

INTRODUCTION TO THE IMPACT PROBABILISTIC RISK AND TRADESPACE ANALYSIS TOOL FOR MEDICAL SYSTEM DESIGN

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BACKGROUND: Probabilistic risk analysis (PRA) is a method for estimating risk in complex engineered systems that, at a basic level, focuses on what can go wrong and the likelihood and consequences of those occurrences. NASA has used PRA as an integral component of medical system risk estimation and design for spaceflight. IMPACT (Informing Mission Planning via Analysis of Complex Tradespaces) is a novel tool to meet these goals for exploration missions.

OVERVIEW: IMPACT performs hundreds of thousands of Monte Carlo simulations of missions to build aggregate pictures of medical risk. These simulations are based on 120 possible medical conditions (the IMPACT Condition List) selected in a consensus-based process because they are of highest likelihood and/or consequence for exploration spaceflight. The conditions are then tied to clinical capabilities which can be used for management (e.g., inserting an IV) and then to over 600 specific resources needed to deliver a capability (e.g., an angiocath or an ultrasound). Different mission profiles can be simulated with user-specified inputs such as mission duration, destination, number of crew and pre-existing medical conditions, and EVA frequency. While the IMPACT evidence base is designed for exploration environments, these user inputs allow the tool to be used across a broad range of missions. IMPACT's primary outcome metrics include loss of crew life (LOCL, a measure of in-flight mortality due to medical conditions), need for evacuation (RTDC, return to definitive care), and crew disability (TTL, task time lost based on how medical conditions impact the ability to perform over 1000 specific exploration mission crew tasks). In addition to modeling medical risk, IMPACT also accepts user-specified constraints, such as limitations of mass or volume, and will output a recommended clinical capability set and specific medical resources that meet the mission constraints.

DISCUSSION: This abstract will provide an introduction to IMPACT and describe the nature of the underlying medical evidence. It will also detail potential use cases for how this tool can be utilized by NASA or commercial spaceflight providers.