AUTONOMOUS, IN-FLIGHT CREW HEALTH RISK MANAGEMENT FOR EXPLORATION-CLASS MISSIONS: LEVERAGING THE INTEGRATED MEDICAL MODEL FOR THE EXPLORATION MEDICAL SYSTEM DEMONSTRATION PROJECT

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STRACT

Background

The Integrated Medical Model (IMM) captures organizational knowledge across the space medicine, training, operations, engineering, and research domains. IMM uses this knowledge in the context of a mission and crew profile to forecast risks to crew health and mission success (Figure 1).

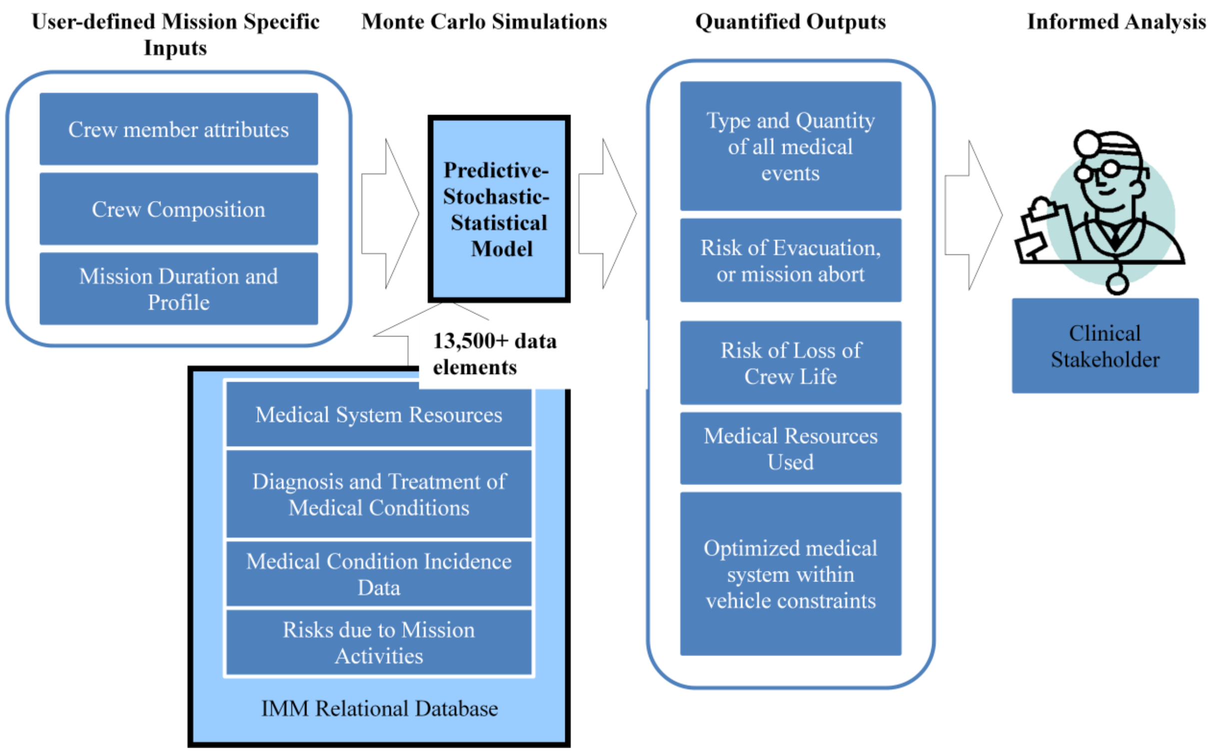

Figure 1. A Flexible Decision Support Tool - The IMM outputs helps clinical stakeholders mitigate in-flight crew health risks by optimizing mission-specific medical capabilities.

The IMM establishes a quantified, statistical relationship among medical conditions, risk factors, available medical resources, and crew health and mission outcomes. These relationships may provide an appropriate foundation for developing an in-flight medical decision support tool that helps optimize the use of medical resources and assists in overall crew health management by an autonomous crew with extremely limited interactions with ground support personnel and no chance of resupply.

Methods

The IMM models not only the likelihood of a medical event, but also the available risk mitigation strategies and the subsequent clinical outcomes that may result. IMM uses a Monte Carlo simulation technique (a random sampling of the inputs as described by their statistical distribution) to determine the probable outcomes. Because the IMM is a stochastic model (i.e. the input parameters are represented by various statistical distributions depending on the data type), it can generate a prediction of the most probable medical outcomes from simulated missions that have a given set of medical capabilities. In the context of an in-flight tool, crew medical records, medical resource consumption data, mission task timeline data, and vehicle environmental data could furnish the IMM in effort to manage crew health risks through prospective estimates of risk.

Discussion

For missions beyond low earth orbit, autonomous crews will require an unprecedented level of in-flight support from software agents that regularly monitor vehicle and crew health systems. These agent-based systems will help crews detect issues early so crew behaviors, activities, and processes can be adjusted to limit problems that could otherwise cause mission abort or crew loss. The Exploration Medical System Demonstration Project (EMSD) attempts to show how the effective integration of data from traditionally independent systems can increase mission success and crew health. The existing IMM could serve as an algorithmic kernel for such an integrated data system since the IMM has already established the processes, tools, and conventions for crew health risk management respective to the mission and crew profiles.

Conclusion

The EMSD project is leveraging the IMM, database, conventions, and tools, and is well positioned to benefit from the 6-years of clinical research, development, and challenges transitioning from concept to operations. Data integration and presentation is critical to software-based decision support, and the IMM, or one of its components, may become a critical pillar to EMSD success.