

Fiscal Year:	FY 2011	Task Last Updated:	FY 01/06/2012
PI Name:	Butler, Douglas M.B.A.		
Project Title:	Integrated Medical Model (IMM)		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Operational and clinical research		
Joint Agency Name:	TechPort:	Yes	
Human Research Program Elements:	(1) ExMC :Exploration Medical Capabilities		
Human Research Program Risks:	(1) Medical Conditions :Risk of Adverse Health Outcomes and Decrements in Performance Due to Medical Conditions that occur in Mission, as well as Long Term Health Outcomes Due to Mission Exposures		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Organization Type:	NASA CENTER	Phone:	281-212-1380
Organization Name:	Wyle Integrated Science and Engineering		
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City:	Houston	State:	TX
Zip Code:	77058	Congressional District:	22
Comments:			
Project Type:	GROUND	Solicitation / Funding Source:	Directed Research
Start Date:	10/01/2005	End Date:	01/31/2011
No. of Post Docs:	No. of PhD Degrees: 7		
No. of PhD Candidates:	No. of Master' Degrees: 4		
No. of Master's Candidates:	No. of Bachelor's Degrees: 1		
No. of Bachelor's Candidates:	Monitoring Center: NASA JSC		
Contact Monitor:	Watkins, Sharmila	Contact Phone:	281.483.0395
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Flight Program:			
Flight Assignment:	NOTE: Received extension to 1/31/2011, per PI; original end date was 9/30/2010 (Ed., Jan 2011)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Freire de Carvalho, Mary Ph.D. (Wyle Integrated Science and Engineering) Kerstman, Eric M.D. (University of Texas Medical Branch - Galveston) Minard, Charles Ph.D. (Wyle Integrated Science and Engineering) Myers, Jerry Ph.D. (NASA - Glenn Research Center) Walton, Marlei Ph.D. (Wyle Integrated Science and Engineering) Strauss, Sam M.D. (Wyle Integrated Science and Engineering) Saile, Lynn M.S. (Wyle Integrated Science and Engineering) Lopez, Vilma M.S. (Wyle Integrated Science and Engineering) Iyengar, Madurai Sriram Ph.D. (University of Texas) Bickham, Grandin M.S. (Wyle Integrated Science and Engineering)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	<p>Since illnesses and injury during space flight pose risks both to crew health and to mission objectives during Space Exploration, these risks must be minimized in multiple ways (e.g., selection criteria, preventative measures, flying appropriate hardware, and procedures). Under this task, the principal investigator produced a software-based decision support tool using an evidence-based approach to delineate clinical strategies for minimizing risks to crew health during space missions.</p> <p>The Integrated Medical Model (IMM) is designed to identify and quantify crew health risks during flight and to evaluate the effectiveness of in-flight mitigation strategies. The IMM integrates terrestrial and space flight evidence bases to quantify the probability and the consequences of in-flight medical risks using Monte Carlo simulations. Utilizing well accepted scenario driven techniques, such as probabilistic risk analysis, as a guide, IMM generates a set of quantitative measures, such as mission time lost, probability of crew evacuation, and probability of loss of crew life, to enable decision makers to make objective assessment of crew health and mission outcomes with respect to our current level of knowledge.</p> <p>The current IMM can be used to optimize in-flight medical system capabilities, manage science and technology development portfolios, prioritize crew medical training, and support a variety of "what if" scenarios posed by mission planners. The latest version of the model, IMM 3.0, includes a SQL database and Reference Manager central library, which quantify and document all the clinical evidence used by the IMM.</p> <p>This interdisciplinary research effort included the establishment of a conceptual framework, the development of an extensive input dataset and SQL database, the development of external models, the creation of simulation and optimization model software, and the design and implementation of novel verification, validation, and configuration management processes.</p> <p>OBJECTIVES</p> <p>The IMM Project was tasked to develop an evidence-based, probabilistic decision support tool and integrate the tool in the decision making processes of customers within the Space Life Sciences Directorate (SLSD). The five key objectives of the IMM Project support these overarching goals: 1) develop a software-based, stochastic decision support tool useful to clinical stakeholders and medical mission planners; 2) develop a knowledge management tool for the clinical evidence used by the model; 3) update the medical risk estimates of the Probabilistic Risk Assessment model used by the International Space Station (ISS) Program; 4) develop the ability to optimize the mass and volume for an in-flight medical system and specified level of risk; and 5) help close the communication gaps among science, clinical operations, and engineering communities.</p>
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	<p>The IMM, a product of six years of research, development, and testing, provides NASA a flexible decision support tool for managing human performance and health risks in the harsh, resource-constrained environment of space. The IMM may also find applications in the emerging commercial space flight industry, military missions, maritime and aviation industries, or other remote operations where resources are limited and definitive medical care is not readily available. The ability to categorize health threats according to crew physiology, crew activities, mission tempo, and mission environment enables prioritized training, space flight systems development, and procedures that result in positive health and mission impacts. IMM can provide a defensible position for making cost-effective decisions regarding crew health, and will help achieve mission success by focusing limited funds on the most relevant health care policies, protocols, and technologies.</p>
Task Progress:	<p>The IMM project was funded from 1 October 2005 to 31 January 2011, at which point the IMM transitioned to an operational tool used by the International Space Station Program to update evacuation and loss of life risk estimates due crew medical events. During the course of development, validation, and transition to operations, both the model data inputs and outputs have aided a broad set of users address in-flight mission and crew health risks, science portfolio allocations, emergency return scenarios, crew training, and in-flight medical system capabilities.</p> <p>Three key tools created by the IMM Project increase SLSD knowledge management, research, and operational capabilities: 1) IMM Central Library - The IMM Central Library houses all citations and references used to form the clinical basis for each medical condition represented in the IMM. This central library creates the foundation for the SLSD Enterprise-wide Library Solution; 2) IMM Database - The IMM Database is accessible by the SLSD science and clinical operations community. Custom-designed reports can be tailored for each user while automatic notifications will ensure they are aware of the latest additions or alternations; and 3) IMM - The evidence-based, analytic representation of in-flight crew health risk -- in the context of a specific mission and crew profile -- provides an unprecedented capability to communicate clinical risk in engineering-centric programs. The IMM also provides an objective foundation for mission planning dialogue based on evidence and all available relevant data sources.</p>
Bibliography Type:	Description: (Last Updated: 04/10/2019)
Articles in Peer-reviewed Journals	<p>Minard CG, de Carvalho MF, Iyengar MS. "Optimizing medical resources for spaceflight using the Integrated Medical Model." Aviat Space Environ Med. 2011 Sep;82(9):890-4. http://dx.doi.org/10.3357/ASEM.3028.2011 ; PubMed PMID: 21888273 , Sep-2011</p>
Awards	<p>Butler DJ, Kerstman E, Saile L, Freire de Carvalho M, Minard CG, Lopez V, Bickham G, Walton M. "NASA Johnson Space Center Exceptional Software Award, July 2011." Jul-2011</p>
NASA Technical Documents	<p>Fitts MA, Kerstman E, Butler DJ, Walton ME, Minard CG, Saile LG, Toy S, Myers J "The Integrated Medical Model: Statistical Forecasting of Risks to Crew Health and Mission Success." NASA Technical Document, 4 Feb 2008. Internet Archive. Document ID 20080010658. https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20080010658.pdf , Feb-2008</p>

Papers from Meeting Proceedings

Fitts M, Myers J, Kerstman E, Minard CG, Walton M, Butler D, Risin D, Iyengar MS, Johnson-Throop K. "Assessment of Medical Risks and Optimization of Their Management Using the Integrated Medical Model." 59th International Astronautical Congress 2008, Glasgow, Scotland, September 29-October 3, 2008.
IAC paper 2008-2370, September 2008. , Sep-2008