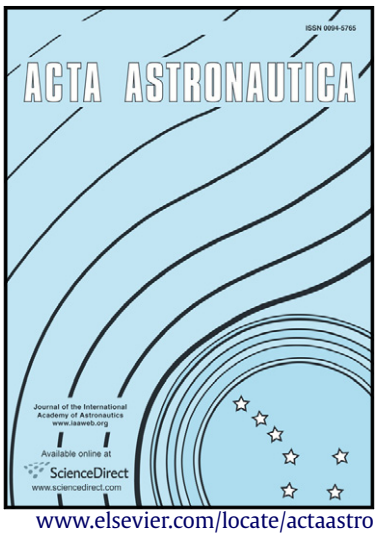

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O.I. Orlov, V.N. Sychev, G.I. Samarin, E.A. Ilyin, M.S. Belakovskiy, A.R. Kussmaul

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MULTIDISCIPLINARY RUSSIAN BIOMEDICAL RESEARCH IN SPACE

O.I. Orlov
SSC RF-IBMP RAS, Russia, orlov@imbp.ru

V.N. Sychev, G.I. Samarin, E.A. Ilyin, M.S. Belakovskiy, A.R. Kussmaul
SSC RF-IBMP RAS Russia, info@imbp.ru

Abstract

Research activities on a comprehensive multidisciplinary program are vital to enhancement of the system of crew medical care, environmental health and hygiene in space missions. The primary goal of the program must be identification of patterns, intensity and dynamics of structural and functional shifts in organism induced by an aggregate of spaceflight factors including microgravity, isolation, artificial environment, space radiation, etc. Also, the program must pursue differential assessment of emerging deviations from the standpoint of adequacy to the spaceflight conditions and prospects of returning to Earth and guide the development of principles, methods and techniques necessary to maintain health and working capacity of humans during short- and long-duration missions and on return to Earth. Over 50 years, since 1963, the IBMP researchers apply systemic and innovational approaches to fundamental and exploratory studies in the fields of medical sciences, radiation biology, engineering science, biotechnology etc. with participation of various biological specimens and human volunteers. Investigations aboard manned spacecrafts and biological satellites as well as in ground-based laboratories further enhancement of the medical care system for crews on orbital and remote space missions; they give insight into the fundamental problems of gravitational physiology and biology, psychophysiology, radiation biology, and contribute thereby to the development of knowledge, methods and technologies, as well as medical and scientific equipment.

I. INTRODUCTION

Institute of Biomedical Problems was founded in 1963 to be at the head of the USSR programs of space biology and medicine research, and building the system of medical care, environmental health and hygiene for manned spacecrafts. In 1998, the Institute was formally assigned leadership in defining the content and implementing the national program of biomedical research and experiments onboard the Russian segment of the International Space Station.

Multidisciplinary fundamental and exploratory studies of the Institute cover medical sciences, radiation biology, engineering science, biotechnology, etc. having as objects various biological specimens and human volunteers.

Methodology of scientific data acquisition comes down to three approaches: direct estimate of space factors' effects on the human body with participation of space crewmembers on mission, ground-based modeling space effects of specific concern, and use of biological models for investigations in real space flight. Each approach has merits and limitations. Evaluation of the influence of physical factors on the human body reveals their synergic effect, shed light on risks to the human from participation in space flight and evoke search for risks mitigation or abatement. However, data standardization is hardly possible because of individualized countermeasures planning. In addition, bioethics restrictions on the use of invasive procedures complicate all-round and accurate assessment of human physiological systems both in space flight and ground-based test models giving no way of studying some systems, tissues and organs, with the use of new cellular and molecular biology techniques in particular. Besides that, despite the rather elaborate methods of simulating specific factors, absolute reproduction of even the zero gravity effects alone is unattainable in theory. Because of this, launches of bio-satellites with animal models are a good alternative, despite the complexity of extrapolating findings on the human organism. The paper reviews the Russian space multidisciplinary investigations except for the description of ground-based simulation studies.

II. INVESTIGATIONS IN PILOTED MISSIONS

The primary goals of scientific researches in orbital missions are:

- establishment of patterns, intensity and dynamics of structural and functional shifts in the human organism induced by the aggregate of spaceflight factors (microgravity, isolation and confinement, artificial environment, space radiation, etc.);
- identification of casual relationships underlying these shifts;