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Perspective

Long March to Live on Mars: Medication and Physiological Challenges

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Human ambition in space exploration is limitless. By the landing of Apollo 11 on the moon on July 20, 1969, mankind has initiated the beginning for the interstellar traveling era. The next breakthrough after reaching the moon will be visiting then colonization of Mars. National Aeronautics and Space Administration (NASA) has announced its willingness to put man on Mars by 2030s [1]. The time that will be spent on this long trip will be about three years during which astronauts will face different hostile conditions that will impact their health [2]. In addition, accidents may occur during the mission which requires medical emergency intervention. Investigations showed that astronauts had to take at least one medication during their relatively short missions into space [3]. Thus, ensuring the availability of enough stock from a broad range of drugs and medicines is mandatory when traveling to Mars.

The role of medications will not be confined to treating sickness conditions but also in emergency cases such as shock, trauma and bleeding as well as protecting bodies of astronauts from adverse environmental conditions in space. However, the required effect of the medicinal dosage form in space flight may not work as could be expected on earth for several reasons. Human body physiology is altered in space with subsequent modification in the bioavailability, pharmacokinetics and pharmacodynamics of the drug [4]. Stability of the pharmaceutical dosage form is questionable in space where the storage conditions are different from that on earth, especially the high levels of radiations which may affect the product adversely resulting in faster degradation for sensitive materials. Also, it may be important to modify the formula and packaging of the medicinal product for convenience of use in microgravity condition in space [5]. Importantly, a specific type of shields may be developed as a lining layer in the spacecraft to protect and enclose not only cosmonauts but also the sensitive materials and even electronics from the destructive effect of radiation from space.

Apart from genetic alteration (to combat radiation) and artificial gravity condition that could be created during the trip in the space shuttle (if that was put into consideration during design of the mission and spacecraft), a comprehensive list of medications that should be carried onboard must be established to fulfill the urgent need for the health and safety support of the astronauts as there is no way to come back during the journey to bring forgotten or depleted medicines. Compact clinical laboratory system based on Artificial intelligence (AI) should be rendered available in long missions for diagnosis of any disease conditions that may occur during travel. An example of this situation is an infection that requires culture from a specimen of the ill individual(s) before choosing the most appropriate antibiotic or antimicrobial for the treatment of the infected member from the pharmacy store on the space vehicle by the professional medical astronaut doctor.

Some researchers have listed the impact of harsh space conditions on human body physiology which may be exacerbated during long-term missions more than low-earth orbital ones [1,6]. Many of these problems are linked to microgravity conditions and even on Mars low gravity condition constitute a problem on long-term living. The gravity of Mars is 3.71 m/s^2, while that of earth is 9.81 m/s^2 [$G_E > (G_M \times 2.6)$] [7]. These health problems include:

Space (Zero-G) Sickness: Similar to motion sickness experienced on earth during flight in airplane and sea travel, imbalance felt by human brain center - that is responsible for spatial orientation - causes nausea and severe feeling of unwell-being which may last for several days. This problem occurred in 1968 during Apollo 8 mission to Moon to an astronaut [1]. In such instances, motion sickness medication may provide a flee from this illness.

Mental Health: When a human subject is being left in confined space for long time with only limited view through small window into darkness, the mental health, emotions and thoughts may be impacted in a way that could impact the mission adversely [1,8]. Moreover, the natural clock that controls awakening and sleeping may be impaired. In these situations, the presence of anxiolytic and psychotropic treatment could be used. In addition, other measures that could be set in spacecraft to make the place more friendly as home earth. Also, telepsychological monitoring and support by a psychologist will be crucial from the ground control center

Muscle Weakness: Muscle weakness during space travel is also among the health problems which could be expected that should be minimized by regular daily exercises in an area dedicated for a gym in the spacecraft and held by a belt to the exercise machine [1,6]. Several medications also can be used for muscle weakness, especially if associated also with sleeping disorders.

Visual Deterioration: Space fights that last for more than six months impact eye function due to changes in its structure as declared by NASA [11]. Eye aiming and location determination of the objects could be impaired under zero-G [10]. On the other hand, irreversible vision distortion may occur due to change in the eye lens shape due to fluid shift to the head and cranial bulging behind the eyeballs. This hurdle may end up with astronaut wearing glasses to correct vision problems [1].

Weight-Bearing Bones Problems: The weakening of human bones may occur in a prolonged state of weightlessness [12]. As the other problems related to zero gravity, the creation of artificial gravity that mimics that of the earth may solve the problem. Otherwise, a prophylactic medical treatment could be used as those used in Osteoporosis.

Anemia After Return: Neocytolysis is a selective destruction of new red blood cells (RBCs) that occur after returning from space travel (high altitude) to the earth. This symptomatic anemia occurs also if the human body is subjected to the same situation. Prevention of this condition can be achieved by using erythropoietin (EPO) injections [13]. In general, many changes in blood picture should be considered and taken into account.

Puffy Appearance Accompanying Head Congestion: A fluid shift that occurs in zero-G condition results in the accumulation of the body fluid in the head with consequent puffy face appearance of the astronaut. The brain is floating slightly higher in the zero gravity condition. That additionally may help clarify a few symptoms seen in returning space travelers. The more they had spent in space, the more pronounced effect could be observed on their gray matter [14].

Disorientation: Space travelers encounter comparative vibes of tipsiness and bewilderment amid their initial couple of days in the microgravity condition of the room. After coming back to Earth after a delayed presentation to microgravity, space travelers much of the time experience issues standing and strolling upright, settling their look, and strolling or turning corners in an organized way. A space explorer's feeling of adjusting and body introduction sets aside an opportunity to re-adjust to Earth-ordinary conditions. Something about the vestibular framework clearly adjusts to evolving conditions during space flight [15].

Decreased Efficiency of The Immune System: Exposure of human to a myriad of stressors along the whole spaceflight mission may contribute to immune system dysfunction, in addition to oversensitization of some cosmonaut manifested as hypersensitivity signs [16]. Accordingly, Immunomodulating or medicines that support immune system should be considered for cosmonaut during space missions.

Leg and Spinal Muscles Shrinkage: Upon long stay in space during microgravity conditions, shrinkage of leg and spinal muscles of cosmonauts and become weak. The effect of zero-G could be minimized by regular daily physical exercises for two hours to maintain the health the muscles as well as the bones. Due to the absence of gravity in the space as in International Space Station (ISS), special modifications to the training exercise instruments were made such as a hanging device [6,17].

Fluid Redistribution: Fluid shift in the cosmonaut body is a consequence of the microgravity condition [18]. The impact of fluid redistribution on some of human organs has been discussed previously. Moreover, renal excretion rate increases and the risk of developing renal stones is elevated, if coupled with accelerated loss of bone mass [6]. Thus, drugs that protect kidneys from renal calculi may be deemed necessary in such instances.

Radiation Hazard: Earth's magnetic field provides a protective shield from radiations for those on it or low orbiting space shuttles or stations. However, in the deep space cosmonauts become exposed to various types of hazardous radiations: non-ionizing (ultraviolet (UV)) and ionizing (solar energetic particles, trapped particles and galactic cosmic radiation). The liability for malignancy dangers from people strike by radiation is broad for dosages over 100 millisieverts (mSv) [19]. Accordingly, providing the astronauts with radio-protected habitat, protective medical treatment may be used and/or alteration in specific genes of the cosmonauts could provide protection of the human cells from adverse consequences of the long exposure to radiation in space.

Infections: Microbiological quality of the environment, food, water and medicines should be carefully controlled to avoid any exposure of an astronaut to adventitious pathogenic or objectionable microbial contaminant. The problem that is related to the deficiency in the function of the immune system of the astronauts in space has been discussed before and it renders them more susceptible to infections which may require suitable treatment with appropriate antimicrobials in an appropriate pharmaceutical dosage form depending on the site of the infection. As a component of the present Health Stabilization program, space travelers are secluded from contact with others in the herd for a timeframe more noteworthy than the incubation time frame for the most basic viral upper respiratory tract, gastrointestinal viral, and bacterial diseases. Segregation starts seven days before dispatch [20].

Medical Emergency: Emergency cases are numerous and different scenarios could be expected in space such as trauma, fractures, injuries and bleeding [21]. Accordingly, different medications (such as blood plasma substitute, anaesthetic drugs, glucose solution, etc.) should be considered to treat such situations which require a space physician and well-trained cosmonauts in order to handle these situations correctly.

Conclusion

Apart from many challenges that face astronauts in space travel, in addition to the problems that will be associated with early attempts of interplanetary colonialism, the health and safety of human members of any space travel will be of prime priority. To achieve this goal, there should be a combined solution of physical, chemical and biological methods and modifications that will support the cosmonauts in the surrounding hostile environment. It will be important in these early missions to provide drug inventory with divergent types of medicines that will cover all possible cases of health compromisation until a self-sufficiency could be attained by a suitable technology. Achieving self-sufficiency is an important step in the colonization of other planets.

Bibliography

1. Jurblum M. "Getting Sick In Space On The Way To Mars". Pursuit (2018).
2. IANS. "NASA To Explore How 3-Year Mars Mission Could Affect Humans". BGR India (2017).
3. Davis Betsy. "Pharma On Mars: Getting Drugs Ready For Deep Space Travel". Pharma.Elsevier.Com (2017).
4. Kast, Johannes., *et al*. "Drugs in space: pharmacokinetics and pharmacodynamics in astronauts". *European Journal of Pharmaceutical Sciences* 109 (2017): S2-S8.
5. Mehta Priti and Dhara Bhayani. "Impact of space environment on stability of medicines: Challenges and prospects". *Journal of Pharmaceutical and Biomedical Analysis* 136 (2017): 111-119.
6. Hodkinson PD., *et al*. "An overview of space medicine". *British Journal of Anaesthesia* 119.1 (2017): i143-i153.
7. Calhoun Philip., *et al*. "Conceptual design and dynamics testing and modeling of a mars tumbleweed rover". 43rd AIAA Aerospace Sciences Meeting and Exhibit (2005).
8. Kanas Nick., *et al*. "Psychology and culture during long-duration space missions". *Acta Astronautica* 64.7-8 (2009): 659-677.

9. Stein TP. "Weight, muscle and bone loss during space flight: another perspective". *European Journal of Applied Physiology* 113.9 (2013): 2171-2181.

10. Ross Helen E. "Haptic perception in space travel". Human Haptic Perception: Basics and Applications". Birkhäuser Basel (2008): 273-280.

11. "NASA Finds That Space Flight Impacts Astronauts' Eyes And Vision". American Academy of Ophthalmology (2013).

12. "Space Bones | Science Mission Directorate". Science.Nasa.Gov (2001).

13. "NASA - Effects Of Microgravity On The Haemopoietic System: A Study On Neocytolysis". Nasa.Gov (2016).

14. Ornes S. "En Route To Mars, Astronauts May Face Big Health Risks". Science News For Students (2018).

15. "NASA - Human Vestibular System In Space". Nasa.Gov (2004).

16. Frippiat Jean-Pol., *et al*. "Towards Human Exploration of Space: The THESEUS Review Series On Immunology Research Priorities". *NPJ Microgravity* 2.1 (2016).

17. Grush Loren. "Astronauts' Spinal Muscles Shrink And Weaken After Long Stays In Space". The Verge (2016).

18. "NASA - Fluid Shifts Before, During And After Prolonged Space Flight And Their Association With Intracranial Pressure And Visual Impairment". Nasa.Gov (2018).

19. Mars Kelli. "Space Radiation Risks". NASA (2018).

20. Mermel LA. "Infection prevention and control during prolonged human space travel". *Clinical Infectious Diseases* 56.1 (2012): 123-130.

21. Kuypers MI. "Emergency and wilderness medicine training for physician astronauts on exploration class missions". *Wilderness and Environmental Medicine* 24.4 (2013): 445-449.

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