Design for Future of Health and Safety in Commercial Human Spaceflight: Human-Centred Exploration Medical Ecosystem Design Infrastructure

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ABSTRACT

In conventional practice, medical systems requirements for human spaceflight are considered towards the end phases of a space systems engineering project, leaving little room for the integral medical requirement codification within spacecraft design parameters (NASA ExMC, 2021). As mission character increases in length and remoteness, the level of care and required medical capabilities increase dramatically. The longer and more remote the mission, the greater is the need for human-centeredness. To address that, it is crucial to incorporate a human-centric approach at the early stages of defining key mission architecture parameters and constraints of mission and vehicle/habitat planning. *'[Human] spaceflight has reached a critical moment where the transition to a human-centric mission architecture must become reality if exploration missions are to succeed'* (Antonsen, 2017).

This paper presents an overview of the current state of the art and the diversity of approaches within prospective orbital, suborbital and deep-space missions and scope opportunities within a design for health and safety in commercial space transportation. It provides a rationale for the development of Exploration Medical Ecosystem Design Infrastructure (ExMEDI) as a method and a tool to define medical capabilities required for specific future spaceflight contexts, and optimize design requirements for healthcare systems, such as a medical workstation or medical bay, to best support crew's health. The ExMEDI would serve as a tool compatible with currently developed system architecture solutions to calculate health risk, and would allow to the integration of human-centered parameters, such as crew profile and needs, as well as medical capabilities, instrumentation, and material requirements, to optimize the solutions for specific mission contexts and characters, such as extended LEO habitation, space hotel facility, lunar space station, or transit to Mars.

Keywords

Human-Centered Requirements Driven Medical Systems, Space Medical Bay System Architecture, Design for Healthcare Futures, Transdisciplinary Parametric Optimisation, Second-Order Cybernetics