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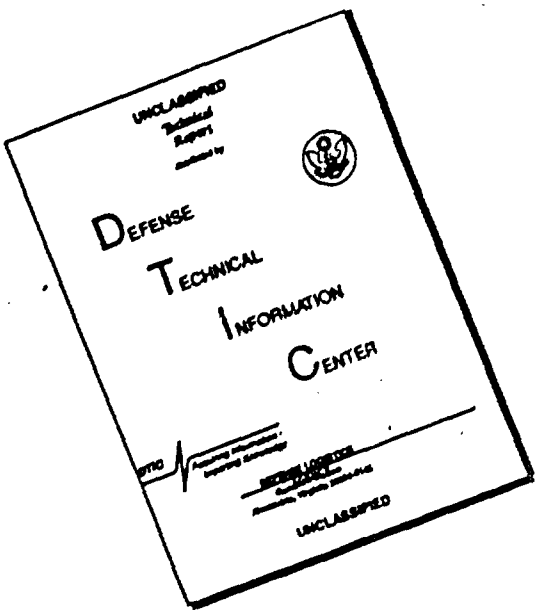


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AID Report P-63-91

3 July 1963



# SOVIET LITERATURE
# ON
# LIFE SUPPORT SYSTEMS
# A. BIOSCIENCES

AID Work Assignment No. 22

(Report No. 15 in this series)



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## FOREWORD

This report, prepared in response to Work Assignment No. 22, is the fifteenth in a series reviewing Soviet developments in life support systems. It is based on materials made available at the Aerospace Information Division through March 1963. Items are selected from Soviet open literature.

The materials in this series are grouped according to the following topics:

Part A. BIOSCIENCES
- I. Space medicine and biology
- II. Space physiology
- III. Perceptual physiology
- IV. Space psychology
- V. Space vehicle ecology
- VI. Survival conditions

Part B. INSTRUMENTATION

Materials in this report deal with topics I and II.

NASA Report P-63-91
Work Assignment No. 22
3 July 1963

# SOVIET LITERATURE ON LIFE SUPPORT SYSTEMS

## PART A. BIOSCIENCES

## TOPIC I. SPACE MEDICINE AND BIOLOGY

1) Revis, V. A. The treatment of acute radiation sickness by transplantation of homologous bone marrow preserved by freezing. Patologicheskaya fiziologiya i eksperimental'naya terapiya, no. 6, 1962, 44-49.

Experiments were conducted with 35 test and 28 control rabbits of the same breed, 5 to 6 months old, weighing 2500 to 3200 g, in which acute radiation sickness was induced by total-body x-irradiation from an RUM-3 apparatus (180 kv, 10 ma; filter 0.5 mm Cu + 1.0 mm Al; distance 40 cm). Five control animals were irradiated with 700 to 800 r and 23 with 1100 r; all the test animals were irradiated with 1100 r. A free graft of bone marrow which had been frozen in glycerin at -79°C for 24 hrs and kept at -15°C for 10 to 25 days was performed subcutaneously in the test animals 24 hrs after exposure. Prior to transplantation the bone marrow was thawed out and washed to remove glycerin by placing it for 15 to 20 min in sterile physiological saline solution with a small amount of penicillin at 37°C. Bone marrow from the thighbone and shinbone (about 2.5 g) was transplanted in 31 rabbits; bone marrow from the thighbone alone (about 1.5 g) in 4 rabbits. Subcutaneous transplantation of muscle fragment (3 to 4 g) from a healthy rabbit was performed in 5 control animals 24 hrs after exposure to 1100 r, producing traumas similar to those in the test animals (Table 1).

In contrast to the control rabbits, the test rabbits showed the following changes: 1) the greatest drop in the leucocyte count occurred between the 3d and 8th days instead of the 3d and 5th days after exposure (Fig. 1); 2) leucopenia was usually less pronounced; 3) the minimal number of lymphocytes was 4 to 16%, whereas in the controls they were either absent or occurred in an insignificant amount. At the height of leucopenia the segmented neutrophils constituted 87 to 91% of all the forms present. The erythrocytes and hemoglobin content dropped 2 to 3 days after exposure and continued to decrease for one month to 65-67% of the initial value (Fig. 2).

Table 1. Survival rate of control rabbits after total-body x-irradiation

| Nature of experiment | Dose (r) | Number of rabbits | Time of death after exposure (days) | | | | | | | | | | | | | | | Survived |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 15 | 16 | 18 | 31 | 33 | |
| Irradiation | 700-800 | 5 | | | 1 | | 1 | | | | | 1 | | | | | | | 2 |
| Irradiation | 1100 | 18 | 3 | 1 | | | | 1 | | | 1 | | 4 | 1 | 1 | 1 | 1 | 1 | 3 |
| Irradiation + transplantation of muscle | 1100 | 5 | | | | 1 | | | 2 | 1 | | | | | | | | | 1 |
| Total | | 28 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 4 | | 1 | 1 | 1 | 1 | 6 |

Table 2. Survival rate of rabbits exposed to 1100 r, after transplantation of preserved bone marrow

| Amount of bone marrow transplanted (g) | Duration of preservation (days) | Number of rabbits | Time of death after exposure (days) | | | | | | Survived |
|---|---|---|---|---|---|---|---|---|---|
| | | | 5 | 8 | 11 | 14 | 19 | 23 | |
| 2.5 | 10-15 | 10 | 1 | 1 | | | | | 8 |
| | 16-20 | 10 | | | | 1 | | | 9 |
| | 21-25 | 11 | | 1 | | | 1 | | 9 |
| 1.5 | 14 | 2 | | | 1 | 1 | | | 0 |
| | 20-21 | 2 | | | | | | 1 | 1 |
| Total number of rabbits | | 35 | 1 | 2 | 1 | 2 | 1 | 1 | 27 |

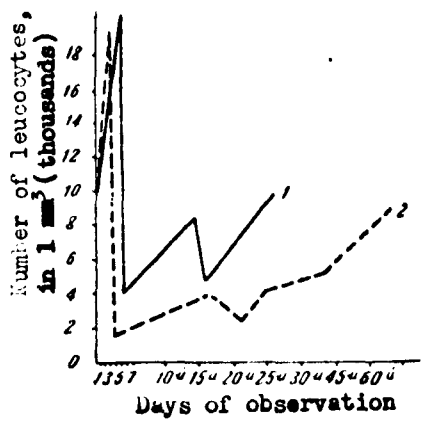


Fig. 1. Changes in number of leucocytes in peripheral blood of rabbits exposed to 1100 r after transplantation of homologous bone marrow

1 - test rabbits; 2 - control rabbits.

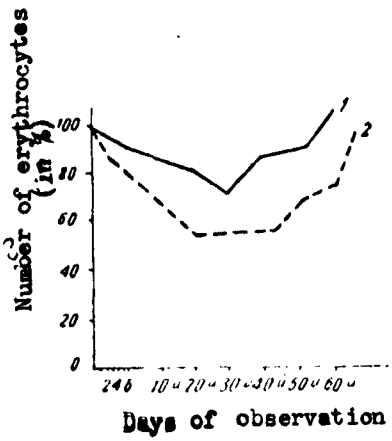


Fig. 2. Changes in number of erythrocytes in peripheral blood of rabbits exposed to 1100 r after transplantation of homologous bone marrow

1 - test rabbits; 2 - control rabbits.

The course of disease was less severe in the test animals and it should be noted that the increase in sedimentation rate was smaller. No particular local reaction occurred in the test group at the site of transplantation. The animals were observed for 2 months. The transplant was excised on the 9th, 11th, 12th, 14th, 15th, 16th, and 17th days after exposure. Histological examination showed that the bone-marrow transplants gradually necrosed, became encapsulated, and 15 to 16 days after transplantation, were transformed into detritus. Only 6 out of 28 control animals survived; 27 out of 35 test animals survived. No appreciable difference in survival rate was observed in animals in which bone marrow preserved for 10 to 25 days was transplanted. The amount of bone marrow transplanted was apparently an important factor in survival: 1 out of 4 rabbits survived with 1.5 g of bone marrow; 26 out of 31 survived with 2.5 g.

The data obtained show that transplants of bone marrow frozen in glycerin at -79°C for 24 hrs and kept at -15°C for 10 to 25 days exert a protective effect against radiation sickness. The therapeutic effect of preserved bone marrow is almost as pronounced as that of fresh bone marrow.

2) Sheremet, Z. I., and L. I. Kazanova. The effect of vitamin $B_{12}$ on the nucleic acid content in the hematopoietic organs of irradiated animals. Meditsinskaya radiologiya, no. 1, 1963, 46-54.

Experiments (27) were conducted with guinea pigs weighing 300 to 600 g exposed to 300 r from an РУМ-3 apparatus (180 kv, 10 ma; distance, 70 cm; filter, 0.5 mm Cu; dosage, 13 to 26 r/min). The test animals (54) were given 10 or 40 μg of vitamin $B_{12}$ intramuscularly every other day, from the day of irradiation to the time of decapitation. The bone marrow from the hind legs and the spleen was homogenized in water (1:5) and chilled and the nucleic acids were isolated. The DNA and RNA content was determined with an СФ-4 spectrophotometer. Smears of the bone marrow from the forelegs were taken for morphological and cytochemical studies. Comparative studies were made of changes in the content of nucleic acids in the bone marrow and spleen of guinea pigs after irradiation, after the injection of vitamin $B_{12}$, and after irradiation in conjunction with administration of vitamin $B_{12}$.

Total-body x-irradiation caused a considerable decrease in the nucleic acid content of the bone marrow and spleen (Table 1).

Table 2 shows the ratio of leucoblasts to erythroblasts (L:E) and the maturation indexes of granulocytes and erthrocytic normoblasts.

Seven days after exposure, most of the animals developed hypoplasia and aplasia of the bone marrow. The predominant hematopoietic elements included reticular cells, mature granulocytes with signs of degeneration, and plasmatic cells. The nucleic acid content decreased considerably, as did the number of erythroblasts. The decrease in the nucleic acid content of the bone marrow of irradiated animals is probably caused not only by radiation, but also by changes in the morphological composition of the bone marrow.

Vitamin $B_{12}$ given during the first half of radiation sickness usually led to a greater decrease in the DNA content of the bone marrow. In most of the experiments with animals killed 7 days after exposure, the nucleic acid content of the bone marrow of guinea pigs which had received vitamin $B_{12}$ was less (by 35%) than in the controls (Table 3). Aplasia of the bone marrow was so pronounced that the L:E and maturation indexes could not be determined (reticular cells predominated -- 89%). The vitamin caused practically no change in the DNA and RNA content of the spleen. The data obtained indicate that vitamin $B_{12}$ should not be used in the early stages of radiation sickness, but during the restoration of hematopoiesis.

Table 1. Change in nucleic acid content of bone marrow and spleen of guinea pigs after total-body x-irradiation (300 r)

| Group | No. of guinea pigs | Mean wt. before exp., g | Bone marrow | | | | | Spleen | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | In 100 mg of tissue, mg | | In bone marrow of hind legs, mg | | RNA:DNA | In 100 mg of tissue, mg | | In entire spleen, mg | | RNA:DNA |
| | | | DNA | RNA | DNA | RNA | | DNA | RNA | DNA | RNA | |
| Nonirradiated (controls) | 4 | 5[illegible] | 1,[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Irradiated 24 hrs after exposure | 2 | 5[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 3 days after exposure | 2 | 5[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Nonirradiated | 5 | 3[illegible] | 1,51[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Irradiated, 7 days after exposure | | | | | | | | | | | | |
| 1st group | 4 | 3[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 2nd group | 3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 3rd group | 3 | 344 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

Table 2

| Guinea pigs | L E | Maturation index | |
|---|---|---|---|
| | | Granulocytes | Erythrocytic normoblasts |
| Healthy, nonirradiated | 2.7-3.9 | 0.7-0.9 | 0.6-0.9 |
| 24 hrs after exposure | 5.1-6.3 | 0.4-0.5 | 0.8-1.0 |
| [illegible] | 5.5-7.0 | 0.26-0.3 | 2.1-2.3 |

Table 3. Effect of vitamin $B_{12}$ on nucleic acid content of bone marrow and spleen of irradiated guinea pigs (7 days after exposure)

| Group | No. of guinea pigs | Mean wt. before exposure g | Bone marrow: In 100 mg tissue, mg DNA | Bone marrow: In 100 mg tissue, mg RNA | Bone marrow: In entire bone marrow of hind legs DNA | Bone marrow: In entire bone marrow of hind legs RNA | Bone marrow RNA:DNA | Spleen: In 100 mg tissue, mg DNA | Spleen: In 100 mg tissue, mg RNA | Spleen: In entire spleen mg DNA | Spleen: In entire spleen mg RNA | Spleen RNA:DNA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Decrease in nucleic acid content caused by vitamin $B_{12}$** | | | | | | | | | | | | |
| Irradiated | 10 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Irradiated + vitamin $B_{12}$ | 10 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| **Increase in nucleic acid content caused by vitamin $B_{12}$** | | | | | | | | | | | | |
| Irradiated | 7 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Irradiated + vitamin $B_{12}$ | 7 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| **No change in nucleic acid content after injection of vitamin $B_{12}$** | | | | | | | | | | | | |
| Irradiated | 4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | |
| Irradiated + vitamin $B_{12}$ | 4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | |

3) Shubina, A. V. Effect of certain pharmacological preparations on experimental radiation sickness. Meditsinskaya radiologiya, no. 11, 1962, 83-85.

Three hundred white rats weighing 150 to 170 g were exposed to 700 r from an RUM-3 apparatus (180 kv, 15 ma, focal distance 40 cm, filters 0.5 mm Cu + 1.0 mm Al, dosage 34 r/min). Two series of experiments were conducted. In series I, extracts from two plants, aralia (Aralia Tournefortian) and restharrow (Ononis L.) were administered to the rats (0.8 ml per rat) immediately after irradiation and then daily for 30 days. The general condition of the rats did not improve. The survival rate of the test rats was lower than that of the controls. Administration of restharrow 20 days after irradiation caused an increase in the leucocyte count (11.3%), hemoglobin (8.3%), and monocyte count (27%), and a decrease in the number of erythrocytes, thrombocytes, and reticulocytes. After the administration of aralia the number of erythrocytes and thrombocytes decreased (17%) and of lymphocytes (21%), but the number of reticulocytes and leucocytes exceeded that of the controls (37 and 5.7%, respectively). No aplasia was found in the bone marrow of the test rats, although it was found in the controls. Six months after exposure, hematopoiesis was restored in the test rats, but not in the controls. The restoration of red blood formation was more complete but proceeded more slowly than the formation of white blood cells.

In series II, the rats were divided into the following groups: 1) controls (irradiated); 2) and 3) administration of aralia or restharrow on the 6th day after exposure; 4) administration of leucogen on the 1st day after exposure; 5) and 6) administration of leucogen immediately, and of aralia or restharrow on the 6th day after exposure. The most beneficial were the two latter combinations. The survival rate of rats in the fifth and sixth groups was twice as high as that in the controls. When only leucogen, aralia, or restharrow was administered, the survival rate exceeded that of the controls 1 1/2 times. The general condition of rats in the fifth and sixth groups was superior to that of the other rats throughout the entire experiment. Even at the height of radiation sickness (14 days after exposure), the leucocyte content was 73% higher, hemoglobin 23% higher, lymphocytes almost 2 times higher, and monocytes, 1 1/2 times higher than in the controls.

Six months after exposure, the general condition and blood indexes of rats which received restharrow and leucogen were similar to those of the healthy rats, except that the thrombocyte count was 10% less. The effect of the preparations depended on the time of administration and their combination with each other. According to previous data, it is more beneficial immediately after irradiation to use preparations such as leucogen, which do not promote oxidative processes. Aralia and restharrow accelerate oxidative processes, which explains the absence of a beneficial effect in the Series I experiments.

4) Vissarionova, V. Ya., and I. L. Chertk[illegible]. The therapeutic effect of purified properdin in acute radiation sickness in mice. Meditsinskaya radiologiya, no. 1, 1963, 62-64

Experiments were conducted with 205 white mice of both sexes weighing 18 to 20 g subjected to Y-irradiation with an absolutely lethal dose of 750 r (180 kv, 10 ma, filters 0.5 mm Cu + 1 mm Al, distance 50 cm; dosage 12 r/min). Purified properdin (obtained from bovine serum) was injected intravenously into the test animals in a single dose of 0.5 ml (3000 units/kg) 1, 24, 48, 72, or 96 hrs after exposure or in three doses 2, 3, and 4 days after exposure. The control mice (85) were given intravenous injections of physiological saline solution (0.5 ml) at the same periods of time.

After exposure to 750 r the control mice died. Their mean life span ranged from 8.3 to 10.6 days. The mean life span of the test mice was higher than that of the corresponding control groups. Two out of 20 mice which had received a single dose of properdin 3 days after irradiation survived; 3 mice out of 20 survived after repeated injections of properdin. The mechanism of the therapeutic action of properdin in radiation sickness is apparently connected with its antitoxic properties. However, properdin is such a weak protector that its independent use in the treatment of radiation sickness cannot be considered. Further research is required as to the possible use of properdin in combined therapy.

Effect of purified properdin on mean life span and survival rate of mice with acute radiation sickness

| Injected preparation | Day of injection after irradiation | Mean life span (days) | Ratio of surviving to total |
|---|---|---|---|
| Properdin | 1 hr | 10.6 ± 1.1 | 0:20 |
| Physiological saline solution | 1 hr | 8.3 ± 0.8 | 0:15 |
| Properdin | 1st day | 13.3 ± 1.3 | 0:20 |
| Physiological saline solution | 1st day | 10.6 ± 1.4 | 0:15 |
| Properdin | 2nd day | 11.0 ± 0.9 | 0:20 |
| Physiological saline solution | 2nd day | 9.6 ± 0.7 | 0:15 |
| Properdin | 3rd day | 10.7 ± 0.7 | 0:20 |
| Properdin | 4th day | 11.6 ± 0.6 | 0:20 |
| Physiological saline solution | 4th day | 9.8 ± 0.8 | 0:20 |
| Properdin | 2nd, 3rd, 4th days | 12.2 ± 0.5 | 3:20 |
| Physiological saline solution | 2nd, 3rd, 4th days | 12.6 ± 0.5 | 0:20 |

## TOPIC II. SPACE PHYSIOLOGY

1) Arkad'yevskiy, A. A. The combined effect of vibration and noise on man. Gigiyena i sanitariya, no. 10, 1962, 25-29.

Experiments were conducted for one hour with five healthy men 19 to 24 years old with normal hearing in order to determine the combined effect of noise (85 db, medium frequency) and total-body vertical vibration (frequency, 50 cps; amplitude, 15). The observations were conducted in a sound-proof chamber equipped with a 0.2BC-70 vibrator. The noise was supplied from a tape recorder; vibration from the vibrator. The noise of the vibrator was eliminated by noise-suppressing devices. The observations were made in order to determine the effects of 1) laboratory conditions without stimulation of noise or vibration; 2) noise alone; 3) vibration alone; and 4) combined effect of vibration and noise. The functional condition of the organism was determined before and immediately after stimulation, and after certain time intervals for a period of 30 min. The audiometric, chronoreflexometric, and electrocardiographic methods were used.

Laboratory conditions without stimulation caused no appreciable changes in the functions of the organism. Noise and vibration applied separately caused insignificant functional changes, with restoration of the initial reactions in 1 to 1 1/2 min. Vibration combined with noise decreased the auditory sensitivity by 8 to 10 db and delayed restoration for 3 min. The latent audiomotor reaction time without stimulation was either prolonged or shortened by 5 to 10 δ. The combined effect of noise and vibration prolonged the reaction time for 16 to 25 δ. The restoration occurred in the 3d or 5th min. The EKG showed no changes in the potentials of the myocardium after separate application of the noise or vibration stimuli. However, the combined effect of noise and vibration resulted in prolonging the diastolic phase by 0.03 to 0.07 sec and restoration of the initial index in 5 min, a pulse rate of 60 (a decrease of 3 to 5 beats), and a decreased systolic index (by 3%). The height and shape of the T-wave did not change during the experiments with the noise-vibration stimuli.

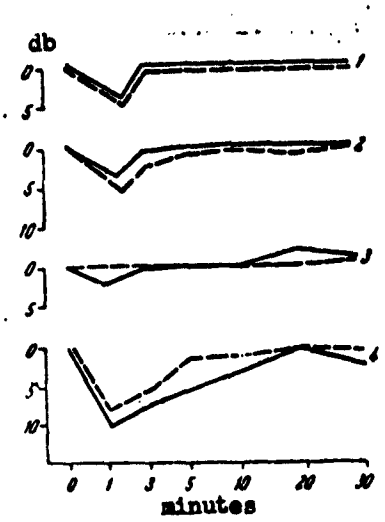


Fig. 1. Change in auditory threshold after combined effect of total-body vibration and noise

Dotted lines - auditory sensitivity to auditory signal of 200 cps frequency; solid lines - auditory sensitivity to auditory signal of 2000 cps frequency. 1 - without stimulation; 2 - after noise stimulation; 3 - after vibration stimulation; 4 - after noise + vibration stimulation.

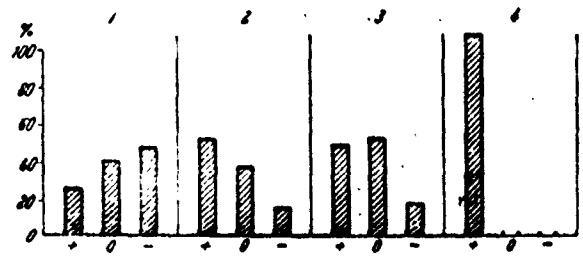


Fig. 2. Distribution of time deviations in the latent period of the audiomotor reaction

1 - without stimulation; 2 - after noise stimulation; 3 - after vibration stimulation; 4 - after noise + vibration stimulation

2) Ivanov, K. V., M. V. Zhukov, and M. G. [illegible]. Effect of accelerations produced during irradiation of animals on the course of acute radiation sickness. Patologicheskaya fiziologiya i eksperimental'naya terapiya, no. 5, 1962, 74-75.

Experiments were conducted with 44 male rats weighing 110 to 120 g which were irradiated with 1000 r from an RUM-3 apparatus (180 kv, 20 ma; 0.5 mm Cu + 1 mm Al; distance, 60 cm; dosage 38.3 r/min; irradiation and acceleration time, 26 min). The test animals (19) were irradiated during centrifugation; control group I (7) was only centrifuged; control group II (18) was only irradiated.

The irradiated rats in the test and control groups developed equally pronounced symptoms of a severe form of acute radiation sickness. All the test and control group I animals developed leucocytosis 5 min after exposure (116 to 198% of the initial leucocyte count). A drop in the number of leucoctyes (81 to 29%) occurred in control group II. The most pronounced leucocytosis (140 to 180% of original leucocyte count) occurred in the test animals (combined effect of irradiation and acceleration). A few days later, leucopenia in the irradiated animals of the test and control group II was identical. After rotation at 200 rpm, the rats of control group I showed no marked signs of vestibulosomatic reactions. A sharp decrease in the motor activity of the rats of group II occurred 1 1/2 to 2 min after irradiation. This decreased motor activity was accompanied by an absence of reaction to mild pain stimulation, and a decrease in respiration rate. Acousticomotor epilepsy, which occurred in 4 rats of control group II before irradiation, did not occur after exposure. After the combined effect of radiation and acceleration, the number of rats with increased motor excitation doubled. The mean drop in body weight in the test rats was 16 $\pm$ 0.86%; in the control rats, 21.4 $\pm$ 1.12%. The mean life span of the test rats was 10 $\pm$ 0.6 days; of rats in control group II, 8.7 $\pm$ 0.7 days.

The data obtained indicate that accelerations during irradiation did not aggravate radiation sickness.

3) Rusin, V. Ya. Effect of physical training and dibazol on the adaptation of animals to cold and heat. Patologicheskaya fiziologiya i eksperimental'naya terapiya, no. 6, 1962, 63-65.

Three series of experiments were conducted with 160 male white mice weighing 17 to 23 g and 60 male white rats weighing 180 to 250 g. Four groups of animals, with 20 mice or 15 rats in each, were used in each series. The first group (control) received daily subcutaneous injections of physiological saline solution; the second group received dibazol in a dose of 1 mg/kg; the third group was given daily training in swimming in water of 28 to 30°C; the fourth group received dibazol in combination with physical training (mice, 25 days; rats, 30 days). The resistance of mice to low and high temperatures was determined by changes in rectal

temperature after chilling for 3 min between 2 rubber bags containing ice, or heating for 3 min at 57°C with relative humidity of 30 to 40%. The reaction of rats to local chilling was determined by the rate of restoration and the skin temperature of the back of the foot of the right hind leg after chilling for 1 min with ice in a copper cylinder (Figs. 1 and 2).

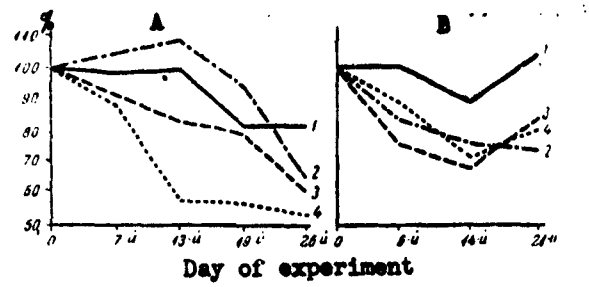


Fig. 1. Change in difference between rectal temperature before and after chilling (A) and before and after overheating (B) of white mice during the experiment (mean data)

1 - 1st group (control); 2 - 2nd group (dibazol); 3 - 3rd group (physical training); 4 - 4th group (physical training and dibazol).

On the 7th day after chilling, no changes were observed in the rectal temperature of the animals of group I; a decrease of 11% occurred in group IV. On the 13th day, the temperature of the animals of group IV decreased by 43%, while that of group III decreased by 18%. No marked changes were observed in the temperature of the animals of groups I and II. By the end of the experiments the rectal temperature in the first group had decreased by 20%; in the second group by 35%; in the third group by 41%; and in the fourth group by 46%.

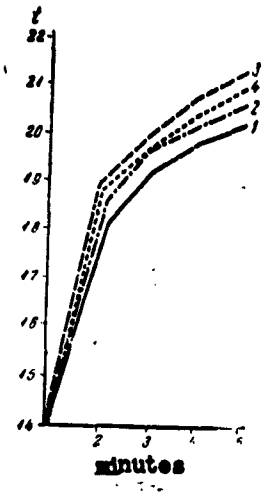


Fig. 2. Restoration rate of skin temperature in white rats after brief local chilling at end of experiments (mean data). Designations same as in Fig. 1

When exposed to heat, the animals of group I (controls) showed no change in the rectal temperature before and after the experiment. On the 6th day, the temperature of the animals of group II decreased by 16%; on the 21st day by 26%. In group III, the temperature of the animals decreased by 24% in the first week and by 31% in the second week. In group IV, the temperature decreased by 10% on the 6th day, and by 20% on the 21st day. In all the test groups the skin temperature after local chilling was restored more rapidly than in the controls. There was also a considerable difference in the maximum temperature during the period of restoration at the end of the experiments between the control and test groups (Fig. 2).

Physical training of the animals, combined with the administration of dibazol, produced a higher degree of adaptation to high and low temperatures than resulted when either of these was used separately.

4) Yakovlev, V. V. Results of investigation of some indexes of peripheral blood circulation in dogs during and after space flight. IN: Akademiya nauk SSSR. Iskusstvennyye sputniki zemli, no. 13, 1962, 130-133.

The condition of the peripheral blood vessels of the dog Belka was investigated 6 times before space flight and on the 1st, 2nd, 4th, and 5th days after flight (Table 1). Slight changes in arterial and venous tonus and rate of blood flow indicated vascular dilation.

Table 1. Data on condition of peripheral blood circulation in dog Belka

| Period | Number or period of observation | Arterial tonus | Arterial pressure, mm Hg | Venous pressure, mm Hg | Venous tonus | Rate of blood flow, $cm \cdot sec^{-1}$ |
|---|---|---|---|---|---|---|
| Before flight | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| After flight | 1st day (morn) | 0,25 | [illegible] | 12,5 | 0,027 | [illegible] |
| | 1st day (eve) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | 2nd day | [illegible] | [illegible] | 17 | 0,05 | [illegible] |
| | 4th day | [illegible] | [illegible] | 21 | 0,033 | [illegible] |
| | 5th day | [illegible] | [illegible] | [illegible] | 0,033 | [illegible] |

The results of experiments with the dog Malek are given in Table 2. The increasing air temperature in the cabin (by 2 to 4°C) apparently caused the dilatation of the peripheral blood vessels and the decrease in the arterial tonus. The high arterial tonus characteristic for the first 20 seconds of the flight began to decrease markedly 40 seconds after the beginning of the flight and continued to decrease up to the 70th second of the flight. Beginning with the 71st second, a vascular spasm was recorded (while the air temperature in the cabin continued to increase) which continued until the plethysmogram was completed. This indicates that the vascular changes were not caused by the increased air temperature, but by different flight factors.

The increase in the arterial pressure was apparently caused by strong noise and vibration stimuli. The increase in the venous pressure was caused by accelerations. No marked disturbances were observed in the dogs after flight.

Table 2. Data on the condition of peripheral blood circulation in dog Malek during flight

| Period | * | Arterial pressure mm Hg | Venous pressure, mm Hg | Arterial tonus | Venous tonus | Rate of blood flow, $cm \cdot sec^{-1}$ |
|---|---|---|---|---|---|---|
| Before flight | | | | | | |
| During flight (overload) | | | | | | |
| During flight (weightlessness) | | | | | | |

* Number of observation or time from start of flight, min

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