COMBINING SYSTEMS ENGINEERING WITH CLINICAL APPROACHES DURING DEVELOPMENT OF A CONCEPT OF OPERATIONS FOR AN EARTH INDEPENDENT MEDICAL OPERATIONS – BASED DECISION SUPPORT SERVICE

Prashant Parmar[1], Arian Anderson[2], Gina Vega[3], Andrea Legreid[4], Mareyna Karlin[3], Chris Brown[4], Marina Parker[4]
1. University of Texas Medical Branch, 2. University of Colorado School of Medicine, 3. KBR, 4. Analytical Mechanics Associates

BACKGROUND: As crewed missions move beyond Low-Earth Orbit, pre-mission planning cannot fully negate the medical risks of exploration-class missions. Martian missions, with hazards such as long-duration spaceflight, surface-level EVA operations, and communications delays, will require a paradigm shift. An Earth-Independent Medical Operations-based Medical System (EIMO-MS) will be able to accomplish this goal by having an interactive, adaptable interface that will be able to provide real-time medical services based on the level of crewmember training, medical situation, and available resources. Development will thus require both clinical and Systems Engineering input. Developing a collaborative Concept of Operations (ConOps) allows distillation of requirements and highlights necessary capabilities from a multidisciplinary perspective.

OVERVIEW: A series of clinical scenarios of escalating complexity was developed with clinical and systems engineering input. These scenarios describe in clinical detail what a theoretical future medical system, enhanced with multiple information streams (such as a medical database, an AI-based Decision Support System, real-time monitoring, enhanced in-situ laboratory imaging, etc.) can achieve in conjunction with a trained and experienced crew. Using this collaborative approach, scenarios have a dual core of a clinical narrative section and an extrapolated systems engineering activity diagram. The “swim lanes” of the activity diagram act as the logistical core of each scenario and show how the MS will interact with the crew, ground support, and other in-flight systems. “Translating” the clinical narrative into an activity diagram enables Systems Engineering-based activities such as functional decomposition to inform requirements. The Design Reference Mission that is used for the scenarios is based on existing reference mission profiles [1] and scenarios span the spectrum from planned evaluations, minor medical care, urgent care, surgical guidance, critical and expectant management, and behavioral health care.

DISCUSSION: As mission complexity increases, it is critical to involve clinicians in the systems engineering development process and, conversely, it is vital for medical considerations to be able to be “translated” into a systems engineering approach. This project showcases the viability and value of a combined approach in the fast-approaching exploration-class mission world.

[1] Hoffman, S.J. et al. HEOMD-415: Reference Surface Activities for Crewed Mars Mission Systems and Utilization. NASA Technical Reports Server. https://ntrs.nasa.gov/api/citations/20220000589/downloads/MarsSAC21SurfaceOps_2022-Jan_Version%201%20FINAL_update.pdf