Chapter 2
Innovations and Challenges in Space Medicine and Healthcare

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ABSTRACT

The lack of readiness levels for humans is delaying their inclusion in technology development and making it difficult to identify human health hazards. Developing medical capabilities for spaceflight independently and creating a safety framework is crucial for aligning spaceflight medical capability with terrestrial medical requirements. Space travel affects human health due to physiological changes, stress exposure, and limited medical care. Flight surgeons play a vital role in safeguarding astronauts' wellness and functionality. Some studies have suggested strategies to help astronauts overcome challenges, including 3D printing for personalized medicine in space exploration. Spaceflight affects crewmembers by exposing them to physical and mental stressors, requiring adaptation to microgravity, and reducing their infection-fighting ability. Space travel affects human health at the cellular level and influences processes like cancer cell survival. Proposed solutions for space medicine include Point-of-care Ultrasound Training and AI algorithms for automated image interpretation.

DOI: 10.4018/979-8-3693-6869-5.ch002

1. INTRODUCTION

Overview of Space Medicine and its Relevance to Healthcare on Earth

Space medicine encompasses all aspects of preventative medicine, including screening, health care delivery, and maintaining human performance in the extreme environment of space. It also involves preserving the long-term health of space travellers. Space medicine is essential for future orbital and interplanetary space flights, and it contributes to the development of Earth medicine. This development is driven by the extreme environment and limited resources of space, leading to the invention of new technologies to cope with these conditions. Space technology refers to any technology related to activities in or exploration of space. Research objectives in space medicine include early detection of illnesses and statistical studies to aid in epidemiology. Additionally, there are potential future opportunities that could benefit the development of mankind and Earth medicine as a whole (Shirah et al., 2022).

In healthcare and medical technology, space plays a crucial role in driving innovation for medical assistance and healthcare under extreme conditions. Advances in space life science research are being applied to help improve healthcare delivery on Earth, particularly in remote locations and during natural disasters. This explores the similarities between healthcare in crewed space missions and terrestrial healthcare to identify potential solutions for challenges in epidemics and pandemics. While space medicine developments may offer insights, their practical application to global health on Earth has limitations, as they are based on research studies on astronauts and may not fully translate to a larger population. The dynamics of analogue astronauts during ground-based space missions may have parallels with smaller groups in society, but might not accurately represent larger-scale populations (Cinelli & Russomano, 2021).

Scientists around the world are studying the effects of microgravity and cosmic radiation using the International Space Station (ISS) as a laboratory platform. The ISS has facilitated discoveries that extend beyond our basic understanding of Earth. Over 300 medical experiments have been conducted to date, aiming to expand our knowledge for the benefit of humanity.

The numerous medical findings from space identify challenges and gaps and put the achievements into perspective for long-term space travel while also benefiting our home planet. The medical contents are structured into three parts: the well-being of space travellers (astronaut health studies), medical formulation research under space conditions, and a blueprint for space pharmaceutical manufacturing. This covers essential elements of Earth-based pharmaceutical research such as drug discovery, drug and formulation stability, drug-organ interaction, drug disintegration, bioavail-