

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)  
Medical Care for Humans in Space (3)

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INVESTIGATING THE FEASIBILITY OF 3D-PRINTING CUSTOMIZED PHARMACEUTICALS FOR  
LONG-DURATION DEEP-SPACE HUMAN MISSION

**Abstract**

For long-duration missions to the Moon and beyond, the crew sizes will be bigger and the group-setup will be more diverse. So the personal needs for medicines will become more complex. By this, the availability for certain pharmaceutical substances will be limited with respect to the logistics of either prefabricated medicaments being shipped with resupply, or the local production of these by means of local machinery and local basic chemical compounds. Additionally, zero-gravity conditions affect the drug stability resulting in deterioration of the chemical composition and unpredictable potency and safety, emphasizing the need for on-site synthesis. Both situations, dependent re-supply vs. independent manufacturing, pose different challenges with respect to logistics. With the emerging 3D-printing technologies, producing customized medicines locally and in-time is becoming possible. It enables the advantage of reducing warehousing a huge catalogue of prefabricated medicines and allows a tailored approach of taking common building blocks and combining them in the demanded specification. This paper will show the feasibility of fabricating the most subscribed medicines with the least amount of different basic building blocks. It shall emphasize on the optimization problem on the selection of chemicals to be stocked and stored at the beginning of the mission to allow the fight against the most common illnesses. The paper will suggest possible synthetic pathways for active compounds and excipients (bulking agents) on-site based on the most common building blocks. The candidates for synthesis will be selected according to medical emergency and the possible 3D-printing solutions will be presented, as well as implications for future Earth- and Space-based commercial applications and markets. Our main focus is directed to medications for treatment of health complications as a result of different living conditions on-board (blood pressure variations, musculoskeletal changes, psychological issues) and injuries obtained by executing mission tasks (infections, physical injuries, internal organs failure). The study will derive further classes of treatments. Furthermore the paper will show Earth centered applications fulfilling and enabling the Goal 3 "Good health and well-being for people" of the United Nations (UN) Sustainable Development Goals (SDG) that aims to achieve universal health coverage, including access to essential medicines. This phase 0 feasibility study is conducted within the AerospaceResearch.net's Rapid Design Campaign with the aim of future work and studies at the University of Stuttgart, Germany and the Sts. Cyril and Methodius University (UKIM) of Skopje, North Macedonia.