 men), 666±27, 196±7 and 24.7±1.1 for those 36-49 years of age (21 men). A statistically reliable difference was demonstrated between the last (oldest), first ($P<0.01$) and second ($P<0.05$) age groups with regard to total lipids; this applied to cholesterol between the fourth and first groups ($P<0.02$), third and first groups ($P<0.02$), and the difference was also reliable between the fourth and first ($P<0.002$), second ($P<0.05$) and third ($P<0.01$) groups with regard to α-lipoprotein content.

The parameters studied did not undergo appreciable changes when the subjects were on a diet consisting entirely of dehydrated foods for 4 months, on a diet consisting of one of the variants developed for crews of the Soyuz type spacecraft, which contained 1.3 g cholesterol per day, which the subjects took for 65 days, on the diet developed for crews of Salyut type oribtal stations, which contained up to 290 g/day simple sugars (70% of the diet's carbohydrates) for 60 days, or on a diet of dehydrated foods after long-term storage (for 1 and 2 years) and exposure to 12,000 and 24,000 rad protons during storage, respectively, which the subjects consumed for 70 days. Good assimilation (96-98%) was also indicative of the high biological value of fats in the tested diets.

In experiments with clinostatic (first experiment) and antiorthostatic (second experiment) hypokinesia, we observed an appreciable increase in total lipids, cholesterol and relative levels of β-lipoproteins on the 35th-48th days of hypokinesia, although these changes were not statistically reliable for all parameters in all experiments, because of significant individual fluctuations of reactions to hypokinesia.

There was significant decrease in α-lipoprotein content when the subjects spent 7 to 90 days in the pressure chamber. By the end of the stay in the chamber (mean data obtained from 17 experiments on 58 subjects), α-lipoprotein content constituted 22.7±0.7%, versus 28.9±0.9% before entering the chamber ($P<0.001$), and 28.6±1.0% 6-12 days after leaving it ($P<0.001$). Total lipid content was 600±17 mg% before entering the chamber and 620±24 mg% after leaving it, cholesterol constituted 182±4, 190±3 and 179±4 mg%, respectively (the difference between figures obtained in and out of the pressure chamber are statistically unreliable, $P>0.05$). The submitted data indicate that hypokinesia and the conditions in the sealed chamber had the most marked effect on the parameters of lipid metabolism that we studied.

BASAL METABOLISM OF MAN AS RELATED TO REGULATED DIET AND VARIOUS LEVELS OF EXERCISE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 123-125

[Article by V. M. Baranov and V. V. Polyakov]

[Text] The amount of energy expended to maintain vital processes in the body or, as it is generally referred to, basal metabolism of man depends on a number of endogenous and exogenous factors. Numerous studies (Z. I. Barbashova, 1960; Ye. M. Berkovich, 1964; R. P. Ol'nyanskaya, 1950; A. D. Slonim, 1952; I. M. Buznik, 1978, and others) have been made of the effect of ambient temperature, diet, climate, emotional factors, etc., on basal metabolism, as well as extent of deviation thereof from the range of normal fluctuations in the presence of some pathological states. The cited works justify consideration of basal metabolism in a somewhat different aspect, i.e., as an indicator of degree of effect of the environment, particularly the extreme factors of space flight, on man.

In this study, an effort was made to use basal metabolism as an indicator of level of oxidative processes for the purpose of assessing the influence of a diet consisting of pure nutrients with low protein content and hypokinesia.

A total of 15 healthy men participated in studies lasting 45 days, 5 of whom (group A) performed their usual work, 5 (group B) maintained bed rest around the clock during the experimental period and 5 (group C) performed a set of exercises corresponding to energy expenditure of 522±44 kcal/day, against the background of their usual activities. Nitrogen content in the diet constituted a mean of 6.84±0.25 g/day, the daily ration constituting 3000±24.5 kcal in group A, 6.73±0.33 g/day and 2432±35.7 kcal/day, respectively in group B; 7.98±0.17 g/day and 3484.3±51.2 kcal/day in group C.

The results of our studies of basal metabolism (in kcal/day), which were averaged for three 2-week periods, are listed in the Table.

According to the data on this table, there was some decline of basal metabolism during the experimental period in both the A and B groups of subjects, as compared to the background period. However, while the decline was gradual and statistically reliable only between the 30th and 45th days of the study in the A group, we observed a reliable decline of basal metabolism in the B group (hypokinesia) already in the period from the 1st to 15th days. Subsequently, there was negligible change

in energy expenditure under basal metabolic conditions during hypokinesia. In the C group (increased energy expenditure), there was a reliable decline of basal metabolism during the experimental period, and its level was stabilized by the 30th day of the study.

Table

Group	Background M±m	Day of examination						Recovery (6th day) M±m
		1-15, M±m	P	16-30, M±m	P	31-45, M±m	P	
A	2023±142	1791±79.3	> 0.1	1730±117.7	>0.05	1545±100.6	<0.01	1722±95.1
B	1804±22.2	1696±20.4	<0.001	1680±33.0	<0.01	1714±33.2	<0.05	1809±26.6
C	1764±18.2	1932±38.6	<0.001	2413±53	<0.001	2415±74.3	<0.001	---

The submitted results can be interpreted as follows: The decline of basal metabolism in the group with usual motor activity is indicative of the effect of the diet with low protein content on man. At the same time, the more marked decline of basal metabolism during hypokinesia (B group) and increase in the group of subjects who expended more energy are indicative of the fact that the level of exercise has a stronger effect on level of oxidative processes in the body than a low protein content.

EFFECT OF VITAMIN AND AMINO ACID SUPPLEMENTS ON COMPOSITION OF INTESTINAL MICROFLORA IN THE PRESENCE OF NERVOUS AND EMOTIONAL STRESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 125-126

[Article by N. N. Liz'ko, M. S. Belakovskiy and G. D. Syrykh]

[Text] Data have been recently obtained that are indicative of reliable changes in intestinal microflora in the presence of complex nervous and emotional stress. The observed disturbances of intestinal biocenosis were manifested by disappearance of bifidobacteria and E. coli or decrease in amount of lactobacilli (N. N. Liz'ko, 1970; G. W. Tannock, D. C. Savage, 1974). In the opinion of other authors, bacteria of the genus Bacteroides are the most susceptible to change in species composition (L. V. Holdeman et al., 1976). It is believed that stress affects factors regulating the localization and level of microbial populations in the gastrointestinal tract.

In view of the importance of stability of the intestinal microbial cenosis, particularly in the presence of extreme states of man under difficult living conditions in the cabins of space vehicles, we undertook a study directed at finding the means of preventing changes and normalizing the intestinal microflora.

We studied the intestinal biocenosis of subjects in ground-based experiments with simulation of nervous and emotional stress (simulation of "ascents to high altitudes" and exposure to accelerations) and of cosmonauts participating in orbital space flights differing in duration.

We used the method of application of watch glasses with 4-6-h culture of Serratia marcescens (N. N. Liz'ko et al., 1975) to examine the intestinal microflora. These studies revealed that there was a decline in lactobacillus and E. coli content in the intestinal microflora of subjects under the influence of factors associated with onset of nervous and emotional stress. Changes in microecology of the intestine were already demonstrable in cosmonauts in the preflight period. They were characterized by a decrease in bifidobacteria and lactobacilli, to the extent of total disappearance, which we tend to evaluate as the result of nervous and emotional tension during the period of training and preparing for the flights.

As a result of flights, we demonstrated consistent changes in intestinal biocenosis of all crew members involved in flights differing in duration. A formula consisting of vitamins and amino acids (A. S. Ushakov et al., 1978) was used as a preventive agent with such changes in intestinal microflora.

These studies demonstrated that, against the background of intake by the subjects of vitamin and amino acid supplements, there were no dysbiotic changes in microbial cenosis of the intestine. Moreover, we found a statistically reliable increase in bifidobacterial content and tendency toward increase in lactobacilli.

The developed mixture of vitamins and amino acids was recommended for the crews of the second missions aboard Salyut-4 and Salyut-6 orbital stations in the course of 63- and 140-day space flights. The obtained data were indicative of marked changes in composition of intestinal microflora in the direction of normalization under the influence of vitamin and amino acid supplements.

The results of our studies are indicative of the desirability of the used nutrients, which normalize and regulate intestinal microflora under space flight conditions.

CLINICOPHYSIOLOGICAL STUDY OF THE EFFECT OF DESALINATED POTABLE WATER DIFFERING IN MINERALIZATION ON FLUID-ELECTROLYTE EQUILIBRIUM OF THE BODY

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 127-128

[Article by Yu. A. Rakhmanin, V. P. Plugin, M. M. Andrianova and R. I. Mikhaylova]

[Text] At the present time, the problem of setting the scientifically validated bottom and optimum level of salts in recycled water involving desalinization processes is gaining much importance. In the USSR and worldwide practice, standards for potable water are limited only to the top range of total mineralization of water and its main salt constituents.

For this purpose, a study was made, in the hospital in the city of Shevchenko, of the effect of desalinated water differing in salt content on fluid-electrolyte metabolism (balance of electrolytes and fluid, total amount and distribution of fluid in the body, electrolyte concentration in blood serum, homeostasis parameters related to fluid-electrolyte metabolism) in volunteers (52 essentially healthy subjects who were hospitalized for a total of 580 days). We tested a distillate and desalinated water with salt concentration of 50, 100, 200, 400 and 1000 mg/ℓ. The subjects were kept on a strict standard diet throughout the observation period, which provided for physiologically proper intake of the required salt constituents. Each diet was prepared separately using the tested water samples. Water intake was at lib, but a strict record thereof was also kept.

The results of the clinicophysiological studies of fluid-electrolyte metabolism revealed that the most marked changes were demonstrable in the balance of osmotically active sodium ion. The sodium balance retained a positive value in all groups of subjects; however, the level of elimination thereof was higher with intake of distillate and water with 50 mg/ℓ salts than water with mineralization of 100 mg/ℓ. In addition, we observed an increase in blood serium sodium concentration in subjects who drank water with low mineralization. The most marked and statistically reliable ($P<0.05$-0.01) increase in sodium concentration of blood serum, as compared to background data, occurred with intake of completely mineral-free water (distillate) and water with 50 mg/ℓ salts. A tendency toward increase in blood serum sodium was also noted under the influence of desalinated water with 100 mg/ℓ minerals.

Analysis of potassium and chloride balance revealed that there was also increased elimination of these elements under the influence of distillate and water with low

mineral content. A study of the fluid-containing spaces of the body enabled us to demonstrate some increase in plasma volume with relative decrease in extracellular fluid under the influence of distillate, and to a lesser extent under the influence of desalinated water samples with 50 and 100 mg/ℓ salts.

Studies of 600 volunteers who had made a long trip in the desert under extreme conditions, which were conducted to determine the thirst-quenching qualities of desalinated water differing in mineralization, revealed that desalinated water with total salt content of 200-400 mg/ℓ quenched thirst the most adequately. The studies also revealed that desalinated water with calcium salt supplement to the level of 25 mg/ℓ had good thirst-quenching properties and the best taste. These studies confirmed the results of our previous experimental studies on rats, that had been kept on a synthetic diet for 1 year, to the effect that desalinated water with calcium content on the level of 25 mg/ℓ had a beneficial effect on homeostasis.

Our findings stress the importance of regulating the salt composition of recycled water, and they enable us to recommend 100 mg/ℓ as the minimum permissible level of mineralization of regenerated and desalinated water, with 25 mg/ℓ calcium (the optimum overall mineralization is in the range of 200-400 mg/ℓ). These recommendations have been taken into consideration in setting quality standards for recycled water.

USE OF EMERGENCY FOOD SUPPLIES DIFFERING IN COMPOSITION IN SELF-CONTAINED FLOATING RESCUE CRAFT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 129-130

[Article by V. G. Volovich, V. N. Uskov, I. P. Bobrovnitskiy and P. A. Lozinskiy]

[Text] The property of available food supply to retain fluid in the organism is of special importance when there is a shortage of fresh potable water. For expressly this purpose, the emergency supply rations in the naval aviation of FRG, England and Holland were made up mainly of carbohydrates (Hanson, 1955; Nicholi, 1960; Drecoll, 1967).

The purpose of this study was to make a comparative physiological and hygienic evaluation of a carbohydrate diet consisting of vitamin-enriched caramels and emergency food supply NAZ-7 during long-term (up to 7 days) self-contained floating on PSN-6a rafts at high (20-28°C) ambient temperature.

The subjects used in these studies were 33 volunteers, men 21-38 years of age. They were divided into two groups. The diet for the first group (16 men) consisted of products contained in the NAZ-7 emergency food supplies and for the second group (17 men), vitamin-enriched caramels. The caloric value of each diet constituted 3400 kcal. Water intake was not limited, and it was the parameter we determined.

As a result of these studies, it was established that there was marked decrease in orthostatic stability, heart rate and drop of resting arterial pressure, increase in hemoglobin, erythrocytes per μl blood and 12-17% increase in hematocrit, drastic decrease in excretion of sodium, chlorides and, to a lesser extent, potassium in urine, decrease in blood plasma sugar and potassium, as well as EKG change of potassium deficiency genesis, at the end of the experiment in both groups of subjects, regardless of their diet, as compared to the base values.

Actual water intake with the diet consisting of the mixed foods in the NAZ-7 emergency food supplies constituted 3890±130 ml in 7 days, and with intake of the vitamin-enriched caramels 3420±155 ml ($P<0.05$). Diuresis was lower throughout the experiment in the second group than the first. On the carbohydrate diet, 650-800 mM less total nitrogen was eliminated over the entire experiment (i.e., 55-70 g less protein was digested) than with intake of NAZ-7 foods.

One of the flaws of the caramel diet is that one grows very tired of it, so that it was not entirely consumed. Probably as a result of this, weight loss was more marked in the second group, constituting 7.1±0.3% of initial weight by the end of the experiment, versus 6.4±0.1% in the first group ($P<0.05$).

CARBOHYDRATE METABOLISM AND FUNCTIONAL LOAD TESTS ON CIVIL AVIATION FLIGHT PERSONNEL ENGAGED IN CROP DUSTING

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 130-132

[Article by L. I. Kuznetsova, L. N. Nachatkina, M. M. Ismaylov and A. I. Dobrova]

[Text] There are very few data in the literature concerning the incidence of disturbances referable to carbohydrate tolerance of flight personnel. In the practice of expert medical certification of pilots, it is important to make early detection of disturbances in carbohydrate metabolism and to constantly observe individuals with detected disorders. This makes it possible to keep pilots in flight work as long as possible when they have incipient, compensated disturbances of carbohydrate metabolism.

We studied flight personnel involved in crop dusting (before and after work) in order to investigate the effects of toxic chemicals on carbohydrate metabolism. The work involved the use of chemicals with low (mineral fertilizers), medium (chlorophos, butyl ether, cuprosan) and high (metaphos, carbophos, butiphos, methyl mercaptophos) toxicity.

We used the 3-h glucose tolerance test to assess carbohydrate metabolism. Blood was taken from the finger every 30 min for 3 h. It is necessary to take blood in the 30th and 60th min because the glycemic peak is referable to the 30th min in 85% of the cases and 60th min in 15%. The subjects stayed on their usual diet and performed their usual activities. Glucose was given at the rate of 1 g/kg body weight. We calculated the hyperglycemic and postglycemic coefficients for quantitative evaluation of the glycemic curves.

We based ourselves on the criteria proposed in the methodological instructions for active detection of diabetes mellitus, approved by the USSR Ministry of Health, No 10-67 dated 9 Jul 72, to evaluate the glycemic curves.

Since the blood sugar level depends on the functional state of the liver and enzymes are the first to be depressed by toxic chemicals, the set of biochemical tests included the following: blood cholinesterase assay by the method of Schefer et al., alanine-aminotransferase by the method of Raytmon and Frenkel', and the thymol test by the method of Juergo and Popper.

Analysis of glycemic curves of AN-2 aircraft pilots with the glucose test prior to crop dusting revealed that 24 out of the 102 examined had diminished carbohydrate

tolerance, with reliable elevation of the hyperglycemic index. In 50% of the cases, the glycemic curves were characterized by rapid and high elevation of sugar in the 30th and 60th min and slow decline, without returning to normal 2 h after the glucose load. There was no hypoglycemic phase. In 5 pilots, the glycemic curve did not show a steep elevation; it was characterized by slow decline, which did not return to normal not only after 2 h, but even after 3 h. In this case, one can apparently consider an impairment of glycogen-forming function of the liver.

We demonstrated a tendency toward decrease in cholinesterase in 18 out of 102 pilots, negligible elevation of thymol test in 25 and increased activity of alanine aminotransferase in 14 pilots.

The subjects performed crop-dusting work for 3 months, first with mineral fertilizers, then chemicals of average and high toxicity. The second examination immediately after this work revealed that the percentage of normal glycemic curves remained the same (74.2%); however, the glycemic curves became diabetic after crop dusting in six pilots who presented low carbohydrate tolerance before this work. Examination under hospital conditions of subjects with the diabetic type of curve revealed latent diabetes mellitus in five out of the six cases. We observed some instances when the glycemic curve changed, from a hypoglycemic one, to a diabetic one after working with toxic chemicals.

Functional liver tests failed to demonstrate significant changes after crop dusting work with chemicals.

Thus, the specifics of crop-dusting work should be viewed as an adverse factor for flight personnel with diminished carbohydrate tolerance. As a rule, the impairment of carbohydrate metabolism worsened significantly after performing such work. When settling the question of whether individuals with low carbohydrate tolerance or marked hypoglycemia should be allowed to fly on crop-dusting jobs, an individual approach must be used. A thorough clinical examination, including a 3-h glucose test, yields objective data to settle this question.

OTHER PRESSING PROBLEMS OF AEROSPACE MEDICINE

FEASIBILITY OF PREDICTING THE FUNCTIONAL STATE OF THE ORGANISM EXPOSED TO RADIATION AND OTHER SPACE FLIGHT FACTORS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 135-136

[Article by Ye. I. Vorob'yev, Ye. Ye. Kovalev, V. M. Petrov and V. G. Gorlov]

[Text] Cosmonauts are exposed to galactic, solar and earth's radiation belt radiation during long-term space flights. For this reason, methods are needed for detection of potential individual radiation reactions to assure radiation safety of crews. In developing such methods, it is desirable to take into consideration the following main theses of radiobiology and medicine.

There is a genotypically determined reserve in the organism, which diminishes in the course of vital functions as a function of magnitude of accumulated dose of radiation.

Instantaneous or gradual formation of an irreversible lesion, as well as persistence of changes in the organism and incomplete postradiation recovery, are typical distinctions of the effects of radiation.

It can be assumed, on the basis of the dynamics of cell populations in the presence of radiation syndromes, that the functional activity of an organ or physiological system is determined by the number of surviving and functional cells, and degree of preservation of regulatory processes.

Organs and systems that are less affected by radiation are capable of compensating (to a certain limit) for the functions of damaged structures by means of compensatory hyperfunction that is specific to an individual.

In developing methods for evaluating individual radiosensitivity, the means must be found to determine the potential reserves of the integral organism and its different systems.

Within the framework of the approach we are developing, the following methods can be used to determine general radioresistance of an organism: determination of genetic range of functional activity of different systems and the integral organism; evaluation of systems of the organism in which the effective dose exceeded a threshold value; consideration of modifying effects of space flight factors.

The formulated theses constitute the basis of the approach the authors are developing to detect the effects of radiation on spacecraft crews.

THE PROBLEM OF PRIMARY RADIATION REACTION DURING SPACE FLIGHTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 136-137

[Article by V. V. Antipov, D. N. Gavrilyuk, B. I. Davydov and B. L. Razgovorov]

[Text] Our objective was to study the primary radiation reaction under the complex influence of ionizing radiation and accelerations, with shielding of the head or middle part of the abdomen. Experiments were conducted on 186 rats and 77 dogs. The animals were exposed to gamma radiation in a dosage of 800 R. We shielded the entire head of the animals or middle third of the abdomen by means of lead blocks that attenuated the radiation dose to one-half to one-tenth (K--coefficient of attenuation of radiation--from 2 to 10). The animals were submitted to $+G_x$ accelerations (30 units, 2 min for rats; 8 units, 3 min for dogs) on a centrifuge with a 4.2 m arm. We assessed the severity of the primary reaction of dogs according to vomiting and duration of generalized and alimentary depression. In rats, we used the peristaltic and evacuating function of the gastrointestinal tract to assess the severity of the initial period of radiation sickness.

In intact rats, the stomach emptied uniformly in 1-4 h. Transverse accelerations did not reliably alter the time of stomach emptying in the rodents. Exposure of the animals to 800 R radiation increased retention of emptying of the stomach by 15-20 times. Shielding of the abdomen or head during exposure to radiation had the same protective effect for the first 2 h after exposure, attenuating the radiation effect by 1.5-2 times.

Although shielding of the head and abdomen had about the same protective effect on impaired functions of the gastrointestinal tract for the first 2 h, survival rate and time were greater when the abdomen was shielded than with shielding of the head. For this reason, we conducted subsequent studies only with shielding of the abdomen.

Transverse accelerations did not reliably alter the severity of disturbances referable to evacuatory function of the stomach of irradiated animals, with or without shielding of the abdomen, as compared to corresponding control groups that were not exposed to accelerations. Accelerations used prior to irradiation had a protective effect ($P<0.05$).

Three series of experiments were conducted on dogs. In the first series, we investigated the effect of location of the shield on early radiation-induced vomiting. Exposure of the dogs to radiation in a dosage of 800 R elicited general alimentary

depression lasting 6-8 h and an average of 4 vomiting episodes in all animals. Although shielding of the head (K = 10) did reduce the duration of general and alimentary depression by one-half, it had not effect on vomiting. Analogous protection of the abdomen diminished reliably the probability of vomiting, as well as severity of the vomiting reaction.

In the second series of experiments, we studied the vomiting reaction as a function of the coefficient (K) of attenuation of radiation dose to the abdomen. A shield with K = 5 was less effective than with K = 10. Protection of the abdomen with a shield, with K = 2, had no effect on vomiting.

In the third series, we assessed the efficacy of shielding (K = 5) the abdomen during exposure to accelerations. Postradiation exposure to accelerations aggravated the primary reaction: there were more vomiting episodes and they lasted longer than in the control. With regard to other symptoms, the duration of the primary reaction was also longer than in the control group. When we changed the order of exposure, i.e., when accelerations preceded irradiation with shielding, there was no appreciable change in parameters of the vomiting reaction. However, there was a decrease in duration of the primary reaction, as determined by the symptoms of general and alimentary depression.

Analysis of the obtained data shows that accelerations have some modifying effect on different symptoms of the primary reaction.

This paper also discusses the possible effects and mechanism of action of other flight factors, and the means of providing radioprotection against the primary radiation reaction.

CELL REACTIONS TO COMBINED FACTORS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) p 138

[Article by V. G. Petin, V. G. Skvortsov and V. P. Komarov]

[Text] Some of the patterns of cell reactions to combined factors are discussed here on the basis of the author's own experimental data and analysis of the literature.

Electromagnetic radiation from low-intensity superhigh frequency waves as well as gamma radiation can stimulate metabolic processes in cells and even attenuate the subsequent effect of ionizing radiation on cells. This is related both to acceleration of metabolic processes in cells and activation of repair systems.

With higher intensities of ionizing and nonionizing radiations, two cellular reactions are demonstrable to combined factors, which are basically different. The observed cumulative effect equals the sum of effects elicited by each factor when each is used independently. Such interaction is called additive. Synergistic interaction is observed when the total effect is substantially greater than expected. Ultraviolet waves, ultrasound, thermal levels of superhigh frequency radiation and certain other physical factors have a sensitizing influence on the effects of ionizing radiation.

Examples are given of manifestation of additive and synergistic interaction of hyperthermia, superhigh frequency radiation, ultraviolet and ultrasound with ionizing radiation with different LET in the case of exposure of bacterial and yeast cells, as well as mammalian cells.

THE COMBINED EFFECT OF HYPEROXIA, HYPOXIA AND DIVERSE RADIATIONS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 138-139

[Article by V. V. Antipov, B. I. Davydov, M. V. Vasin and V. S. Tikhonchuk]

[Text] Experiments were conducted on mice, rats and dogs. Hyperoxia was produced by breathing with oxygen (97-98%) at normal pressure and hypoxia, by breathing with a gas mixture with low O_2 content (15, 10, 8 and 7%). The animals were exposed to γ-rays (100 to 20,000 rad) or electromagnetic waves (2400 MHz) with magnetic fields of 10 to 100 mW/cm^2. The factors were used simultaneously or successively.

Breathing with pure oxygen enhanced the intestinal reaction with all doses of γ-radiation that we used (300 to 1000 rad). This was manifested by intensification of blocking of mitotic activity of epithelial cells of the intestinal crypts and hypoplasia of its mucosa, with increase in animal death rate during the period of manifestation of the "intestinal" syndrome of radiation sickness.

The effect of O_2 on radiosensitivity of hemopoietic tissue depended on the radiation dosage.

We observed a negative effect of O_2 on hemopoietic tissue only with delivery of superlethal doses (up to 1000 rad) of γ-rays, and it was manifested by intensification of leukopenia, hypoplasia of bone marrow, spleen and thymus.

Breathing with O_2 during delivery of sublethal doses of γ-rays had a beneficial effect on proliferative activity of bone marrow, as manifested by a higher mitotic index on the first postradiation day.

Moreover, several experiments demonstrated that breathing with O_2 prior to exposure to γ-rays (1000 rad) elicited an increase of about 40% in survival of experimental mice.

Radioresistance was enhanced in mice and rats when breathing with a gas mixture with low O_2 content during exposure to γ-rays. We demonstrated a hyperbolic relationship between the radioprotective effect of hypoxia and level of decrease in O_2 content of the gas mixture. The radioprotective effect of hypoxia was more marked in the experiments on mice than on rats. This difference was particularly distinct when using mixtures with 7 and 8% O_2. However, we failed to demonstrate a radioprotective effect of hypoxia (10-12% O_2) in the experiments on dogs, with concurrent use of the factors.

The study of biological interaction of microwave and ionizing radiation revealed that in the range of radiation test doses of 100 to 20,000 rad a synergistic effect is demonstrable in the radiation lesion to the hemopoietic system.

EFFECTS OF MICROWAVES ON BIOCHEMICAL PARAMETERS OF BLOOD AS RELATED TO DIFFERENT FUNCTIONAL STATES OF THE DIGESTIVE SYSTEM

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 140-141

[Article by B. P. Surinov, N. A. Karpova and I. A. Rudakov]

[Text] A study was made of the relationship between changes in biochemical parameters of blood after exposure to microwaves and functional state of the digestive system.

In the experiments, all rats were kept without food for 24 h. Then the first group of animals was given the usual mixed feed, while the second was kept without food, as before. After another 1.5 h, some of the animals from each group were exposed to radiation from an LUCh-58 unit (wavelength 12.6 cm) with 40 mW/cm^2 intensity of the superhigh frequency field and exposure for 30 min. The remaining animals were not irradiated (control). Irradiated and control animals were decapitated at different times, namely, immediately, then 1, 3 and 24 h after exposure. We assayed blood serum glucose content (reducing sugars) and alkaline phosphatase activity (hydrolysis of n-nitrophenylphosphate).

Glucose content of blood serum was low 1 h after irradiation and higher 3 h after irradiation in experimental animals exposed to radiation after feeding, as compared to the control. The changes in glucose content of blood of starving rats after irradiation consisted only of elevation of its level 3 h after exposure.

Alkaline phosphatase activity was lower immediately after irradiation in rats exposed after feeding, and did not differ from activity in nonirradiated animals at subsequent observation times. In starving rats, radiation elicited an increase in activity of this enzyme of blood by the 3d h, as compared to nonirradiated fasting animals.

As we know, the blood glucose level is determined by its absorption in the intestine, migration from the liver and uptake by various tissues. In rats, the activity of blood alkaline phosphatase depends primarily on the amount of enzyme passing from epithelial cells of the intestinal mucosa. For this reason, the observed changes in these parameters after irradiation could be attributed to inhibited function of the digestive system of fed animals in the immediate postradiation period (within 1 h) and a manifestation of a stimulating effect 3 h after irradiation.

EFFECT OF ATTENUATED GEOMAGNETIC FIELD ON SOME PROPERTIES OF MICROORGANISMS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 141-143

[Article by O. A. Alferov]

[Text] The intensity of the magnetic field (MF) diminishes as one moves farther away from earth during space flights. Direct measurement of intensity of the magnetic field, taken aboard space vehicles, revealed that it ranges from 1 to 30 γ in the region of interplanetary space, 24-40 γ on the moon, and MF of Mars constitutes only 0.1% of the geomagnetic field (Heppner et al., 1963; Bumba, 1965; Cahill, 1965; Ness, 1965; Wilcox, 1966; Dolginov, 1968; Dyal, 1970).

The sparse data in the literature indicate that an attenuated geomagnetic field (AGMF) may alter the course of biological processes. However, several researchers deny the possibility that AGMF can affect biological objects (M. V. Vol'kinshteyn, 1977). Thus, this problem remains debatable, although it is very important to obtain a definitive answer to such a question (Michaelson, in "Fundamentals of Space Biology and Medicine").

Our objective was to investigate the influence of AGMF on some aspects of vital functions of microorganisms and to determine the extent to which the observed effect depends on duration of exposure to AGMF.

E. coli served as the object of our study. We obtained an AGMF by shielding the GMF with steel cylinders, which attenuated it by 160 times. After manufacturing the cylinders, they were heated to eliminate magnetic fields generated when handling them. The residual MF level in the cylinders constituted 200-300 γ, according to estimates and direct measurements, and it increased somewhat during days of magnetic perturbation.

The bacterial cultures were placed in the cylinders in such a manner as to be exposed to AGMF. Control cultures were raised under the usual conditions. The observations were usually made after 1, 5, 10, 20 and 40 daily passages of bacteria in the AGMF, and in the control on the same days during exposure to GMF.

We examined the effect of AGMF on growth, morphology and activity of some enzymes of E. coli, its resistance to deleterious factors, capacity to secrete lysozyme and incidence of spontaneous mutations. The total number of cells in the culture,

counted by the method of Vinogradskiy, served as the indicator of E. coli growth. We measured the dimensions of the cells with an ocular micrometer. Catalase activity was determined by the permanganate method and dehydrogenase by the method of Tunberg.

We tested antibiotic resistance of the bacteria by the method of serial dilutions, and resistance to phytoncides by the method of B. S. Drabkin.

We used the "lacuna" method (Bukharin et al.) to test the capacity to secrete lysozyme, and conventional methods to assay spontaneous mutations (J. Miller, 1976).

The obtained data revealed that AGMF affects several of the parameters of vital functions of E. coli. For the first 2 days, exposure to AGMF led to 17-21% inhibition of bacterial growth. Then the growth rate reached the control level and was 22-53% higher than the latter on the 13th-31st days. In the experiment, there was inhibition of growth by 11-20% between the 3d and 40th days. Cultivation of E. coli in an AGMF also caused a reduction in cell size. Thus, the length of the bacterial cell decreased by 29-50%, depending on how long the culture was exposed to AGMF. The width also decreased by 20-39%. The changes in growth and morphology in an AGMF are apparently due to metabolic changes that occur in bacterial cells under such conditions. For example, alcohol dehydrogenase and lactate dehydrogenase activity decreased by 20 and 22%, respectively, although there was no change in activity of catalase and formic dehydrogenase.

AGMF increased the resistance of E. coli to deleterious factors--ultraviolet rays, antibiotics and phytoncides--without affecting heat resistance of the bacteria. At some points in our study, resistance to ultraviolet rays increased by 5 times and to antibiotics (monomycin) by 2 times. Resistance to other antibiotics (streptomycin, morphocycline, oxytetracycline, ampicillin) increased by 20-60%, and E. coli became more sensitive only to ceparin.

In an AGMF, there is depression of lysozyme genesis, decrease in percentage of lysozyme secreting colonies in the E. coli culture.

Finally, AGMF increases the incidence of spontaneous, direct auxotrophic mutations. The incidence of mutations (quotient from dividing number of mutant colonies by total number of cells) was higher in the experiment than the control, in spite of the fact that the metal cylinder partially shielded bacteria from natural radiation also.

Analysis of the obtained data leads us to the conclusion that an AGMF is a biologically active environmental factor, which is capable of exerting a direct effect on living systems.

EFFECT OF ALTITUDE CONDITIONING ON MAN'S ENDURANCE OF ACUTE HYPOXIA AND OXYGENATION OF TISSUES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 143-145

[Article by Ye. A. Kovalenko, A. Yu. Katkov, V. N. Sementsov, S. A. Vtoryy, V. P. Krotov, E. S. Mailyan, G. P. Mikhaylovskiy and V. L. Popkov]

[Text] Conditioning to altitude in a pressure chamber is one way of enhancing resistance to hypoxia. The most effective variant thereof is the one where periodic increase and decrease of hypoxic factors are used in order to trigger compensatory antihypoxia mechanisms many times (M. A. Totrov, 1946; R. Riley, C. Houston, 1951; A. V. Yeremin et al., 1971; Ye. A. Kovalenko et al., 1978; A. A. Aydaraliyev, 1978).

We tested a method of 10-day conditioning in a pressure chamber for 6 h a day, with daily change in "altitudes" six times on the following program: "ascent" for 15 min to 5000 m, exposure to this "altitude" for 30 min, 5-min "ascent" to 6500 m, and "descent" to "earth" in 10 min. These studies were conducted on 17 men, 9 of whom underwent conditioning in the pressure chamber and the others served as a control. We determined endurance of acute hypoxia before and after conditioning: 1) during "climb" in the pressure chamber at the rate of 20 m/s and successive 10-min stays at "altitudes" of 5000, 6000, 7000, 8000, 9000 and 10,000 m; 2) while using pure nitrogen for breathing. The experiments were stopped if seizures, severe disturbances or loss of consciousness occurred. We made a continuous record of oxygen tension in the skin of the forearm by the polarographic method, using the Czech Oxymeter instrument in order to determine tissular oxygenation.

There was statistically reliable increase in erythrocytes per mm^3 blood (from 4,430,000±94,000 to 4,910,000±103,000) and hemoglobin (from 14.0±0.25 to 14.8±0.19%) under the influence of conditioning of the subjects in the pressure chamber. The radioisotope method also demonstrated a statistically reliable increase in erythrocyte mass and stroke volume of the heart. Overall time spent under conditions of progressive hypoxia in the pressure chamber increased reliably from an average of 35±1.2 to 49±2.0 min. The time spent at the final "altitude" increased from 5 min at 8000 m to 9 min at 9000 m. The control group of subjects involved in a second experiment (after 10 days) presented only a tendency toward increased total time spent under conditions of increasing hypoxia in the pressure chamber, from 34±2.5 to 39±2.2 min. After conditioning in the pressure chamber, the subjects' reaction

to hypoxia was characterized by less marked tachycardia, increased pulmonary ventilation due to depth of respiration, higher oxygen tension in capillary blood and the skin. By the time the altitude experiment was stopped, oxygen tension in the skin dropped from 52.6±8.4 to 8.5±1.38 mm Hg before conditioning in the chamber, and from 57.7±5.4 to 8.1±1.09 mm Hg after conditioning. In the control group, oxygen tension of the skin dropped to 9.5-9.6 mm Hg at lower altitudes.

There was virtually no change in time during which pure nitrogen was used for breathing under the influence of conditioning in the pressure chamber, and it constituted a mean of 60±6.6 s before conditioning versus 65±6.3 s after. Muscle seizures and loss of consciousness while breathing with pure nitrogen occurred at much higher oxygen tension in capillary blood and skin than in the case of staggered increase in hypoxia in the pressure chamber.

On the whole, the impression was gained that the increased resistance of the human body to acute hypoxia after conditioning in the pressure chamber was attributable primarily to optimization of the process of delivery of oxygen to tissues. Oxygen tension of the skin may be one of the important indicators of this process.

BLOOD CLOTTING AND ADRENOSYMPATHETIC SYSTEM REACTION TO NATURAL HYPOXIA COMBINED WITH ADVERSE TEMPERATURE FACTORS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 145-146

[Article by V. A. Isabayeva, T. A. Ponomareva and Dzh. Zakirov]

[Text] A study was made of parameters of hemostasis and activity of the adrenosympathetic system of man in a high altitude environment (3200 and 3600 m above sea level) and in experiments on animals submitted to uncomfortable temperatures (+4, +38°) for long periods of time at high altitude.

We demonstrated phasic changes in blood clotting processes in the mountains. In the acute phase of adaptation to high alitude there was typical anticipatory activation of the adrenosympathetic system (197% increase in epinephrine, 42% decrease in norepinephrine) followed by increased general coagulability of blood with intensification of cellular and tissular reaction of hemostasis and megakaryocytopoiesis (130% increase in adhesiveness of thrombosites, 95% increase in aggregation, 97% increase in clotting activity of thrombocytes). In addition, there was inhibition of plasma coagulating mechanisms of hemostasis (27% decrease in prothrombin, 36% decrease in factor V, 55% decrease in factor VIII and 60% decrease in factor XIII).

There was a decrease in activity of the adrenosympathetic system (22% decrease in epinephrine and 27% in norepinephrine) and development of a distinct state of hypocoagulation in the hemostasis system (deficiency of plasma coagulating element of hemostasis and thrombocyte hypofunction) with chronic exposure to mountain factors. These changes may play a decisive role, depending on the phase of adaptation, in origin of the thrombohemorrhagic syndrome.

Additional exposure to high and low temperatures, which elicited a moderate reaction by the adrenosympathetic system in the lowlands, caused marked activation of this system in the mountains (235% increase in epinephrine, 254% increase in norepinephrine) with inversion of the reaction to additional stimuli. Severe hypocoagulation of the consumption coagulopathy type was demonstrated in the system of hemostasis.

Correlation analysis demonstrated the functional correlation between hemostasis and the adrenosympathetic system under conditions of spontaneous acclimatization to high altitudes and dissociation thereof when the organism is exposed to the combined effect of extreme factors (hypoxia, low and high temperatures).

RAPID METHOD OF ENHANCING ANIMAL RESISTANCE TO HYPOXIC HYPOXIA AND OTHER EXTREME FACTORS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 146-147

[Article by V. B. Malkin, V. A. Smirnov, Ye. V. Loginova, N. F. Landukhova, A. S. Shanazarov and Ye. P. Gora]

[Text] Experiments on animals demonstrated the possibility of obtaining the effect of adaptation to acute and chronic hypoxia after brief conditioning "ascents" in a pressure chamber. These experiments showed that it is possible for early consolidation of the adaptation trace after conditioning ascents to 5000-9000 m and total exposure time of 100 to 300 min.

It was demonstrated that the conditioning mode is of substantial significance in forming the adaptation effect in a pressure chamber. Most effective was a variable mode consisting of numerous (up to 15-20 times) ascents in steps to altitudes of 8000-9000 m, where the plateaus lasted 1 to 3 min every 1000 m at altitudes of 5000 to 9000 m. After each conditioning cycle, i.e., ascent to maximum altitude, the animals were returned to normal barometric pressure for up to 3 min.

The stationary mode, in which the conditioned animals were constantly at the same altitude of 6500 m for 3 to 6 h elicited a relatively negligible effect, which could be enhanced by repeating such conditioning in the next 2-3 days.

The above conditioning modes led to a reliable increase in altitude resistance of conditioned animals, and this was usually the only indicator of the adaptation effect.

Rapid conditioning of animals in a drowsy state or asleep, induced by giving them elenium in a dosage of 50 mg/kg weight, revealed an adaptation effect--elevation of "altitude ceiling" of the same magnitude as control animals.

The increase in altitude resistance after high-speed conditioning is apparently due essentially to stimulation of nonspecific adaptation mechanisms (hypothalamus-hypophysis-adrenals), as indicated by the reliable increase in adrenal weight after conditioning. We cannot rule out the possibility of mechanisms of "autonomic memory" in development of adaptation to hypoxia.

This finding warrants the belief that such a conditioning method enhances animal resistance to various extreme factors--radial accelerations, high and low temperatures.

PHYSIOLOGICAL AND BIOCHEMICAL BASES FOR INCREASING RESISTANCE TO ACUTE HYPOXIA DURING COMBINED EXPOSURE TO HYPERCAPNIA, HYPOXIA AND EXTERNAL COOLING

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 147-148

[Article by Ye. M. Stabrovskiy, V. I. Bayev, A. S. Yegor'kova, V. I. Bertash, V. V. Vasil'yev and L. I. Yampol'skaya]

[Text] A method based on combined exposure to gradually increasing concentrations of CO_2 and decreasing concentrations of O_2, and external cooling is one of the means of increasing the body's resistance to acute hypoxia. The biochemical essence of the reaction was studied on the basis of changes in carbohydrate-phosphorus, energy, lipid and nitrogen metabolism in tissues of the brain, myocardium, liver, skeletal muscles and blood. It consists of enhancement of carboxylation processes in tissues. The presence of carbon dioxide is the decisive factor of the complex effect. Metabolism and the systems that regulate it undergo changes of a relaxation nature. With combined use of hypercapnia, hypoxia and cooling, morphohistochemical and radioimmunological studies (ACTH, T_3, T_4, cortisol, thyrotropic hormone, testosterone and other hormones) were made of interaction between the endocrine glands. It was found that the availability of substrates of oxidation to tissues under experimental conditions was apparently the prime factor of interaction between biochemical phenomena and state of the hormonal element of regulation of metabolism, and this is of some interest, not only from the standpoint of general physiology, but system theory. Mathematical models (M-20 computer) were proposed for changes in a number of biochemical parameters and prevailing environmental factors. Equations were discussed, on the example of nonlinear correlation between ACTH and cortisol, that make it possible to simulate cybernetically the processes of biosynthesis of adrenocortical hormones during exposure to a given factor.

The discussed changes and patterns are proposed as the physiological and biochemical basis for increasing resistance to acute hypoxia under the combined effect of the above-mentioned factors.

DYNAMICS OF ZINC AND COPPER EXCRETION IN URINE DURING SIMULATION OF THE EFFECTS OF HYPOXIA AND NOISE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 148-149

[Article by A. A. Bochenkov]

[Text] It is known that the levels of trace elements in tissues and organs affect the functional state of the organism, increasing or decreasing its resistance to adverse factors. For this reason, it is of some interest to investigate excretion of zinc and copper in subjects during simulation of some of the conditions of long-term flights.

We tested 8 men 28-30 years of age, who participated in 16 experiments. Urine was collected in the morning before the experiment (0800 hours), after 8 h (1700 hours) and 12 h (2200 hours) of exposure to hypoxia in a pressure chamber (3000 m) and noise (96 dB). After the experiment, urine was collected on the morning of the following day (0800 hours). We used the polarographic method to assay zinc and copper in urine, and excretion thereof was calculated per hour and 100 mg creatinine* assayed in the same batch of urine.

The results of this study revealed that there was maximum zinc excretion in the morning prior to exposure (43±2.4 μg/h or 68.3±13.9 μg/100 mg creatinine). After exposure to the combined factors for 8 h, there was significant decrease in excretion of zinc (14.4±0.2 μg/h or 23.4±0.24 μg/100 mg creatinine) followed by gradual increase, which constituted 33.3±2.6 μg/h or 43±2.7 μg/100 mg creatinine after 12 h. On the following morning, zinc excretion was virtually on the base level (48.5± 2.3 μg/h or 58±3.3 μg/100 mg creatinine). The dynamics of copper excretion were somewhat different. Maximum excretion was also noted on the morning before exposure (21.2±1.6 μg/h or 35.1±4.2 μg/100 mg creatinine), after which it progressively decreased. After 8 h, copper excretion constituted 18.7±0.2 μg/h or 24±0.1 μg/100 mg creatinine and after 12 h, 17.1±3 μg/h or 27±0.23/100 mg creatinine. On the following morning, copper excretion remained significantly diminished (14.2±0.13 μg/h or 19±0.15 μg/100 mg creatinine. The close link between zinc and copper, on the one hand, and activity of oxidative processes, on the other, suggests that the decreased excretion of zinc and copper during the experiment was attributable to retention due to activation of enzymatic systems involved in adaptation of the organism to moderate hypoxia. After 10 h of rest following exposure, the functional changes due to the set of factors did not revert entirely to normal, since copper excretion at this time was significantly lower than the initial levels.

*Translator's note: the unit for creatinine is indicated as milligram and microgram in source, as rendered.

ADENYLIC SYSTEM OF THE ANIMAL BRAIN IN THE PRESENCE OF ACUTE ALTITUDE HYPOXIA

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 149-151

[Article by N. N. Ivkov, A. M. Dudchenko, Yu. I. Naumov and A. I. Mukhankin]

[Text] At the present time it is common knowledge that impaired delivery of oxygen to body tissues leads, first of all, to a shortage of energy in cells. The order of development of disturbances on the level of the entire organism under conditions of acute hypoxia or anoxia will be determined primarily by the tissues and cells that require a large influx of energy to perform their specific functions. As we know, these tissues include nerve tissue primarily, and of this tissue, that of the cerebral cortex. On the other hand, several studies of animal resistance to acute hypoxia demonstrated differences in sensitivity of specimens of the same species to a shortage of oxygen. For this reason, we undertook assays of ATP, ADP, AMP, inorganic phosphate and cAMP in the brain of rats differing drastically in sensitivity to an oxygen shortage (interval between time at which an altitude of 12,000 m was reached to onset of signs of agony--4-6 min for rats with low resistance and 25-30 min in rats with high resistance).

We assayed adenine nucleotides of the animals' brain by means of standard reagent kits supplied by the Beringer Firm, FRG, while cAMP was measured by the radioimmunological method using the kit of reagents manufactured by the Amersham Firm, England.

These studies revealed that there was a reliable 52% decrease in ATP content at an altitude of 12,000 m in animals with low resistance to oxygen shortage--the "nonresistant" animals, ADP dropped by 20%, AMP rose by 71% and P_i [inorganic] increased by 57%. Under the same conditions, there was only a 12% drop in ATP content of the brain of animals with high resistance to oxygen deficiency, i.e., the "resistant" ones, while ADP content increased by 25%, the increase in AMP and P_i being less marked, constituting 36% and 15% above the control levels.

We assayed cAMP of the rat brain without prior separation of the animals into "resistant" and "nonresistant" groups. At an altitude of 12,000 m, cAMP of the rat brain constituted about 75% of the control level. It was also demonstrated that the rate of ascent also had a substantial effect on cAMP content of the rat brain.

The obtained experimental data are a direct indication of the fact that the survival time of animals with acute hypoxia depends appreciably on the stable concentration

of macroergic compounds in tissues. Moreover, the decline of cAMP level in brain tissue is indicative of a significant shortage of ATP, since stress factors, which include in particular hypoxia, should usually elicit elevation of cAMP level.

CHARACTERISTICS OF THE ORGANISM'S ADAPTATION SYSTEM IN THE PRESENCE OF CHRONIC HYPOBARIC HYPOXIA

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 151-152

[Article by V. I. Korol'kov, V. P. Krotov, Yu. V. Gordeyev, V. V. Vasil'yeva, M. A. Dotsenko, I.I. Britvan and G. V. Letyagina]

[Text] The nonspecific resistance of an organism increases with adaptation to hypoxia. However, the time an organism has to spend under hypoxic conditions to achieve stable adaptation has not yet been clearly defined. In the opinion of a number of authors, reaching the phase of stabilization of function of vital systems is a criterion of such adaptation (M. M. Mirrakhimov, 1966; M. M. Mirrakhimov et al., 1970). For this reason, our objective was to define the time of occurrence of the phase of stabilization of nonspecific reactions of the organism during the period of long-term conditioning to hypobaric hypoxia.

Experiments were conducted on 245 rats submitted to hypobaric hypoxia for 37 days to examine the parameters of morphological composition and acid-base equilibrium of blood, weight characteristics of the "target" organs--the thymus and adrenals, concentration of 11-hydroxycorticosteroids, aldosterone and renin by the radioimmunological method; we also determined total body fluid, mass of circulating blood and its components, and amount of adipose tissue.

For the first 2 weeks, there was some retardation of weight gain in experimental animals, as compared to the control, drastic increase in number of erythrocytes and reticulocytes, as well as hemoglobin, with development of respiratory alkalosis and metabolic acidosis, with prevalence of the latter (pH shift in the direction of acidity), increase in total and free 11-hydroxycorticosteroids, decrease in blood aldosterone content, some decrease in weight of the thymus and increase in weight of the adrenals. There was a distorted reaction by the hypothalamohypophyseo-adrenal system to the insulin test, as manifested by a decrease in both free and total 11-hydroxycorticosteroids in response to administration of insulin.

In the next 2 weeks of the experiment, we observed a tendency toward normalization of most of the parameters studied. The latter reached the base level, or else did not differ from values obtained for control animals in the 5th week of conditioning to hypobaric hypoxia. During this period, the differences between experimental and control animals disappeared, with regard to both the specific reactions to hypoxia (reticulocyte content, acid-base equilibrium of blood) and nonspecific

ones (body weight, weight of "target" organs, concentration of aldosterone, renin, 11-hydroxycorticosteroids and reaction of the hypothalamohypophysioadrenal system to the insulin test). Total body fluid and circulating plasma volume did not differ from the control.

Thus, the obtained data indicate that nonspecific reactions to hypoxia revert to normal only in the 5th week of conditioning, i.e., in our opinion this period of time can be considered as the period of occurrence of stable adaptation to hypobaric hypoxia.

MORPHOLOGICAL BASES OF STRUCTURAL AND METABOLIC PROCESSES OF MYOCARDIAL ADAPTATION TO ALTITUDE HYPOXIA

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 152-153

[Article by V. A. Kononova]

[Text] An experimental study was made of processes of adaptation of the animal myocardium to altitude hypoxia (Tuya-Ashu pass, 3200 m above sea level). Experiments were conducted with 230 rats on the 1st, 3d, 7th, 15th, 30th and 45th days in the mountains. Morphometric studies were pursued: separate weighing of the heart, determination of cross section area of muscle fibers and their nuclei, percentile ratio between area of the microcirculatory vascular bed and myocytes in the left and right ventricles of the heart. Histological, histoenzymatic and electron microscopy methods were used. There were 20 animals (in Frunze, 760 m above sea level) that served as a control. Analysis of the obtained data established the following:

1. An increase in absolute weight of the heart, due to hypertrophy of the left and mainly right ventricular myocardium, was the structural manifestation of adaptive reactions of the circulatory system to altitude hypoxia. There was progressive increase in absolute weight of the right ventricle, cardiac and ventricular indexes, and area of cross section of muscle fibers at each stage of the experiment.

2. Concurrently with increasing hypertrophy, there was intensification of myocardial vascularization in the right ventricle. This was indicated by the increase in area of the arterial part of the microcirculatory vascular bed.

3. Altitude hypoxia elicited damage to muscle fibers, connective tissue and vessels of the rat heart, and it occurred in stages. At the early stages of adaptation (1st-15th day of experiment), along with compensatory changes in the rat myocardium there were destructive and necrobiotic changes, which were dominant. There was drastic decrease in activity of a number of redox enzymes in the myocardium (succinate dehydrogenase, cytochromoxidase, NAD diaphorase, ATP and others), glycogen and build-up of processes of anaerobic glycolysis. Ultrastructural organization of myocytes was impaired.

During the second stage of adaptation to hypoxia (30th-45th experimental days), there was more distinct manifestation of compensatory changes in the rat myocardium, manifested by activation of enzymatic system, increase in glycogen content and gradual involution of destructive changes.

However, the second stage of the experiments cannot be considered the period of complete adaptation of animals to altitude hypoxia, since normalization of metabolic and structural processes did not occur in the rat myocardium.

ALTERED GAS ATMOSPHERE AND COOLING AS FACTORS DETERMINING RESISTANCE OF ORGANISMS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 154-155

[Article by S. S. Mogutov, V. I. Bertash, A. M. Zaychik, V. P. Yevgraf'yev, Ye. S. Sergeyeva and V. F. Shtrom]

[Text] A complex study was made of the pathophysiological mechanisms determining the increase in resistance to extreme environmental factors. Radioimmunological, fluorimetric and morphological methods were used to examine endocrine regulation in animals on different levels: hypothalamus-hypophysis, epiphysis, tropic hormones and target organs.

It was established that the change in resistance, which was observed after exposure to combined factors (hypothermia, hypoxia, hypercapnia), is attributable to the nature of reactions of endocrine glands. There were distinct stages of change in activity of supraoptical and paraventricular nuclei of the hypothalamus and epiphyseal pinealocytes. There was impairment of patterns of secretory orientation of cells in the anterior lobe of the pituitary. At different stages of cooling, changes in different directions or the same direction were demonstrated in concentrations of various tropic hormones of the hypophysis (ACTH, thyrotropic hormone, follicle-stimulating hormone, luteinizing hormone). There was a change in hormone secretion (T_3 and T_4, corticosterone and cortisol) by the target organs--follicular epithelium of the thyroid and adrenal cortex. At different stages of cooling, the changes in endocrine status conformed with the levels of oxygen uptake muscle and brain tissue. The functional efficiency of vital systems (cardiovascular, respiratory) was determined, to some extent, by adequacy of humoral changes in response to hypothermia, hypoxia and hypercapnia.

These studies demonstrated the feasibility of using different combinations of these environmental factors for the purpose of deliberately changing the activity of the endocrine system and, accordingly, the cardiovascular and respiratory systems, when developing methods to enhance the body's resistance to extreme environmental factors. The obtained experimental data can be also used to validate methods of hormone therapy in the overall set of measures used to bring the organism out of life-threatening states caused by the combined effect of the above factors.

USE OF RHEOGRAPHY TO ASSESS MAN'S RESISTANCE TO HEAT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) p 155

[Article by Ye. I. Kuznets, V. A. Zinochkin and E. V. Yakovleva]

[Text] Bipolar rheography was used to evaluate circulation and vascular tonus in the brain, liver and peripheral tissues when man is submitted to overheating.

Experiments were conducted in a heat and moisture chamber at air temperature of +50° and relative humidity of 25%. In the first series of tests, the subjects were in the chamber in a state of relative rest and in the second series they performed physical work corresponding to 40 W intensity. The experiments ended when the subject developed a maximum heat state. In all, we conducted 85 experiments involving 24 volunteer subjects.

These studies revealed that consideration of the dynamics of pulsed delivery of blood to regional vessels enables us to describe the efficiency of circulatory system function in the presence of heat stress. The rate of decrease in tonus of cerebral and peripheral vessels can serve as an indicator of the "cost" of control of overheating of the body, while the degree of change in rheographic parameters with increment of rectal temperature of 1°C from the base level provides information about the endurance of hyperthermia by subjects differing in heat resistance.

Thus, the use of rheography in practical expertise permits more objective evaluation of individual resistance to heat in individuals for whom greater requirements prevail with respect to such resistance. In our opinion, use of the rheographic method will aid in refining the medical support of space flights.

SOME OF THE EFFECTS ON MAN OF 'STEPPED' HYPERCAPNIA AS RELATED TO DIFFERENT LEVELS OF HYPOXIA

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 156-158

[Article by L. Kh. Bragin and A. I. Yelfimov]

[Text] There are reports in the Soviet and foreign literature that "stepped" [changing in steps] hypercapnia against the background of hypoxia has an effect on man (N. A. Agadzhanyan et al., 1977; Maheretal, 1975, and others). In our study here, the purpose of which was to determine the optimum concentration of carbon dioxide with different levels of hypoxia, some effects on man were demonstrated of the selected concentrations of carbon dioxide and oxygen in inhaled air. This study was conducted on 8 male subjects 24-30 years of age in a state of relative rest, sitting in a chair, at normal atmospheric pressure and ambient temperature of 20±2°C. At first, the subject breathed with atmospheric air for 15-30 min. At the end of this period, we measured physiological function parameters; then we changed to a gas mixture for respiration with P_{CO_2} 19 and P_{O_2} 160 mm Hg. Then we changed successively to breathing mixtures with P_{O_2} 160 and P_{CO_2} 38 and 57 mm Hg. The subject breathed with each mixture for 15 min (up to 30 min). In the next series of tests, in the presence of hypoxia of 130 mm Hg, the subject successively passed through the same hypercapnic "steps" (P_{CO_2} = 19, 38 and 57 mm Hg) as in the next two series against the background of 100 and 70 mm Hg hypoxia. At the end of each hypercapnic "step" we took readings of physiological information. The data listed in Table 1 indicate that one can obtain the same oxygen tension in capillary blood with different combinations of P_{O_2} and P_{CO_2} in inhaled air; for example, Pa_{O_2} constituted a mean of 61.2-63.4 mm Hg with either P_{O_2} = 70 and P_{CO_2} = 57 mm Hg, or with P_{O_2} = 100 and P_{CO_2} = 19 mm Hg. We see here the effect of "reduction" of altitude to one-half and carbon dioxide to one-third. At the same time, Pa_{O_2} (76.9 mm Hg) with P_{O_2} = 100 and P_{CO_2} = 57 mm Hg coincided with the Pa_{O_2} observed in the subjects with P_{O_2} = 130 mm Hg, both without addition of carbon dioxide and with increase in P_{CO_2} to 19 and 38 mm Hg. Here there was a "reduction" effect to one-half. With P_{CO_2} = 57 and P_{O_2} = 130 mm Hg in inhaled air, Pa_{O_2} (83.0 mm Hg) coincided with oxygen tension of capillary blood at sea level (84.0 mm Hg). Pulmonary ventilation demonstrated a close relation to these changes: regardless of level of hypoxia, inhalation of mixtures with P_{CO_2} 57, 38 and 19 mm Hg consistently increased minute volume. Inhalation of mixtures with P_{CO_2} = 57 mm Hg increased minute volume by 3.4-3.8 times, as compared to inhalation of mixtures with P_{CO_2} 19 mm Hg, whereas with inhalation of mixtures with P_{CO_2} = 38 mm Hg, minute volume increased by 2.2-2.9 times, as compared to the values obtained without adding

carbon dioxide to inhaled air. Thus, we demonstrated a distinct correlation between Pa_{O_2} and pulmonary ventilation, which regulates it. Table 1 also shows that one must add 5% CO_2 (38 mm Hg) to inhaled air at an "altitude" of 6420 m in order to obtain the same Pa_{O_2} as at an "altitude" of 3200 m without addition of CO_2. We cannot fail to note that breathing mixtures with P_{CO_2} = 57 mm Hg elicited an appreciable increase in HR [heart rate] and elevation of AP [arterial pressure], both systolic and diastolic, although the changes were not significant.

Table 1.

P_{O_2}	84 mm Hg	77 mm Hg	61-63 mm Hg	55 mm Hg
P_{O_2}/P_{CO_2}	160/0; 130/57	130/0; 19; 38; 100/57	100/19; 70/57	100/0; 70/38
MV, ℓ BTP/min	7.4; 36.9	6.9; 11.1; 37.8; 20.9	9.8; 38.0	8.5; 18.7
Altitude, m	0 1600	1600-3200	3200-6420	3200-6420
HR	68 76	69; 68; 70; 82	71 82	69 78
AP	116/79 135/81	120/76; 118/77; 130/89; 125/81	117/83 130/79	116/78 112/79

These data suggest that carbon dioxide has a corrective effect on oxygen-supplying function of blood in man with the above-mentioned levels of hypoxia.

POSSIBLE USE OF HYPERBARIC OXYGENATION IN AEROSPACE MEDICAL PRACTICE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 158-159

[Article by I. N. Chernyakov, V. I. Prodin and P. Ya. Azhevskiy]

[Text] The possibility of using hyperbaric oxygenation as a means of curbing disturbances caused by decompression is given experimental validation on the example of effective treatment of caisson's disease and barotrauma of the lungs by using oxygen at 3 atm pressure for breathing.

A severe form (paresis and paralysis of the extremities, respiratory and functional cardiac disturbances) of altitude sickness was induced in dogs and rats used in pressure chamber experiments. In addition, we simulated barotrauma to the lungs of dogs by means of decompression from 4 to 1 atm within 6-10 s, as a model of the conditions of abandoning a sinking flying vehicle at the surfacing stage. Barotrauma of the lungs developed with the typical signs of massive air embolisms, pneumohemothorax, tissular emphysema, functional disturbances of the cardiovascular and respiratory systems.

Animals with persistent symptoms of caisson's disease and pulmonary barotrauma were treated with hyperbaric oxygenation (breathing oxygen at pressure of 3 atm for 1 h). Periodically, we changed from oxygen to air for breathing for 5 min, every 10 min, to prevent oxygen toxicity.

Hyperbaric oxygenation eliminated entirely or partially the symptoms of decompression disorders in most animals. It was also demonstrated that these symptoms were curbed more completely with hyperbaric oxygenation than therapeutic recompression with air.

In studies involving people, regimens of hyperbaric oxygenation were developed (90, 180 and 360 min) that were safe with respect to oxygen toxicity and suitable for arresting altitude sickness and barotrauma of the human lung in the event of development thereof in pressure chamber experiments or in flight.

There is validation of the desirability of continued research on evaluation of efficacy of hyperbaric oxygenation to also treat other forms of oxygenation disorders induced by flight factors (motion sickness, hypodynamia, chronic overfatigue), with due consideration of the main elements in the mechanism of the therapeutic effect of hyperbaric oxygenation (elimination of hypoxia and acidosis of tissues,

restoration of depressed metabolism and improvement of microcirculation) and the broad spectrum of its effects, as well as safety with respect to oxygen toxicity, in the modes we developed.

The successful solution of these problems will arm aerospace medicine with a new effective means of restoring the health of pilots and cosmonauts.

EMERGENCY TREATMENT OF ACUTELY DEVELOPING ALTITUDE SICKNESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 159-161

[Article by R. Yu. Abbasov and E. V. Bondarev]

[Text] It is known that meteorism, abdominal pain, nausea, vomiting (occasionally bloody), loose stool and, in rare cases, acute abdomen are observed in individuals with decompression disorders.

It is interesting to study external secretory function of the pancreas, both to gain understanding of the mechanism of development of the above clinical signs and from the standpoint of possible effects of changes therein on pathophysiological reactions of the organism.

We studied the exocrine function of the pancreas of 46 healthy subjects who participated in experiments in a pressure chamber lasting 10-12 h. Altitude decompression disorders (ADD) developed in 17 subjects when barometric pressure was lowered.

We tested pancreatic exocrine function under hospital conditions before the experiment and 11-14 h after it ended.

We examined proteolytic activity in blood and assayed trypsin inhibitors in serum (method of Erlanger-Shaternikov); we measured lipolytic activity (method of Natel'son) and amylolytic activity (method of Smith-Roy in the modification of A. M. Ugolev). We tested proteolytic activity and inhibitors of trypsin and diastase in urine.

The obtained digital material was processed by the nonparametric statistical method.

Substantial differences were demonstrated when we compared the parameters of exocrine activity of the pancreas before and after the experiment between subjects who endured the test without complications and with ADD. It should be noted that lipolytic and proteolytic activity of blood was several times higher after the experiment in subjects with ADD than in those who endured the test without complications. In the latter, lipolytic activity increased by a mean of 0.08 conventional units/mℓ, proteolytic by 3.12 μM/mℓ, versus increases of 0.42 conventional units/mℓ and 6.60 μM/mℓ, respectively in subjects with ADD. There was a more marked increase in trypsin inhibitors of blood in subjects without complications (140.8 μM/mℓ) than those with ADD (80.0 μM/mℓ).

A study of the changes in proteolytic activity in urine and concentration of trypsin inhibitors before and after the experiment revealed a reliable increase ($P<0.01$).

On the whole, examination of the nature of differences in exocrine function of the pancreas revealed that the increase in enzymatic activity of duodenal contents and proteolytic activity of blood was of dominant significance in subjects with ADD, whereas in those who endured the experiment without complications there was more marked increase in secretion and bicarbonate alkalinity of duodenal contents and trypsin inhibitors of blood.

According to the foregoing, there is impairment of the physiological correlation between proteolytic activity of blood and inhibitors thereof in favor of the former (1:25 with development of ADD, versus 1:50 before the experiment) in subjects with ADD, which could have aggravating clinicopathophysiological sequelae.

Pathogenetically, testing and use of protease inhibitors (trasylol, contrical, pantrypin and others) as immediate measures are warranted for the prevention and elimination of possible pathophysiological reactions with acute development of ADD.

STUDY OF PARTIAL OXYGEN TENSION OF HUMAN BLOOD WHEN USING OXYGEN AT EXCESS PRESSURE FOR BREATHING

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) p 161

[Article by I. D. Yertanov and M. M. Kvasova]

[Text] Our objective was to determine partial oxygen tension of blood as one of the criteria of oxygen supply when using altitude-compensating gear.

For this purpose we studied partial oxygen tension of blood when breathing with oxygen at uncompensated excess pressure of 10, 20 and 30 mm Hg for 3 min. We collected numerous samples of blood from the finger for analysis on a micro-Astrup instrument.

The parameter under study increased for 3 min when using oxygen for breathing at uncompensated excess pressure of 10 and 20 mm Hg. With excess pressure of 30 mm Hg, partial oxygen tension of blood increased only for the first 2 min, and decreased in the 3d min. This could probably be due to hemodynamic disturbances related to difficulty of venous return to the heart.

We also examined partial oxygen tesnion of blood with the use of altitude-compensating gear providing for pneumomechanical counterpressure in the region of the trunk and lower extremities, with excess pressure in the breathing system of 30, 40 and 60 mm Hg for 3 min.

Use of compensating gear raised significantly partial oxygen tension of blood. The change in partial oxygen tension of blood with the highest excess pressure (60 mm Hg) reflected to a substantial degree the efficacy of the altitude-compensating gear.

MEANS OF IMPROVING RESISTANCE TO EXTREME ENVIRONMENTAL FACTORS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 162-163

[Article by A. A. Aydaraliyev]

[Text] We know that acclimatization of man to high altitude enhances his resistance to a number of deleterious environmental factors.

There is also information indicative of the beneficial effect of pressure chamber conditioning on resistance of the organism.

Studies of recent years demonstrated that stepped [in steps] adaptation to the mountains is more effective than nonstepped (A. N. Krasyuk, 1969, 1974; O. N. Narbekov, 1970; V. I. Korol'kov, V. V. Verigo, 1975).

Thus, there is no question that hypoxia has a beneficial effect on resistance, but the optimum regimen of hypoxia conditioning has not yet been determined.

The above-mentioned methods used to increase resistance can be enhanced (potentiated) by other measures. In particular, some environmental factors may elicit similar reactions of various systems of the organism, and adaptation to one factor may sometimes have a beneficial effect on resistance to another. Our study revealed that such cross adaptation may be positive or negative.

In particular, we demonstrated a synergistic effect with stepped movement to the mountains after prior adaptation to high ambient temperatures.

The studies revealed that adaptation to high altitude is individual. It was found that one can predict the nature and direction of adaptive reactions from the body's response to the standard bicycle ergometer test, which makes it possible to screen individuals for work in the mountains and condition them to increase resistance.

In some cases, it is necessary to condition people very rapidly for a move to high altitude regions in order to avert the adverse signs that could appear under such conditions (acute edema of the lungs, acute altitude sickness, etc.). Our studies (A. A. Aydaraliyev, A. S. Shanazarov, 1977) revealed that the method we developed for "high speed" conditioning permits significant enhancement of altitude resistance within a short time. This method may also be useful when it is necessary to maintain a high degree of resistance to extreme environmental factors for a long time, up to 3-4 months.

USE OF MEANS OF EXTERNAL HEAT REGULATION TO IMPROVE OPERATOR EFFICIENCY AT LOW AMBIENT TEMPERATURES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 163-164

[Article by V. N. Ishutin, V. I. Kopanev and V. G. Chvyrev]

[Text] A study was made of the extent of effect of overcooling of man on the quality of his operator performance in order to work out physiological and hygienic specifications for external heat-regulating equipment.

We selected accuracy and reliability of control, as well as structure of mistakes in tracking and control performance simulated with the "Device for two-dimensional compensatory tracking" as an indicator characterizing the level of operator efficiency. We measured the maximum muscular exertion of contraposition of the first and fifth fingers to examine the functional state and efficiency of autochtonic muscules of the hand.

The studies (62 experiments) were conducted in a climate chamber with air and wall temperature of -10÷-40°C and velocity of air of up to 0.5 m/s with the subjects at relative rest without and with the use of an individual automatic electric heat-insulating system (EHIS). EHIS was used in combination with winter and special fall-spring clothing.

EHIS consisted of an electrically heated coverall with gloves, boots and helmet, the circuitry of which is divided into six sections with self-contained differentiated automatic regulation of air temperature under the clothing. The EHIS is powered with 27 V and maximum power (when using fall-spring clothing at -40°C) of 130 W.

In the presence of grade I overcooling (in the classification of V. I. Krichagin, 1965), there was negligible decline of accuracy and reliability of operator work over a 2-h period, and an increase in total number of mistakes, whereas duration and magnitude of the latter decreased. With grades II and III overcooling, there was 20-33% decline of control reliability and total number of mistakes decreased, but there was significant increase in their duration and magnitude. The coefficient of correlation between reliability of control and heat content of operators constituted 0.82. Maximum muscular exertion in contraposition of the first and fifth fingers depended more on temperature of the skin of the hand. With significant

cooling of the hands (to 15°C or lower) maximum muscular exertion was 35-40% lower than the base level.

Use of EHIS at low ambient temperature maintained at a comfortable level the thermal status of operators and skin temperature of the hand. Accuracy, reliability of control and strength of autochtonic muscles of the hand remained at the optimum level.

Thus, means of external heat regulation based on autonomic differentiation heat insulation with automatic regulation of electricity used make it possible to maintain a comfortable thermal state and high operator efficiency for a long time in the presence of low negative ambient temperatures.

FUNCTIONAL STATE OF THE ADRENALS DURING MAN'S ACCLIMATIZATION TO CENTRAL ANTARCTICA

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 164-165

[Article by V. P. Khmel'kov, A. F. Zavadovskiy, L. I. Voronin and I. P. Mikheyeva]

[Text] The neurohumoral system and the hypothalamo-hypophyseo-adrenal system play a substantial role in adaptive reactions of the body and maintenance of stable internal environment. When the body is exposed to various extreme factors there is intensification of function of endocrine glands, primarily the sympathoadrenal system and adrenal cortex (R. A. Tigranyan, N. A. Davydova, 1976; V. P. Khmel'kov, 1977; N. F. Kalita, 1977, and others). For this reason, it is very interesting to study adrenocortical function of man when exposed to exceptionally unusual and difficult living conditions.

We examined here hormonal activity of the adrenals of polar research workers who participated in the 12th and 17th antarctic expeditions at different periods of their stay at the Vostok intracontinental station. We assayed 17-hydroxicorticosteroids [17-HC] and 11-hydroxicorticosteroids [11-HC] in blood and excretion thereof in urine of 38 research workers. A comparison of the results of tests made in the period prior to the expedition during the sea voyage there, in the first month at the station, during the period of polar night and last month at the station revealed several changes, the most important of which are as follows. While passing through the tropical zone and antarctic waters there was an appreciable increase in 11-HC and 17-HC content in blood and excretion in urine. During the first month in the antarctic region blood serum 17-HC increased even more, beyond the normal range, while 17-HC excretion in urine did not differ appreciably from the data obtained during the voyage. In subsequent periods, there was no appreciable difference between 17-HC and 11-HC content of blood and data obtained on the ship. The gradual increase in excretion of 17-HC and 11-HC in urine in the 4th-8th months of the stay in Antarctica, during the period of polar night and at the peak of the winter corresponding to the most rigorous time of year, was indicative of marked functional strain of the adrenal cortex. There was some decrease in 17-HC and 11-HC in urine in the last months of the expedition, but they remained above base levels.

These data are indicative of development of certain acclimatization changes in hormonal activity of the adrenals, which are determined primarily by changes in central regulatory mechanisms (hypothalamus-hypophysis system) leading, first of all, to a chnage in production of adrenocorticotropic hormone of the pituitary at different stages of the expedition.

The most marked disturbances of corticosteroid metabolism were observed during the sea voyage, the first month at Vostok, during the period of polar night and the last month of the expedition, which was apparently related to significant nervous and emotional tension, since the subjects were exposed to diverse physical and mental stressors at this time (drastic change in climate and time zones, hypoxia, isolation, etc.).

At the same time, we were impressed by the fact that there was no complete parallel between 17-HC and 11-HC content of blood and excretion thereof in urine.

The obtained data concerning the state of adrenal glucocorticoid function during exposure to extreme stimuli enable us to evaluate development of adaptive reactions under unusual living conditions.

MAN'S ENDURANCE OF LOCAL CONVECTIVE HEAT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 166-167

[Article by A. A. Sheykin and V. A. Savost'yanov]

[Text] Endurance of a turbulent (Re ≈3000) jet of hot air directed over the normal to the surface of the body, hand and flexing surface of the forearm was tested in 78 experiments on 7 subjects. The main characteristics of the parameters of the test factor were: temperature of jet of air (t_j) at skin surface 45+60°C, rate of delivery of air from a nozzle 6 mm in diameter 10 m/s, effective area of influence of the jet on the skin ≈1 cm^2, total ["braking"] pressure 8 mm water column and static pressure 0.4 mm water column, which were similar in values to the parameters of air leaking out of the outlets in the ventilation system of the flight gear.

The coefficient of heat emission (h) and heat flow (Q) were determined experimentally by the calorimetric method (Huang, 1963).

The subjects' subjective sensations served as criteria of endurance, using the time of appearance of a "burning" sensation (τ_b) to determine maximum permissible exposure time, while the period preceding appearance of pain (τ_p) was considered to be the maximum permissible exposure time. Skin temperature (t_s) at the time of appearance of "burning" (t_b) and pain (t_p), the dynamics of t_s, as well as latency period of development of erythema, were used for objective evaluation of endurance. We measured t_s prior to exposure and immediately after it with an Elabb electric thermometer (sensitivity of 0.1°C, time constant 1-2 s).

Air temperature in the room constituted 15-18°C.

It was established that h increases linearly from 140 to 180 kcal/m^2/h/degree and Q increases from 5 to 8 kcal/cm^2/min as t_j rises from 45 to 60°C; at the start of exposure, h and Q are unrelated to the target of the jet, i.e., skin or sensor.

At t_j 45°C to the hand, τ_b constitutes at least 2 min; at t_j 50, 55 and 60°C, τ_b lasts at least 15, 6 and 5 s; at t_j 55 and 60°C, τ_p constitutes 14.7±2.7 and 11.2±0.9 s ($P_{0,95}$). For the forearm, τ_b and τ_p were somewhat lower than for the hand.

It was demonstrated that t_b and t_p are about the same for the hand and forearm, and they drop by 1-2°C with elevation of t_j from 50 to 60°C.

In the case of t_j 45°C, the "burning" sensation is preceded by development of erythema, whereas with t_j above 50°C "burning" and pain precede development of erythema.

THE PROBLEM OF STRESS AND PREVENTION THEREOF IN SPACE MEDICINE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 167-168

[Article by B. M. Fedorov, L. G. Polevoy, N. A. Podrezova, V. V. Tkachev and T. M. Sinitsyna]

[Text] During space flights man is exposed to a set of stressors, which include the following: 1) emotional factors; b) intensive intellectual work in rigidly limited time; c) drastic changes in circadian rhythms; d) changes in physiological functions, particularly those caused by weightlessness (in particular, redistribution of blood in the body), etc. We consider stress to be a generalized tension reaction that occurs under the effect of factors that are a threat to well-being or require significant mobilization of adaptive capabilities to an extent that exceeds significantly the range of ordinary fluctuations. The stressor reaction has a marked effect on man's general condition and his reactivity. A combination of factors that induce stressor reactions is capable of aggravating their course, increasing vulnerability of the organism and causing qualitative distinctions of stress.

Under ground-based conditions, we demonstrated that a decrease in motor activity increases drastically vulnerability under stress conditions. To prevent stressor reactions it is of substantial importance to maintain a high level of motor activity. However, in a number of cases, this is not sufficient and pharmacological agents must be used to obtain a preventive antistressor effect. We tested the efficacy of such agents on model stressor reactions to factors that required intensive intellectual work with a shortage of time and requiring switching of attention. Of the diverse objective indicators of stress reactions, such as changes in catecholamine and corticosteroid content of blood, galvanic skin response, changes in respiration and circulation, we wish to stress in particular the significant informativeness of parameters of arterial pressure and the EKG when they are recorded continuously. Of the agents we tested in our quest for pharmacological approaches to the prevention of stress, we found that fenibut had the most marked effect, seduxen was less effective and fopiron even less so. Nobrium, which is referable to derivatives of the benzodiazepine class, like seduxen, had no beneficial effect.

In searching for methods of preventing stress reactions, it is important to attenuate the anxiety reaction without affecting adversely intellectual performance and attention. It is imperative to bear in mind that emotional tonus plays a secondary role with respect to the success of man's work performance.

STATE OF BLOOD COAGULATION AND ANTICOAGULATION SYSTEM IN THE PRESENCE OF ACUTE EMOTIONAL STRESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 168-169

[Article by Yu. A. Vares]

[Text] The studies of B. A. Kudryashov (1971, 1972), Ye. A. Chazov and V. T. Anan'chenko (1963) are indicative of a close link between blood coagulation and anticoagulation, on the one hand, and adaptive reactions, on the other.

We studied the dynamics of electrocoagulograms of 32 students in a calm situation and in the presence of emotional stress. We used the situation related to taking a test as a model of stress.

Analysis of mean parameters of the electrocoagulograms revealed that marked hypercoagulation appeared in the presence of stress. Start of clotting, end of clotting, as well as the indicator of duration of the clotting process, were shortened with statistical significance, whereas density of the blood clot was diminished.

Analysis of parameters of the fibrinolytic process (time of start of retraction and fibrinolysis, and amplitude of fibrinolysis over a 10-min period) revealed that there were two groups of subjects. The first, larger group (20 people) presented a typical finding of hypercoagulation associated with intensification of fibrinolysis; the typical finding for the second group (12 people) was depression of fibrinolytic activity against the background of hypercoagulation.

Hypercoagulation occurring with emotional stress is, as we know, related to discharge of catecholamines into blood, which confirms the conceptions of adaptive function of emotions.

The data indicating intensification of anticoagulation against the background of hypercoagulation conform with conceptions of the protective role of fibrinolysis, which prevents intravascular blood clotting (M. S. Machabeli, 1962).

Depression of fibrinolysis is the most intensive change. It may be assumed that weakness of the anticoagulating system, which was observed in some healthy subjects, is one of the conditions for onset of vascular diseases related to prolonged emotional tension, in the presence of acute emotional stress.

EFFECT OF NERVOUS AND EMOTIONAL STRESS ON STATE OF THE BODY'S INTERNAL ENVIRONMENT

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 169-170

[Article by M. V. Markaryan, V. A. Korshunova and T. A. Smirnova]

[Text] A study was made of peripheral blood, blood sugar content, concentration of total protein, protein fractions and aldolase in blood serum, as well as vitamins C and B_1 in 24-h urine in the presence of nervous and emotional tension. The latter was produced by simulating stress situations comparable to the professional work of cosmonauts (simulated ascent to an altitude of 8000 m in a pressure chamber, anticipation of gravitational accelerations on a centrifuge, psychological tests--mental work within a limited time under conditions of "success" and "failure" situations).

The results of peripheral blood tests on five healthy male subjects revealed that the most marked changes occurred when anticipating accelerations (increase in leukocyte count, increase in segmented neutrophils and decrease in relative lymphocyte content to 18%).

The reaction of the blood system to the "pressure chamber" was manifested by a decrease in relative number of lymphocytes.

The results of the biochemical studies were indicative of an increase in concentration of total protein in blood serum, chiefly referable to albumins and the fraction of γ_2-globulins, during simulation of ascent. Blood sugar concentration increased in the situation of anticipating accelerations and psychological tests. We demonstrated a significant decrease in excretion of ascorbic acid and thiamin during the psychological tests and thiamin during anticipation of accelerations on the centrifuge ($P<0.001$).

REACTION OF ENDOCRINE GLANDS AND MACROMOLECULAR METABOLISM IN THE CENTRAL NERVOUS SYSTEM IN THE PRESENCE OF STRESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 170-171

[Article by F. I. Furduy, S. Kh. Khaydarliu, Ye. I. Shtirbu, G. M. Babare, L. P. Marin and L. M. Mamalyga]

[Text] The body's reaction to stressors is characterized by significant diversity and involvement of various systems. The most unequivocal data were obtained from studies of the reaction of the hypothalamo-hypophyseo-adrenal system (HHAS).

In recent years, efforts have been made to define the general patterns of central nervous system reactions and metabolism in the presence of stress.

The results of our studies revealed that the changes in metabolism and activity of endocrine glands in the presence of stress may proceed differently, depending on the nature of the stressor and condition of the organism. Thus, with some stress factors (hypoxia, very intensive motor activity, hyperthermia and others), the first phase of the body's reaction is characterized by prevalence of anabolic processes in RNA and protein metabolism. However, the anabolic phase is not necessarily present when the intensity of the stressors is increased. In such cases, there is prevalence of catabolic processes. Typically enough, under such conditions, many endocrine glands are involved in the body's reaction, including the thyroid, reproductive glands, parathyroid and others.

Experiments involving removal of different endocrine glands revealed that the time, order and nature of their involvement in the response, as well as significance to mechanisms of resistance of the organism, are determined by the base state of the endocrine glands, nature of stressor and its other features. Endocrine gland function depends on the stage of development of stress, and the correlation between phases of functional activation is not the same for different glands.

A study of RNA and protein metabolism in different structures of the central nervous system revealed that the level and direction of changes in metabolism depend on the role of the specific structure of the central nervous system in organizing the reaction to a stress factor, nature of the stressor, its intensity, duration of exposure to it, repetition thereof, etc.

EFFECTS OF DIFFERENT SCHEDULES OF MAN'S ACTIVITIES IN A PRESSURE-CHAMBER ON EXCRETION OF TOTAL NITROGEN, UREA AND 17-HYDROXYCORTICOSTEROIDS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 171-172

[Article by V. P. Bychkov, I. I. Borodulina, S. Kalandarov and A. K. Sivuk]

[Text] A study was made of excretion of total nitrogen, urea and 17-hydroxycorticosteroids (17-HC) in urine of 9 subjects who were kept in a pressure chamber 25 m^3 in size at earth's atmospheric pressure.

Our data were obtained from 9 7-day experiments (1 subject in each). There was a normal schedule of activities on the 1st-2d and 6th-7th days in the chamber, whereas there was a 64-h schedule of continuous activity with sleep deprivation on the 3d-5th days.

The subjects were kept on the standard onboard diet developed for the crew of the Salyut station.

Analysis of the results of this study revealed that most subjects presented an increase in excretion of total nitrogen, urea and 17-HC in urine at different stages of the experiment: during the first 2 days in the heat chamber, the 64-h period of continuous activity (3d-5th days) and during anticipation of leaving the pressure chamber (6th-7th days). Total nitrogen of urine increased from 12.1±1.0 g/day in the background period to 14.8±1.61 g/day, 16.7±1.51 g/day and 16.1±1.26 g/day, respectively; urea level rose from 21.6±2.27 g/day to 26.2±3.12 g/day, 29.0±2.6 g/day and 27.2±2.04 g/day; 17-HC rose from 6.6±0.9 mg/day to 10.7±0.88 mg/day, 9.7±1.17 mg/day and 8.7±1.13 mg/day, respectively, in the above experimental periods. The degree of increase in excretion varied in different subjects and on different days of the different periods. However, in most subjects, the general direction of changes in the different periods was the same. Thus, total nitrogen, urea and 17-HC content of urine increased in 6 subjects already on the first day in the chamber and diminished in only 2. This decline is attributable to the fact that these subjects had a distinct reaction to anticipation of "entry" into the pressure chamber, which was associated with increased excretion of end products of nitrogen metabolism, which is usually followed by compensatory retention of nitrogen.

During the 64-h period of continuous activity, maximum increase in excretion was observed on the 2d day in 5 subjects, on the 1st day in 2 and no significant changes were demonstrable in the remaining 2 subjects during this period.

During the period of anticipation of exit from the chamber, 4 subjects presented increased excretion 2 days prior to the end of the experiment and 2 did so 1 day prior to its end.

After exiting from the pressure chamber, excretion of total nitrogen, which constituted 12.2±1.38 g/day, urea--23.6±2.14 g/day and 17-HC--6.0±1.7 mg/day was close to background levels.

The observed changes in excretion of the tested end products of nitrogen metabolism and 17-HC apparently occurred as a result of nervous and emotional tension, which some subjects developed during the period of anticipating entrance into the pressure chamber, during "entry" into the chamber, the 64-h period of continuous activity and anticipation of the end of the experiment. This was associated with increased function of the adrenal cortex, along with intensification of catabolic processes in the subjects.

IMMUNE MECHANISM OF REGULATING CHEMICAL HOMEOSTASIS DURING ACCELERATIONS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 172-173

[Article by A. S. Zaks and A. A. Bykova]

[Text] A study was made of immunity parameters with exposure to accelerations, immobilization and long-term forced swimming of experimental rats. In view of the existence of natural antibodies to mediators, enzymes, hormones and elevation of antibody titer when animals are immunized with the appropriate agents, we studied intact rats, as well as animals immunized with histamine, serotonin, kallikrein, acetylcholine and ACTH. In the former case, antibodies were demonstrable in 72% of the rats and their titer ($\log_2$) did not exceed 0.77±0.29. After immunization, antiboides were demonstrated in 100% of the animals in titers of 3.72±0.1-3.91±0.08.

Immobilization of the rats for 24 h was produced by tying their limbs and head with the animals in supine position. The rats were submitted to accelerations for 60 s on a centrifuge rotating at 200 and 600 r/min. The animals were put in boxes with the immobilized head directed toward the center of the centrifuge. To make the animals swim, they were put in a tank of water for 20 min, attaching a weight equaling 15% of the body weight.

Intact rats, whose blood revealed the appropriate natural antibodies, were used in the immobilization experiments. These antibodies were no longer demonstrable 24 h after this treatment. On the 14th day, they were again demonstrable in all animals in a high titer (3.30±0.04).

Sixty min after rotation at 200 r/min, the rats presented their usual appearance. However, we failed to demonstrate antibodies to histamine, serotonin, kallikrein, ACTH and hydrocortisone in their blood at all tested times (1 h, 3, 5, 7, 10, 14 days), not only in intact, but immunized animals. Accordingly, there were no specific rosette-forming cells in the organs of these rats, and there was a drastic decrease in capacity of lymphoid cells to synthesize antibodies. After forced swimming, antibodies to histamine, serotonin and kallikrein disappeared from the blood of immune animals, and they were not demonstrable over the 2-week observation period.

SCIENTIFIC ORGANIZATIONAL PRINCIPLES OF SUPPLYING INFORMATION FOR RESEARCH IN AVIATION MEDICINE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 173-175

[Article by N. M. Rudnyy, Yu. V. Krylov and V. A. Kurashvili]

[Text] Successful development of research in aviation medicine is possible only if there is well-organized supply of information. The choice of means and rate of development of specific directions of research depend significantly on the work of information agencies.

Although we still have no clearcut economic criteria for quantitative evaluation of information work, it has been noted in the literature that a well-organized information service increases the effectiveness of scientific research by 35%, while the number of workers could be reduced by 25%.

The tasks for an information service referable to aviation medicine can be formulated as follows: maximum gathering and processing of documents dealing with aviation medicine, prepared in the USSR and abroad; preparation of translations, abstracts, annotations, as well as topical and bibliographic information from these materials; building up the reference information stock with Soviet and foreign materials (including patents and standards); information and library service for specialists and administrators (in modes of selective dissemination of information and in the form of differentiated service); analytical and synthetic processing of data, preparation of surveys describing the achieved level and trends of development of scientific research in aviation medicine.

The existing traditional methods of information service are not effective enough to perform the above tasks. It is necessary to change to new, automated forms of service. Development of an automated information system for aviation medicine (AISAM) should proceed on the basis of knowhow gained in allied agencies and organizations, as well as with the use of foreign knowhow in this area. There are plans to integrate AISAM with the International System of Scientific Medical Information, MEDINFORM, as well as such biomedical systems as Dedlars, Excerpta Medica, Biosis, Recon and others.

This problem cannot be resolved solely by information workers and specialists in computer technology; it is imperative for qualified specialists in all branches of knowledge contained in the area of interests of aviation medicine to participate extensively.

Introduction of scientific organizational principles to information services for specialists in aviation medicine would reduce the time and expenditures for the information process; it would improve appreciably the effectiveness and quality of performance of management levels of scientific research and validation of the decisions they make.

STUDY OF INFORMATION NEEDS OF SPECIALISTS IN AEROSPACE MEDICINE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 175-177

[Article by V. A. Kurashvili and G. B. Ryabinina]

[Text] Improvement of effectiveness and quality of scientific research is linked closely with refinement of information support thereof. However, under conditions of the "information explosion," traditional methods of information services cannot meet the increasing requirements of specialists. For this reason, work has presently been deployed on a broad scale to develop automated information systems (AIS).

Introduction of automated methods of information services, in turn, raises several urgen tasks. One of the main tasks is to study the information needs of specialists. This is particularly important to aerospace medicine, since the range of its interests includes a broad spectrum of scientific disciplines.

Our study of the needs of specialists involved three main elements: scientific information analysis of professional tasks of consumers; analysis of demand and requests for information; use of scaling method to elicit the opinion of consumers as to the extent to which their needs are satisfied under existing conditions and improvement of information services.

A special questionnaire was developed for our study. At first, the questionnaire was tested on a small group of specialists. After refinement thereof, with due consideration of comments offered, copies were made of the questionnaire. We combined an interview with having the subject fill out this questionnaire. This enabled us to enlarge the interrogation and gain a more detailed idea about the information needs of specialists.

The surveyed group consisted of 50 people with different periods of tenure in research work and representing different scientific directions. Analysis of the results obtained by the method of expert evaluation (psychometric scaling) was made by the conventional method of processing nonparametric indicators. In the group surveyed, there was prevalence of individuals with medical education--86.8%, 10% were engineers and 3.9% had a psychological education. The scientific qualifications were as follows: 26.8% were doctors of sciences, 56.6% were candidates of sciences and 16.6% had no scientific degree. The positions held by the specialists were as follows: 33.6% were in the field of administration, 46.4% were senior

scientists and 20% were junior scientists. In our analysis of the data, we also took into consideration such parameters as age and scientific tenure. The question about knowing a foreign language revealed a substantial discrepancy between data in the questionnaire and the actual situation. Most of those questioned indicated that they did know some foreign language, but in the course of the interview it was learned that their knowledge of that language was not sufficient to allow them to freely refer to foreign literature in that language.

The multiaspect analysis we made of the results enabled us to demonstrate the following main features of the group questioned. The group of specialists with high qualifications, who combined scientific research with administrative-managerial activity have less time to gather information, but they are expressly the ones to make important decisions. Thus, it is imperative to submit information in more concentrated form for this group of consumers.

Specific data about methods and results of research conducted abroad are of great interest to specialists concerned primarily with research in a relatively narrow field. These distinctions make it obvious that a differentiated approach is desirable to supplying information for different categories of consumers.

On the whole, this questionnaire enabled us to study the means of obtaining scientific information and evaluate their effectiveness, as well as to assess the extent to which various information materials are used, define the extent to which the existing information system meets the needs of consumers and to develop recommendations for improving information services.

Retrieval from primary scientific documents of information that permits analysis of accumulated knowhow and evaluation of the trends of development, then submittal thereof to consumers in the form of analytical and synthetic surveys containing a comparative evaluation and possible variants of solutions should become the most important element of scientific information work.

METHODOLOGICAL PROBLEMS OF MEDICOTECHNICAL ADJUNCT AT THE EARLY STAGES OF DEVELOPMENT OF AVIATION TECHNOLOGY

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 177-178

[Article by B. L. Gorelov]

[Text] This article deals with one of the important aspects of the problem of optimizing the "crew-flying vehicle" system at the designing and planning stages. We refer to organizational ways and means of optimum conformity of man's capacities with the different features of a newly developed flight vehicle (FV).

Medicotechnical adjunct (MTA) is used to refer to the set of scientific-methodological and organizational-technical measures that provide for complete consideration of engineering-psychological and physiological-hygienic factors at the early stages of development of new aviation technology. This set includes the entire cycle of development and execution of engineering-psychological and physiological-hygienic requirements (EPR and PHR) to assure the efficiency, reliability and safety of "crew-FV" systems.

This cycle consists of the following main stages: determination and formulation of problems for scientific research; development of specialized stands and mockups for static and dynamic semi-life size modeling of activities; direct experimental research; development and validation (on the basis of obtained facts, as well as analysis and generalization of experience in operating analogues) of specifications and recommendations for the new FV model; implementation of EPR and PHR in the design work. The above stages correspond to the stages of development of aviation technology TTZ (TZ): technical proposal, sketched design, technical trial plan.

Prompt (prior to development of technical plan) delivery to the FV developer of scientifically validated reliable EPR and PHR is an important element of the entire MTA system. The former constitute requirements referable to the characteristics of the aviation technology under development to assure the process of man's work, while the latter are requirements referable to characteristics that provide the working conditions. The systems analysis approach to validation of these requirements is the methodological basis for the process of developing EPR and PHR. In this case, validation refers to determination of qualitative and quantitative characteristics of the "crew-FV" system, with which are expressed the requirements and restrictions concerning operation of the aviation technology being developed.

The systems approach to substantiation implies analysis of the whole, integral properties of man-machine systems, with demonstration of correlations between all the main elements and their influence on overall efficiency of an ergodic system.

Mathematical modeling, analytical and experimental methods are the principal methods for both validation of requirements and evaluation of technical designs proposed by developers of aviation technology.

HEARING FUNCTION OF PILOTS AND PRINCIPLES FOR SETTING STANDARDS FOR AVIATION NOISE

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 178-179

[Article by E. V. Lapayev and V. S. Kuznetsov]

[Text] Setting standards for noise in aviation should effect the following: 1) assure high pilot efficiency; 2) aid in flight safety; 3) create conditions that prevent development of occupational diseases.

Each of these objectives has its own criteria for setting standards, and there is some inconsistency between them. For flight safety, the noise must not disrupt verbal radio traffic. When using modern means of communication (telephones, microphones, headsets), stable radio traffic is possible in the presence of significant noise, of the order of 115 dB. The criterion for setting the standard that permits a high degree of pilot efficiency in the presence of noise is also less rigid than the criterion for preserving hearing.

In some cases, the octave levels of noise measured in the cockpits of modern aircraft and helicopters exceed the permissible levels, and they could become the cause of persistent elevation of hearing threshold in flight and engineering personnel. Hearing disturbances are related to tenure in aviation, but they are quite variable. It is important to stress the relative independence on degree of decline of tonal hearing of such an indicator of performance as clearity of speech when using communication systems. On the one hand, this enables experienced pilots to conduct distinct and error-free radio traffic but, on the other hand, it obscures the early symptoms of hearing impairment, which could ultimately develop into professional hypoacusis.

Early detection of individuals with poor endurance of the noise factor and steps to prevent noise constitute an important task for modern aviation audiology.

STUDY OF OCULOMOTOR REACTIONS TO VESTIBULAR AND OPTOKINETIC STIMULI

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 179-180

[Article by Yu. V. Kreydich, A. A. Repin and V. A. Barmin]

[Text] It can be assumed that unconformity of vestibular, visual and oculomotor afferent inputs plays a substantial role in the genesis of development of the symptoms of motion sickness in cosmonauts. It was demonstrated that afferent information coming over independent channels is acted upon in an integrative way by the same stem structures, the vestibular nuclei (Yu. V. Kreydich, 1978).

The study of possible mechanisms, etc., of such interaction is of definite interest, and it involves certain difficulties, so that a model that permits quantitative evaluation of the share of information used from the vestibular input in systemic reactions acquires special importance. This applies to the reaction of fixing the eyes on delivered visual stimuli, which has been described by E. Bizzi et al. (1971, 1974), since it is largely (if not chiefly) based on information from the vestibular input. For this purpose, a study was made of the mechanisms of interaction of information from vestibular and visual inputs on the model of the reaction of fixing the eyes on test stimuli. Visual tests were made with subjects in 200 experiments, under both ordinary conditions and in the presence of altered parameters of vestibular (galvanic stimuli) and visual (optokinetic stimuli) inputs.

It was demonstrated that optokinetic stimuli are similar in nature to the galvanic effects on stimulation of vestibular input. Substantial worsening of endurance of reactions was found with successive delivery of galvanic and optokinetic stimuli, associated with autonomic reactions and distinct changes in parameters of the vestibular and oculomotor reaction.

The obtained data are indicative of close integrative interaction between vestibular and visual information on the level of vestibular and oculomotor nuclei, and show that the reaction of fixing the eyes can be used as a test reaction to assess the functional state of the vestibular afferent input.

POSTURAL, MOTOR AND VESTIBULOMOTOR REACTIONS OF ANIMALS AFTER LONG-TERM SPACE FLIGHTS ABOARD COSMOS-782 AND COSMOS-936 BIOSATELLITES

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 180-181

[Article by G. S. Ayzikov, A. S. Markin and A. V. Mokrousova]

[Text] Devices and test procedures that we developed were used in standard preflight and postflight studies of intact and labyrinthectomied Wistar-SPF white rats.

We evaluated the animals' general condition and state of the motor system: positions related to examination of surroundings, rest; walking in an arena [?] and tunnel; equilibrium function according to ability to sit and walk on a narrow bar; animals' ability to alter the position of a tilting platform, moving in relation to the axis of its rotation ("perception of gravity vector"); lifting reflex and its latency period; reaction of turning over and landing when free-falling from supine position.

Analysis of the data led us to the following conclusion. A long-term space flight affects sensory implementation of postural and motor reactions. There is a change in dynamic structure of movements, as well as nature of maintaining and correcting a position. This is related to the unusual environmental conditions, where absence of gravity leads to "loss" of proprioceptive and gravity coordinates of spatial perception, with retention of visual coordinates. New adaptive mechanisms develop in the system of voluntary and reflex control of movement.

The return to usual gravity is associated with destruction of the postural and motor "space systems" and restoration of motor images of prior, "terrestrial" experience. This is a gradual process, occurring simultaneously with readaptation of other functional systems.

GRAVITY FACTOR SCREENING OF COSMONAUT APPLICANTS (BULGARIAN PEOPLE'S REPUBLIC)

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 181-182

[Article by D. G. Dmitrov]

[Text] The so-called active [powered flight] phases--lift-off and earth atmosphere re-entry--are important phases of space flights. In these phases, the cosmonaut is exposed to accelerations that are significant in magnitude and duration, and one can expect changes in endurance of these factors in the second phase of flight, following long-term weightlessness.

These circumstances require meticulous and complex screening of cosmonaut candidates with reference to the gravity factor.

We studied a group of cosmonaut candidates that had been deemed to be clinically healthy.

The following procedures were used to examine each applicant for the purpose of as accurate as possible and complex evaluation of this aspect: two-fold testing on a centrifuge with a + profile of accelerations in the following order--4, 5, 6, 6.5; decompression of lower half of body (LBNP) -70 mm Hg in "sitting" position; rheoencephalography and rheography of peripheral vessels using functional load tests (graded LBNP, -70 mm Hg for 20 s and hyperventilation for 1 min).

It was determined that two-fold testing on the centrifuge yields fuller information about the applicants tolerance of gravity. In 10% of the cases, we observed extrasystolic arrhythmia. It was proven that this arrhythmia (particularly of a regular nature) could be informative with respect to determining autonomic resistance of the body and serve as an objective criterion for screening candidates with autonomic vascular dysfunction.

In one instance, a candidate who presented no visual disturbances at n+ gradually developed a regular extrasystole upon repeated centrifuge testing. Rheoencephalography was also indicative of autonomic vascular dysfunction. This was confirmed by the fact that this applicant demonstrated diminished hypoxic resistance twice, with the collapse syndrome, in the pressure chamber.

LBNP of 70 mm Hg yielded additional information about the mechanism of cardiovascular decompensation with redistribution of blood and anemization of the brain. The test demonstrated the possibility of detecting diminished tolerance of the brain to a shortage of oxygen.

There was a case of latent tendency toward syncope with prolonged hypoxia of the brain, concurrently with endurance of other specific load tests.

Rheoencephalographic (REG) studies demonstrated the efficiency of cerebral circulation, functional lability and activity of vessels, which is particularly important to evaluation of endurance of accelerations, especially after prolonged inactivation. The REG yielded additional information concerning latent forms of autonomic vascular dysfunction.

The main conclusion was that complete information of utmost objectivity concerning candidate endurance of gravity factors can be gained on the basis of complex evaluation, including mutually supplementary informative tests: tests on a centrifuge, LBNP and REG of cerebral vessels with functional tests.

EFFECT OF IMMOBILIZATION ON FUNCTIONALLY DIFFERENT SKELETAL MUSCLES OF RABBITS AND RATS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 182-183

[Article by T. Siladi, A. Ser, M. Rapchak, F. Guba and Ye. Takach (Hungarian People's Republic)]

[Text] We studied the effect of immobilization on changes in contractile, enzymatic and ultrastructural distinctions of functionally different (fast and slow) muscles of mammals.

This study was pursued on white rabbits weighing 2500-3000 g and white rats (same tribe of CFY) weighing 250-300 g.

We immobilized the right hind leg of the animals in a plaster cast. For 28 days we studied changes in weight, fluid content, quantitative and qualitative changes in protein, contractile distinctions and myosin ATPase activity in muscles--the gastrocnemius, EDL [extensor digitorum longus?] and soleus.

The muscles of the contralateral leg served as a control, and we compared the results to muscles of intact animals.

It was established that, in rabbits, immobilization affected primarily the soleus. There was greater weight gain in this muscle than the gastrocnemius. We made the opposite findings in rats, since the gastrocnemius lost more weight.[sic]. These opposite results obtained on animals of different species are attributable to the differences in muscles and different strain thereof.

We failed to demonstrate differences in fluid content between immobilized and control muscles. The studies revealed that hydrostasis did not play a part in weight loss after immobilization.

It was established that atrophy following immobilization altered the amount and quality of isolated contractile proteins. Atrophy of immobilized muscles was associated with significant changes in ultrastructure as well, and we observed disintegration of myofibril structures. This was associated with significant decrease in activity of myofibrillar ATPase, as well as significant decrease in contractile distinctions of glycerinized fibers.

It may be assumed that the observed contractile changes are related to decreased myosin ATPase activity, and reduction of transverse connections between friable myofibrillar elements.

PHYSICAL FITNESS OF THE ORGANISM AND TOLERANCE OF +Gz ACCELERATIONS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 183-184

[Article by K. Klyukovski, M. Klossovski and Yu. Domashuk (Polish People's Republic)]

[Text] The authors studied physical fitness and tolerance of +Gz accelerations in two groups of healthy men; the first group consisted of individuals whose occupation was not related to aviation (n = 35, average age 27.4±5.4 years); physical fitness was determined by the W150 method; the second group consisted of third-year junior officers at the Higher Officers' Aviation School (n = 46; average age 22.9±0.9); physical fitness was determined on the basis of maximum oxygen uptake, $\dot{V}O_2$ max.

The results of these studies and correlation analysis revealed that physical fitness presented no appreciable correlations with the level of tolerance of +Gz accelerations.

CHANGES IN HUMORAL COMPOSITION OF BLOOD AND TISSULAR METABOLISM OF RATS FOLLOWING SPACE FLIGHTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 184-185

[Article by I. Alers, R. Kvetnyanski, L. Makho, Ye. Mishurova, Sh. Nemet, M. Palkovich, M. Praslichka and R. A. Tigranyan (CSSR).

[Text] The purpose of experiments with rats aboard Cosmos-782 and 936 biosatellites was to study the effects of space flight factors (namely, weightlessness) on laboratory rats; in the second experiment, artificial gravity was used aboard the biosatellite.

Studies were made of activation of the hypothalamo-hypophyseo-adrenocortical and adrenergic systems. In the blood of flight animals there was an increase in concentration of corticosterone; ACTH did not change, and no changes were demonstrated in production of corticosterone in the adrenals. In the hypothalamus and adrenals, the concentration of catecholamines and activity of enzyme-synthesizing and enzyme-degrading catecholamines changed insignificantly, and the concentration of catecholamines was increased in the myocardium. There was no change in testosterone concentration in plasma. There was significant increase in amount of thyrotropic hormone. Use of artificial gravity prevented the increase in blood corticosterone and thyrotropic hormone.

Flight rats presented distinct increase in lipomobilization and in serum lipids, namely, triglycerides (TG). The liver presented an increase in concentration of nonesterified fatty acids and TG, change in activity of some "adaptive," lipogenetic and gluconeogenetic enzymes was found in bone marrow, and there was accumulation of TG. Centrifuging flight rats aboard the biosatellite prevented this phenomenon, which is related to the effect of weightlessness. There was elevation of polydeoxyribonucleotide (DNP) level in the spleen and thymus; artificial gravity prevented the changes in the spleen. Dissociation of this complex (DNP) was associated with decrease in nucleic acid content of organs.

Long-term (20 days) presence in space was not an intensive stressogenic state for rats; one should consider some manifestations of stress as the effect of biosatellite landing. Use of artificial gravity aboard the biosatellite had a beneficial effect on some of the changes induced by weightlessness. There was almost complete restoration of "normal" values of the parameters studied during the readaptation period.

THE MICROCLIMATE AND MAN'S SKIN TEMPERATURE IN WEIGHTLESSNESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 185-186

[Article by L. Novak, V. Remek, A. Barta, A. M. Genin, A. Gubarev and A. T. Poleshchuk (CSSR)]

[Text] Heat transfer between a homoiothermic organism and the environment is a mandatory prerequisite for maintaining the required level of metabolic processes. The state of thermal comfort, a state that is characterized, among others, by objective maintenance of average temperature of the skin surface in the range of 33-34°C and subjective sensation of heat comfort without appreciable perspiration, is an expression of dynamic equilibrium between production and discharge of heat.

In weightlessness, when there is no natural movement of air, it should be induced by forced air movement [1]. From the standpoint of industrial physiology and preservation of thermal comfort, a number of new problems arise. What they have in common is the need to find appropriate methods that would permit measurement of the cooling properties of the environment and its effect on the thermal state of the organism.

The purpose of the first series of "Heat transfer 2" experiments, which were planned for the first international Intercosmos mission, was to check the principle of the proposed method on the Salyut-6 orbital complex in weightlessness, using three variants of measurement in the course of a normal work day.

An electric dynamic catathermometer with a six-point indicator of skin temperature was used in the experiment on V. Remek and A. Gubarev. In each series, skin temperature was measured on the forehead, chest, back, dorsal surface of the hand, thigh and heel [or sole] using a special thermistor sensor at constant pressure of 10 g. In the course of each experiment, we measured the cooling effect of the environment with the catathermometer sensor five times. The cycle of measurements was performed on the sixth flight day. Control measurements were taken before the flight and after landing.

The temperature in the cockpit of the orbital complex was several degrees lower (21-22°C) during the flight than under laboratory conditions on earth (23-25°C). The cooling effect of the environment, as measured with the catathermometer, was still 60-70% greater in the orbital complex than on earth. But the mean skin temperature of a clothed cosmonaut remained in the comfort zone at all measured

times, but did not always conform with the sensation of thermal comfort. A satisfactory correlation was demonstrated between the cooling effect of the environment measured with the catathermometer and temperature on the back of the hand and heel. As a result of analysis of the catathermometer readings, it can be stated that the cause of the cosmonauts' sensation of discomfort was most probably due to differences in air velocity (0.05-0.1 m/s on earth, versus 0.3-0.9 m/s aboard the orbital station). Skin temperature was higher on the chest, underneath clothing, where there was no forced movement of air. This is a reflection of the fact that there was greater heat insulation of stationary air in the air pockets between clothing and skin surface in weightlessness than on earth [2].

The method we developed and unique YeDK-1K equipment used in weightlessness aboard the orbital complex justified themselves entirely, and they will be used in future studies within the framework of the Intercosmos international program in "Heat transfer 2" experiments and to solve similar problems on earth.

EFFECT OF HYPOKINESIA ON SOME PARAMETERS OF ACTIVITY OF THE ENDOCRINE SYSTEM AND EXCRETORY FUNCTION OF THE KIDNEYS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 187-188

[Article by B. Likhardus, L. Makho, R. Kvetnyanski, Sh. Nemet, V. Shtrbak and N. Mikhaylovskiy (CSSR)]

[Text] The authors investigated the effect of 60-day hypokinesia on some parameters of activity of the endocrine system and excretory function of the kidneys. Experiments were conducted on male Wistar (SPF) rats , which we bred. Model IMBP cages were used for hypokinesia. After long-term hypokinesia, the experimental animals showed some increase in body weight and relative weight of the pituitary, thyroid and adrenals, as compared to a control group of animals who spent the same period of time under the usual vivarium conditions. There was no change in radioiodine uptake by the thyroid in vitro, nor was there any appreciable change in concentration of thyroxine and triiodothyronine in plasma. There was a decline of plasma corticosterone level in experimental animals following hypokinesia. We also demonstrated a decrease in corticosterone production in the adrenals, but there was no change in corticosterone content of adrenal tissues. Plasma insulin concentration also showed no change.

In addition to these results, data will be submitted on the effects of hypokinesia on excretory function of the kidneys, from the standpoint of circadian rhythms. We monitored excretion of urine, sodium, potassium, calcium, catecholamines and aldosterone. Concurrently, we measured the concentration of some neurotransmitters in selected parts of the central nervous system.

We then observed uptake of ^{14}C-leucine in liver protein. We demonstrated increased hepatic production of protein in animals following hypokinesia, which was consistent, to some extent, with the changes in activity of hepatic enzymes. In this regard, we found that there was an increase in activity of enzymes that are involved in regulation of gluconeogenesis following hypokinesia.

After 1-day and long-term hypokinesia we observed a significant elevation of levels of nonesterified fatty acids in plasma and concurrent increase in basal lipolysis in adipose tissue. After addition of norepinephrine, lipolytic activity of fatty tissue of hypokinetic animals was somewhat decreased, in spite of differences in release of fatty acids; we failed to demonstrate a difference in cAMP content of adipose tissue. Stimulation of release of fatty acids from adipose tissue was the

same in hypokinetic and control animals. We demonstrated significant decrease in weight of the epididymal adipose body. These findings indicate that short- and long-term hypokinesia have an overt lipolytic effect and influence metabolism in adipose tissue.

MORPHOLOGICAL AND GENETIC CHANGES IN CELLS IN WEIGHTLESSNESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 188-189

[Article by V. Brigleb, Y. Neubert, A. Shatz and A. Kogoli (FRG)]

[Text] Theoretical and empirical research on the effects of weightlessness on living cells and tissues, which were conducted recently, revealed that differentiation of intracellular structures, particularly their cybernetic mechanisms, must be correlated with active compensation of gravity factors. In the future, attention must be concentrated mainly on the question of the irreversible changes induced by accelerations and how the cell copes with such influences. At the present time, it is deemed interesting to establish some typical parameters of normal cell function under conditions of simulated weightlessness (one group of experiments). It is even more important to try to establish the parameters that would enable us to comprehend the mechanisms of active compensation of gravity forces (second group of experiments). If we consider the influence on cellular functions of humoral effects, external pressure or other indirect factors, we can realize the analytical difficulties inherent in both groups of experiments. It then becomes understandable why it is necessary to conduct additional in vitro experiments, as well as studies of different stages of plant and animal development on earth.

Our experiments with simulated weightlessness (created in a rapidly rotating clinostat) can be divided into two categories, in accordance with the foregoing: 1) study of normal development (morphological expression) and genetic reactions of multicellular animals; 2) in the event of negative results of the first category of experiments, determination of changes in behavior of intracellular structures that have no direct effect on overall cell function.

The first category of experiments includes studies of the minor increase in teratogenic and genetic defects in the Tribolium flour beetle. At the present time, an important experiment is in progress, which will help answer this question. Teratogenic studies of frog development, which included micromorphology of the vestibular system of younger stage larvae yielded negative results. If we learn that the morphology of the vestibular system of older larvae changes concurrently with a certain change in behavior, the morphological effect should be referred to the second category, since the "anomalous" behavioral reactions are reversible. After completion of metamorphosis of young frogs, the clinostatic method can no longer be used.

The possible direct reactions of blood cells in weightlessness must be referred to the second category, since we do not know of any irreversible changes in cosmonauts during flights lasting up to 140 days. In experiments in vitro with a clinostat we demonstrated some deviations from the corresponding control.

In the second category, the most promising direction is observation of periodic intracellular processes that could be related to the magnitude of gravity factors. We demonstrated fluctuations of rhythmic movements of the nucleus in a plant cell, as well as changes in rhythmic flow of protoplasm in slime mold, the latter may possibly have a specific clinostatic effect, using our system of a clinostat and microscope.

OXYGEN TENSION IN SUPERFICIAL TISSUES OF COSMONAUTS IN WEIGHTLESSNESS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 190-192

[Article by A. Vatsek, Ye. A. Kovalenko, M. P. Bobrovnitskiy, A. Bartonichkova, D. Rogkovska, V. P. Pushkin, V. A. Kaptsov, V. N. Sementsov, S. N. Kharin and N. V. Lapteva (CSSR)]

[Text] Exchange of gases between the body and environment provides for a constant flow of oxygen over the cascades of the bloodstream into tissues. The final and most important element of delivery of oxygen to the organism is the indicator of oxygen tension (pO_2) directly in tissues of a living organism. The pO_2 level in tissues is an integral indicator of two processes of utmost importance, intensity of delivery of oxygen and nature of oxygen uptake in tissues. A prolonged change in pO_2 in tissues, both in the direction of hyperoxia and hypoxia, affects their metabolic and functional activity.

Physiological validation of the parameters of the gas atmosphere of manned sealed spaces is one of the important biomedical problems of space flights. The results of experimental studies of the genesis of disturbances arising under the influence of the extreme factors associated with space flights indicate that tissular hypoxia plays some role. To date, there have been few direct studies of oxygen supply to tissues when an organism is in a weightless state. Changes in hemodynamics during this period are indicative of possible disturbances of oxygenation and desirability of investigating it in human tissues before, during and after space flights.

We developed the Oxymeter instrument for our studies; it operates on the polarographic principle and permits measurement of tissue pO_2 at the site of insertion of a platinum cathode. We used a round silver chloride plate as the comparison electrode; it was glued to the skin with a one-way valve to apply a contact electrolyte. The measurements were taken at a voltage of 0.55 V, with which residual current corresponded to the zero point on the instrument. The electrodes were calibrated in air-saturated saline, while the residual current was measured both in saline after addition of saturated sodium sulfate solution and in the anemic section of skin. The electrodes were sterilized with gamma rays for measurements in space.

We measured pO_2 of the skin of the left forearm of cosmonauts in space using a simplified stereotype, which involved insertion of the electrode into tissue and anemization at the site of insertion and examination of rate of decline of current

("oxygen uptake"). In the ground-based studies, the set of tests also included the oxygen and hyperventilation tests.

In 1978, we measured pO_2 of cosmonauts who were members of international crews on the 4th-5th day of weightlessness and at different times after the flight. At the same time, we took measurements on a control group of subjects of the same age and sex.

We found that pO_2 of the skin of the forearm reached 37.0±0.7 mm Hg when breathing air and the rate of decline of the curve constituted 12.8±0.3 mm Hg/min. When breathing a gas mixture with oxygen content close to the level in the spacecraft cabin, pO_2 rose to an average of 49.8±2.2 mm Hg.

The results of these experiments revealed that skin pO_2 diminishes to different degrees in weightlessness, and there is also a decrease in rate of decrease thereof in tissues (O_2 uptake). Measurement of pO_2 prior to the flight enabled us not only to assess the changes in absolute pO_2 under the influence of space flight factors, but individual reaction of tissular oxygenation of cosmonauts to weightlessness and readaptation thereof to conditions on earth.

Although, few measurements of pO_2 of cosmonauts during space flights have been taken thus far, the demonstrated tendency toward decreased tissular oxygenation may be indicative of some impairment of tissular microcirculation under the influence of weightlessness.

The team of present authors expresses its appreciation to cosmonauts for their creative participation in the experiments.

COMPARATIVE CHARACTERISTICS OF PRODUCTS OF ENZYMATIC HYDROLYSIS OF FOOD PROTEIN OF PLANT AND ANIMAL ORIGIN

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 192-193

[Article by V. I. Fofanov and N. A. Tresvyatskaya]

[Text] At the present time, the crews of spacecraft can be supplied with food only by means of delivery of foodstuffs by other spacecraft. The time crews spend in space is increasing constantly, and will be best to develop a partially or completely closed ecological system, the different elements of which could be used (after appropriate treatment) as food. These products may be unicellular algae, greenhouse products, including leaf and stem mass. It has been established that the nutritional value of plant protein is lower than that of animal protein. The reason for this is not only that there are differences in amino acid composition. Of the various plant proteins one can form a combination that will be identical in amino acid composition to animal protein, but the assimilation of such a mixture is low in man and nonruminant animals. It is assumed that this is related to differences in structure of protein molecules and their subsequent interaction with enzymes of the digestive tract. Casein and soybean proteins were separated into water-, salt- and alkali-soluble fractions by the method of successive extraction. After separation of salt-soluble fractions according to molecular weight (g--100), it was established that there are five proteins differing in molecular weight in the salt-soluble parts of casein and soybean protein. As a result of hydrolysis with trypsin of some proteins (of the above-mentioned ones for casein and five for soybean), data were obtained that fragments differing in molecular weight are formed as a result of enzymatic hydrolysis of casein and soybean protein (smaller ones in casein hydrolysate and larger ones in the hydrolysate of soybean protein). Thus, experimental data were obtained that confirmed the dependence of nutritional value of proteins on molecular structure. The possibility cannot be ruled out that development of the proper preliminary technological processing of plant proteins, which are not generally used as food, could improve their nutritional properties.

In this regard, there is expansion of the possibility of using plants in life support systems for the purpose of recovering nutrients from them.

COSMONAUTS' HORMONAL REACTIONS AFTER 7-DAY SPACE FLIGHTS

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1979. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 193-194

[Article by N. F. Kalita, E. A. Pavlova, B. V. Afonin and V. M. Ivanov]

[Text] A study was made of the hormonal status of cosmonauts who had participated in 7-day space flights (crews of Soyuz-27, Soyuz-28, Soyuz-30 and Soyuz-31 spacecraft) by comparing the findings obtained in the preflight period and period of readaptation to earth's gravity. Venous blood and 24-h urine served as material for taking the readings.

We examined testosterone, insulin, thyroxine (T_4), triiodothyronine (T_3), thyrotropic hormone (TTH), aldosterone, cyclic AMP (cAMP) and prostaglandin (PG A+E, F_1-α and F_2-α) levels in blood and renin activity of plasma. In addition we assayed excretion in urine of total 17-HC [hydroxycorticosteroids] and fractions thereof (free, glucuronides, sulfates) and aldosterone. We used the method of radioimmune analysis to determine the concentration of hormones and biologically active substances in blood and aldosterone in urine. Excretion of total 17-HC and fractions thereof was determined in the reaction with phenylhydrazine.

The obtained data revealed that the preflight period was associated with intensification of adrenocortical function of the adrenals, as indicated by increased excretion of 17-HC and their free forms in urine, increased (beyond the normal range) activity of plasma renin and elevation of level of PG pressor group (F_1-α and F_2-α), which is typical of emotional stress.

The postflight period was characterized by intensification of glucocorticoid function of the adrenals, decline of testosterone level in blood, increased activity of the insular system of the pancreas (elevation of insulin level), increased activity of the thyroid and thyrotropic function of the pituitary, as indicated by the increase in TTH concentration in blood, as well as elevation of cAMP level and prevalence of the pressor PG group. There was an appreciable increase in activity of the renin-angiotension-aldosterone system and excretion of aldosterone in urine in the readaptation period.

The observed changes may be related not only to emotional tension, but the special life style of cosmonauts, which requires much tension of vascular tonus.

CHANGES IN DEEP BODY TEMPERATURE OF MAN DURING 26-DAY IMMERSION

Moscow AVIAKOSMICHESKAYA MEDITSINA. VI VSESOYUZNAYA KONFERENTSIYA PO KOSMICHESKOY BIOLOGII I AVIAKOSMICHESKOY MEDITSINE. KALUGA 5-7 IYUNYA 1-79. CHAST' II in Russian 1979 (signed to press 7 May 79) pp 194-195

[Article by M. Yu. Volkov]

[Text] At the present time, submersion in water at a comfortable temperature (immersion) is used to simulate the effect of weightlessness on man. Numerous works by Soviet and foreign authors describe the adaptive changes that occur in different organs and systems; however, not enough has been written about the heat-regulating changes during the immersion period.

In our study, the subject's body was separated from the water by a flexible, waterproof film by the method of Ye. B. Shul'zhenko (1975). During each experiment, we recorded graphically rectal (T_r) and axillary (T_a) temperature 7 times a day (at 0800, 1200, 1600, 2000, 2400 and 0800 hours). We took temperature readings in the background period, when the subjects activity was not restricted, as well as on the 1st, 3d and 26th day of immersion, when motor activity was drastically restricted. The immersion tank was in a room with artificial light from 0700 to 2300 hours. The subjects received four meals totaling 2000-2500 kcal. Air temperature was 24-25°C and the immersion water temperature was 33.4±0.2°C. We conducted four studies on four subjects.

On the first day of immersion there was a drop of deep body temperature. The calculated mean values of T_r and T_a were significantly ($P<0.01$) lower than background values; however, the subjects reported complete thermal comfort. The shape of the circadian temperature curve did not change, as compared to the normal T_r and T_a curves in the background period.

At the end of the first day in the tank, all of the subjects reported pain in muscles of the back, abdomen and legs, which disappeared on the 3d day of immersion. There was no appreciable difference between subjects with respect to localization and time of onset of such pain.

Mean daily T_r and T_a showed virtually no difference from the background level on the third day in the tank. The shape of the circadian temperature curve also failed to differ substantially from the usual one.

On the 26th experimental day, mean daily T_r and T_a did not change, as compared to the background. However, the shape of the circadian temperature curve was different:

a drastic temperature elevation was not observed in the morning in three cases, but in the evening, whereas the fourth subject presented two temperature peaks, in the morning and evening.

The observed temperature changes during immersion apparently reflect adaptation to conditions of limited motor activity. On the first day of immersion, with comfortable heat sensations, there was a decrease of 0.3-0.4°C in body temperature. Concurrently, there was a change in tonus of antigravity muscles, as indicated by development of pain in them. In the opinion of K. P. Ivanov (1967), the antigravity muscles are the main sources of heat in the body. Subsequently, there is apparently intensification of noncontractile thermogenesis and restoration of temperature to the usual level.

10,657
CSO: 1840/999

- END -