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IMPACT 1.0–TASK IMPAIRMENT: A NOVEL APPROACH FOR ASSESSING IMPAIRMENT DURING EXPLORATION-CLASS MISSIONS

Abstract

Purpose: Exploration-class and International Space Station (ISS) missions have significantly different levels of associated medical risk for crewmembers. The Integrated Medical Model (IMM), the probabilistic risk assessment tool used for ISS medical trade-space analyses, uses a Functional Impairment (FI) metric to determine quality time lost should a crewmember be afflicted with a medical condition. While IMM-based FI has been successful for ISS operations, it has limitations when applied to exploration-class missions. As NASA looks ahead to Gateway, Artemis, and Martian missions, a novel, dynamic, and mission-appropriate impairment paradigm is necessary for accurate contingency planning. This paradigm, Task Impairment (TI), fulfills that need by utilizing mission-specific tasks. TI will allow future capability for a loss of mission metric, previously not available with IMM. TI serves as a replacement metric for FI within IMPACT, the next-generation trade-space analysis tool suite created to replace the IMM. IMPACT significantly increases the fidelity of probabilistic risk assessment for exploration-class missions. Methodology: The Human Exploration of Mars Preliminary List of Crew Tasks (a source of 1200+ exploration-class mission-specific tasks for crewmembers) was used to calculate TI. Using the Task List, 18 individual Human System Categories were identified as being required to perform each task (e.g., Cardiopulmonary, Cognitive, etc.). Each of the 1200+ tasks were mapped to the Human System categories listed in the Task List. The total number of tasks in each category were tallied to determine how many tasks required each Human System. Lastly, each of the 120 medical conditions from the IMPACT condition list were mapped to the Human System categories to complete the TI calculation. NASA subject matter experts across five medical specialties established consensus for the mapping of each condition. The resulting total tasks impaired by each condition were used to calculate discrete TI values. This process was repeated for each of the four severity/resource utilization variants of each condition, and for each of the three phases of clinical care. Results: Discrete TI values were calculated for each of the 120 IMPACT medical conditions and their variants. Conclusion: The Task Impairment metric provides higher fidelity, dynamic utility, and quicker analysis of medical impairment compared to the previous Functional Impairment metric used for the Integrated Medical Model. TI will be used for higher fidelity medical impairment analysis and contingency planning during Lunar, Martian, and other long-term exploration-class missions.