Medical selection of volunteer-participants in long ground-based experiments as a mechanism to improve the structure of medical care in the task for development of deep space

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I will not discuss the following off-label use and investigational use in my presentation:

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MAIN GOALS OF SPACE POLICY

• Scientific, engineering and technological research and development for realization of full-scale space program

• Profound research and exploration of the Universe

• Further development of the International cooperation in advanced manned space missions for mutual benefits

Foundations of Russian Federation Policy in the field of Space Activity up to 2020 and for the future, approved by the President of Russia
• Continue the fundamental and applied physiological and biological research of the ISS, space transportation systems and unmanned spacecrafts, including on the basis of international cooperation

• Accumulate the new biomedical data related to the super prolonged orbital manned flights and future flights of crews to the Moon and Mars

• Provide the medico-engineering and ergonomic support of new manned space systems

• Improve system for the medical support of human in space
MEDICAL RISKS IN SPACE FLIGHTS

Unpredictable accidents
- trauma and damage
- psychological stress
- consciousness loss
- death

Artificial environment
- hypo- and hyperoxia
- intoxication
- hypo- and hyperthermia
- bacterial or fungi infections

Isolation and sensory deprivation
- psycho-neurological disturbances
- sleep disorders
- desynchronosis

Space Radiation
- radiation induced tumors
- acute or chronic radiation sickness

Microgravity, 1/6 and 1/3 g
- kidneys stone
- osteoporosis and lowering of mechanical properties
- muscles atrophy and lowering of contraction force
- deconditioning of cardiovascular system
PERSPECTIVES OF WORKS ON THE GROUND-BASED MEDICAL-TECHNICAL EXPERIMENTAL FACILITY

• Modelling work of the cosmonauts on the surface of a under-exploration planet after long-term space flight («ISS-MARS» project)

• Simulation of the lunar expedition with the imitation of weightlessness effects and work on the Lunar surface

• Activity on the surface of under-exploration planets (Lunar and Martian bases)

• The creation of the module with hypomagnetic field and investigation on influence of this factor on the human and animal organisms

• Development of computer models and technologies of virtual reality for the preparation to the activity on planets under exploration
THE PROJECT «MARS-500»

- **1st STAGE(14-day isolation):** November 2007
- **2nd STAGE(105-day isolation):** March – July 2009
- **3rd STAGE(520-day isolation):** June 2010 – November 2011
The first stage of the project for a period of 14 days (November 2007) was held in two modules of the medico-technical complex.

- a residential module EU 150 - volume of 150 m³
- a medical power plant EU 100 - volume of 100 m³

**Purpose:**
- check the conformance of technical and operational system characteristics of modules, where had to live crew
- evaluation of their usability and maintainability

**Crew** consisted of 6 persons. Volunteers had to spend 14 days in isolation.

**Results** showed that the modules correspond to all necessary requirements.
The second stage of the project for a period of 105 days was held from 31 March to 14 July, 2009.

Purpose:
• obtaining and analysis of scientific-technical information for optimal organization of preparation
• efficient conduction of the main experiment simulating all the stages of a manned flight to Mars
The task of experiment:

• The study of physiological and psychological adaptation of the crew members in conditions of autonomous existence;

• The study of the interaction of the crew with the center's staff management with a view of a delay in communications and others;

• The research program of the 70 experiments was tested and obtained new scientific data on the physiology, psychophysiology and psychology of man in the conditions of model experiment;

• Significant individual variation in the nature of the adaptive reactions, which is apparently caused by different the level of the functional reserves of the crew members;
THE PROJECT «MARS-500»
- 2nd STAGE (105-day isolation)

The task of experiment:

• Criteria of medical and psychological selection and training of the crew for a 520 daily of the experiment were specified;

• Measures have been developed to finalize the experimental medico-technical complex.
The third stage of the project for a period of 520 days was held from June 2010 to November 2011. The experiment was conducted in a ground-based medico-technical complex, consisting of 5 sealed compartments of the total volume of 550 cubic meters, where is ensured by the autonomy of the functioning and almost complete isolation from the outside world.

**Purpose:** Study of mechanisms of human adaptation to the simulation conditions manned expedition to Mars and development of scientific bases of medical-biological ensure super-long orbital and interplanetary missions.

**Crew:** 6 persons, male aged 25 - 50 years
THE PROJECT «MARS-500»
- 3rd STAGE (520-day isolation)

**Data obtained:**

- State of the physical and mental health, working ability and behavior in the simulated flight conditions;

- The Habitat and life support systems;

- The effectiveness of means and methods of diagnostics, treatment and prevention of adverse changes in the body;

- The effectiveness of medical and psychological selection and training of the crew
The aim of the project is to use the international space station to work out issues of biomedical and technical maintenance on super-long manned space flight, including problems of medical care and the effectiveness of the medical crews clustered on the surface of planets (Moon, Mars, asteroids)

Project objectives:

• assessment of the feasibility of effective action on the surface of planets developed after long exposure to the microgravity of interplanetary flight.

• effects on the human body super-long flight (Earth-Mars-Earth), the creation and development of autonomous systems of health care, prevention and correction of adverse effects of microgravity on the human body.

• the establishment and development of autonomous means of sustenance and protection of crew members developed on the surface of planets (spacesuits for planetary, planetary and small protective modules, vehicles
• The further presence of the people in low-earth orbits to make efficient use of the space, the expansion of the circle of specialists, directly involved in space activities, as well as create a reserve for the release of a person outside of near-earth space.
• The exploration of the moon - strategically important natural satellite of Earth, which is located in the available near-earth space, holding the reserves important for vital activity of human resources, providing unique opportunities for a wide range of scientific research and technological experiments as well as valuable object for scientific study.
• Creation of technological reserve and the implementation of the interplanetary flights to Mars and the nearest asteroids. Detailed studies of Mars robotic devices. The beginning of realization of interplanetary manned flights.

The document "development strategy of the Russian cosmonautics", approved by the Deputy Head of the Russian Federal Space Agency A. Davydov (2011), the strategic goals of manned space exploration to meaningful 2050 year
FUTURE MANNED MISSIONS -
THE MAJOR FACTORS AND PROBLEMS

Flights to the Moon and Mars

Habitability (artificial habitat quality, biological life support systems, artificial biocenoses)

Exobiology (quarantine, searching for evidence of modern and past life)

Psycho-physiological problems: selection, compatibility, ergonomics, biorhythms, psychological support

The modified gravity (effects, adaptation, remote consequences), investigating and treating medical risks

Ionising radiation (Galactic cosmic rays, Solar cosmic rays, secondary neutrons)

The problem of autonomous medical care and prevention

Ionising radiation (Galactic cosmic rays, Solar cosmic rays, secondary neutrons)
One of the key scientific engineering, technological, organizational problems and main directions of development of biomedical care is construction of special medical module - «Biomedical laboratory» in the orbital station for:

- processing different methods and tools to use in the interplanetary flights
- carrying out a large number of researches with participation of astronauts and experiments on animals
- assessing sanitary-hygienic condition of the Russian segment and determining possibility of its further functioning
From biomedical laboratory of ISS
to autonomous medical center

• The construction of such laboratory implies to use one of the two science energy modules (SEM), whose volumes and energy may deploy and exploit the scientific and staffing equipment for the decision of tasks of medical care and realization of biomedical research.

• Development and testing of this module in orbital flights, in particular, at the stage of exploitation SEM in the ISS, should be the basis for the construction of similar objects when constructing moon bases and at flight to Mars.
SPACE BIOLOGY AND MEDICINE
(past, present and future)

Y. Gagarin
108 min
Gemini-7 13 d 18 h
Soyuz-9 17 d 17 h
Skylab-4 175 days
V. Lyakhov 84 days
V. Ryumin
L. Kizim
V. Soloviev
V. Titov
M. Manarov 366 days
O. Atkov 237 days
V. Polyakov 438 days
Flight to Mars ~ 500 d

Salyut-1
1961
Salyut-4
1974
Salyut-6
1977
Salyut-7
1982
Mir
1986
ISS
1998

past, present and future