IN-DEPTH MODELING AND SIMULATION ANALYSIS OF ARTEMIS MISSIONS USING THE IMPACT PROBABILISTIC RISK ASSESSMENT TOOL

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BACKGROUND

The Artemis campaign is a Moon exploration program with a series of six planned missions, five of which will be crewed. These five crewed missions will contain a single mission segment (space flight), or multiple mission segments involving space flight (Orion), lunar landing (LTV) and/or space habitat (Gateway). Each crewed segment faces the risk of unique medical conditions, necessitating medical sets/kits tailored to those specificities. To support and enable a data-driven and evidence-based decision-making process through out a mission's life cycle, a software tool called IMPACT was developed. Using probabilistic risk assessment (PRA) methodologies, IMPACT (Informing Mission Planning via Analysis of Complex Tradespaces) is a novel tool built for analyzing the possibility of encountering complex medical risks during space flight, and for identifying the medical resources and capabilities needed to treat those potential at-risk medical conditions. IMPACT achieves this by performing hundreds of thousands of Monte Carlo simulations of missions to build aggregate pictures of medical risk. During an extended simulation modeling phase, IMPACT generated analytical results for medical risks, and the medical resources and capabilities to address those risks, for every segment of every crewed Artemis mission. This presentation will highlight the reliability, consistency and validity of IMPACT's computational modeling techniques and will showcase the library of analytical outcomes generated for the Artemis missions.

OVERVIEW

During the early stages of IMPACT's design, architecture and technical requirements collection, "scenarios" (use cases) - achievement goals required for acceptance testing, were identified by stakeholders. IMPACT successfully completed the scenario testing requirements and undertook an extensive operational run phase utilizing a wide range of input combinations with a goal of delivering a cohesive, trustworthy, reliable, vast, and diverse body of evidence. The intent of these modeling runs was to validate consistency in output, ensure solidity of executable operations and to streamline processes by identifying areas requiring efficiency improvements. Using the many missions of Artemis, IMPACT ran variations of operational runs to assess the output for acceptable, as well as unusual characteristics. This rigorous long-term "shakedown" analysis was implemented to help build a collective body of evidence to aid in securing a high level of confidence, reliability, and validity in the output, whether from the applicational components of IMPACT, or the entirety of the operational process.

ANTICIPATED ANALYSIS AND CONCLUSION

This presentation will discuss the various categories of input criteria; the comparisons in the application of these input criteria to various Artemis missions; the preparation and collection of the body of evidence, and reliability of the computational modeling techniques. This paper serves as an initial analytical overview of IMPACT's probabilistic risk assessment (PRA) medical risk outputs covering Artemis missions and is not intended to be deemed the official medical response for the Artemis campaign.