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Radiation Effects and Risks in Human Space Missions (4)

Author: Prof. Igor Ushakov
Institute for Biomedical Problems, Russian Federation

Dr. Andrey Shtemberg
Institute for Biomedical Problems, Russian Federation

KEY ISSUES OF RADIATION PHYSIOLOGY IN THE CONTEXT OF PLANNING EXPLORATION SPACE MISSIONS

Abstract

In space exploration missions, such as a projected mission to Mars, traverse of the Earth's radiation belts and long exposure to galactic cosmic radiation will increase significantly the risk of functional disorders in crewmembers caused by the radiation factor. There are two key issues that require further experimental investigations. Namely, they are CNS functional disorders due to chronic exposure to ionizing radiation and evaluation and prediction of individual nonspecific resistance and radioresistance of organism. The CNS functional reaction to doses of up to 0.5 Sv, which are realistic in exploration mission, boils down typically to growth of the generalized excitation and appreciable attenuation of inhibitory processes, probably for the reason of cortical neurons tone decline and efficiency reduction (particularly in the event of chronic exposure). These developments point to a decreased CNS functioning and, possibly, uprise of the asthenic syndrome. By and large, they may suggest the risk of deterioration of the crew ability to work in to the radiation environment of remote space. There are quite many methods for experimental evaluation of shifts on different levels of the CNS organization - from neurochemical to integrative (behavior), - and identification of several basic markers of CNS functional disorders that may be essential for addressing the issues under consideration. These include evaluation of relationship between serotonergic and norepinephrinergic activities within the brain neurotransmitter system (neurochemical level), investigation of electrophysiological changes (quantitative EEG Fourier-spectrometry), and analysis of complex forms of behavior simulating various aspects of operator performance (integrative level). Fundamental analysis of radiation effect modifiers is crucial for understanding changes in the CNS function. Therefore, an adequate system of radiation effects evaluation should, first and foremost, enable investigations of individual traits of the CNS functioning, modifiers (nonradiation spaceflight factors), combination of experimental (with animals) and clinical-physiological methods, selection of an efficient set of technologies for studying changes on all levels of CNS organization, consideration of specific features of space radiation, and extrapolation from experimental data. A new method for evaluating and predicting of individual radioresistance in animals by the criteria of hormonal regulation closeness to the population norm was experimentally validated.