

## DEVELOPING MARS-BASED CLINICAL SCENARIOS FOR AN EARTH INDEPENDENT MEDICAL OPERATIONS (EIMO) – BASED DECISION SUPPORT SERVICE

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As crewed missions move beyond Low-Earth Orbit, pre-mission planning cannot fully buy down the medical risks of exploration-class missions. Martian missions, where increased hazards exist, (such as long-duration spaceflight, surface-level EVA operations, and communications delays) will require a paradigm shift in the structure of a medical system. An Earth-Independent Medical Operations-based Medical System (EIMO-MS) will need to optimize four critical domains to help provide medical care: utilization of **Pre-Mission Planning**, augmentation of **Acute and Prolonged Medical Decision Making**, automated tracking of **Resource Management**, and assistance in **Task Load Balance**. The ideal 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. It must respond based on the level of crewmember training, medical situation, and available medical and non-medical resources.

To showcase the capabilities and requirements of such a sophisticated automated MS, a series of clinical scenarios of escalating complexity were 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.

Scenarios are comprised of: a context section including objectives and applicable spaceflight environment, a highlighted assumptions section, a clinical narrative section, and a systems engineering activity diagram demonstrating the integrated Medical System (MS). 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. The Design Reference Mission that is used for the scenarios is based on existing reference mission profiles [1] with a projected 30-sol stay on the Martian surface. Scenarios span the spectrum from planned evaluations, minor medical care, urgent care, surgical guidance, critical and expectant management, and behavioral health care.

Mission complexity will exponentially increase during deep space and Mars exploration-class missions, and medical support for these missions will likewise need to increase in autonomy and adaptability. The integrated system that will support these missions will need to provide assistance in a variety of anticipated and unforeseen scenarios. These medical scenarios, guided by clinician input, are initial steps in crafting the requirements for an EIMO-based medical system. By working in a systems engineering framework, requirements and capabilities can be extracted and mapped while maintaining a clinical core.

[1] Hoffman, S.J. et al. HEOMD-415: Reference Surface Activities for Crewed Mars Mission Systems and Utilization. NASA Technical Reports Server.  
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