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Editorial Open Access

Factors Driving Benefit and Risk for Astronaut Health on Deep Space Missions

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Editorial

During periods of space travel, astronauts live in microgravity (MG) which has long been known to have deleterious effects on human physiology and may have psychological consequences [1]. As humans attempt to further explore the solar system, the duration of space voyages will increase and the risk to astronaut health must be protected by implementation of a range of mitigation strategies. Such strategies include development of pre-screening algorithms to select astronauts tolerant to the space environment, regular exercise, pharmacological intervention and mental stimulation strategies to assist with the management of long periods of boredom. The recent publication of a pan-space agency International Roadmap for Artificial Gravity Research [2]signifies the recognition that one major obstacle to reducing the effects of microgravity is the development and deployment of systems in space which will generate artificial gravity (AG) under rotation speeds in a centrifuge and with either continuous or intermittent regimes which are acceptable to astronauts.

Predominantly in the domain of science fiction up until now, a recent study has demonstrated that AG deployed on the International Space Station (ISS) attenuated the effects of MG on muscle and tissue atrophy, restoring soft and hard tissue mass to nearly the same levels than animals which experience 1 g on Earth [3]. These studies are important as they represent the first proof of principle that AG deployed in space can ameliorate some of the effects of MG on a living organism. The next steps will be to explore what fraction of Earth gravity is both necessary and sufficient to maintain normal physiology and function and in the case of the study in mice, this can readily be assessed by variation of the centrifuge rotation to speed to mimic the gravitational field found on the Moon (0.16 g) or Mars (0.38 g). In parallel, Earth bound studies in humans using various model systems such as head-down tilt bed rest and spring suspension studies may inform on the minimum period for which astronauts need to reside in a habitat which delivers AG and by 2024, it is anticipated that human studies in a short-radius centrifuge will be conducted in the space environment.

Today, travel to Mars by humans is expected to take approximately one year and health effects can be understood from astronauts who have spent a similar length of time on board the ISS. A growing number of astronauts have logged greater than one year on the ISS and the twins study, exploring how a one year mission affected the health of an astronaut compared with his twin on Earth was completed in 2016. Data are reporting on measurements of DNA and RNA mutations and levels of telomerase which functions to protect chromosomes from deterioration. Although concepts for deeper space travel are very much in their infancy, space agencies have started to devise strategies for rapid space propulsion and extension of functional human life in space. Such strategies include development of hyperspace travel, self-sustaining world ships and hibernation or cryogenic technologies. For the distant future, there will many challenges for occupational health and the methodical and rigorous approach being adopted today will stand us in good stead for protecting astronaut health.

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