Fiscal Year:	FY 2016	**Task Last Updated:**	FY 06/10/2016
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Project Title:	Clinical Outcome Metrics for Optimization of Robust Training		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Smart Medical Systems and Technology Team		
Joint Agency Name:		**TechPort:**	No
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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Zip Code:	77058	**Congressional District:**	36
Comments:			
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Contact Monitor:		**Contact Phone:**	
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Flight Program:			
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Task Description:	The objective of this research is to develop clinical outcome metrics and training tools for physician and non-physician crew medical officers (CMOs) in support of likely medical conditions. Multiple assessment techniques will be employed, centered around medical simulation studies which occur in 3, 6, and 12-month intervals after initial training (fundoscopic examination, renal stone screening, ultrasound-guided IV insertion, intubation, and diagnostic activity). These studies will systematically compare clinical outcomes of simulations performed by physician and non-physician crew CMO analogs for short-term outcome metrics. To enhance our understanding of long-term implications of imperfectly performed medical procedures, outcomes will be used as input to a modified version of the NASA Integrated Medical Model (IMM). Short- and long-term outcomes will be used to 1) define differences between physician and non-physician CMOs, 2) refine the outcome metrics themselves, and 3) refine or develop novel medical training products. There are multiple challenges to crew health care during extended spaceflight. Medical procedure performance could be affected by asynchronous communications (time delays), inability to evacuate, and prolonged time from initial CMO training to actual mission medical operations (including emergency and non-emergency care, diagnosis, and treatment). Exploration mission crews would ideally be equipped for autonomous medical care. In extreme resource-limited environments such as spaceflight, it is critical to consider not only the immediate outcome for each procedure, but also the consequences of a missed diagnosis or improperly performed procedure that will endure for the entire mission.
	A two-tiered approach will be used for this project. The first tier will examine the raw clinical outcome metrics by evaluating the performance of both physicians and non-physicians in a medical simulation laboratory with human test subjects and patient simulators to present the conditions and specific procedures being evaluated. The second tier will examine the mission-long impacts of procedural outcomes. A modified version of the IMM will be created which will accommodate diagnoses and procedures that are not 100% correct. Simulation output will become IMM input, with model results informing a novel set of outcome metrics which will demonstrate the true mission impact of medical procedure outcomes. Comparison of physician and non-physician outcomes in both tiers will directly address the value of including physician CMOs on Exploration missions. Based on results from both tiers, deficiencies in training procedures and tools will be identified, and training products refined to improve future outcomes.
	Our multidisciplinary team includes physicians, medical trainers, remote guidance experts, imaging/technology specialists, and human factors experts. This research is expected to produce physician and non-physician clinical outcome metrics and medical condition training tools that will reduce the Human Research Program Exploration Medical Capabilities' Risk of Unacceptable Health and Mission Outcomes Due to Limitations of In-flight Medical Capabilities. In addition to these benefits, the IMM enhancements would allow for the variable success of diagnostic and interventional procedures that could strengthen crew health predictions and expose unidentified medical resource gaps.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Through the analysis of performance (raw metrics) and modeling (long-term outcome metrics), this team expects to distinguish clinical outcomes when physician versus non-physician CMOs perform medical procedures. Training deficiencies will be identified for both groups, and the staggered testing paradigm will inform questions about the rate of skills/knowledge decay and provide data that will indicate when refresher training needs to be scheduled. Training materials for specific medical conditions and their associated treatment protocols will be updated based on types of errors or usability issues that are discovered. Training products developed through this work are expected to serve as an advanced template for other training programs. A module providing expanded functionality will be added to the NASA Integrated Medical Model which will strengthen predictions for spaceflight mission impacts. While NASA missions (particularly exploration class missions) have special requirements for medical training and knowledge retention, this is not a problem specific to spaceflight. The problem of maintaining the proficiency of minimally trained medical caregivers and the changing recommendations associated with this training (e.g., CPR training) are evidence of the need for more information in this area. Additionally, the rapidly expanding field of telemedicine is increasing the demand for effective means of teaching non-medically trained personal to assist with or perform medical tasks. This research is expected to provide a set of refined metrics to link both short- and long-term clinical outcomes to training deficiencies. These metrics can easily transfer to the medical teaching arena and be applied to levels from medical schools to basic CPR classes and telemedicine. Further, this research will yield refined procedural training products which can also be transferred to educational settings. These tools are expected to become a template for expanded use in medical training (terrestrial and space applications) and because of their intuitive nature are expected to become excellent outreach tools as well.
Task Progress:	The team has worked closely with Butler Graphics to develop the just-in-time (JIT) training and testing software, which is a central component of this project. Procedural modules (fundoscopy, kidney/bladder ultrasound, ultrasound guided IV insertion, and intubation) have been fully assembled. The team has been performing practice activities using the nearly complete modules with novice users, serving several functions: 1) identify bugs and required, 2) refine setup and data collection procedures, and 3) provide training practice for team members. Users had helpful suggestions but have also commented on the ease of use and comprehensive nature of material in each module. Diagnostic and treatment module flow, logic, and structure are complete with only minor content additions required. The team had initially chosen to use two tablet devices for this module (guidance software built into the JIT software on one device, while a patient simulator app ran on another). However, the team has chosen to integrate both functions into a single application in order to 1) simplify use (such as importing vitals from the patient simulator to the guidance software), and 2) eliminate the need for a second device. The diagnostic and treatment module has proven a challenging task, but the product is exciting in appearance function. This has been a worthwhile effort due to its importance to the evaluations, and also because it provides a functioning example of a clinical decision support tool that NASA might choose to develop in support of exploratory missions.
	Data collection spreadsheets are in their near-final form, including incorporation of output from the software's click-tracking function. The team has worked to streamline data collection and processing methods, resulting in the plan for three primary data sources: 1) live observation data, 2) click tracking and quiz answer data from the software, and 3) usability questionnaire data. Session video recording will aid with live observation and will also serve as a back-up source of data should observations not be clear or are missed during live observation. Morae monitoring software will also be employed, but will be considered a back-up data source and a potential resource for in-depth usability analysis.
	Subjects have been recruited for the study and have been distributed into the three test groups. The study requires 30 physicians and 30 non-physician subjects, but we chose to recruit 34 of each to account for attrition during the test

period. Recruitment of the trainee test pool progressed well, with over 80 non-physician (Masters or PhD level education) and almost 40 physician responses, providing an ample waiting list. Recruitment included a questionnaire including specialties, training, and practice of specific skills, age, and other factors. Using a custom block randomization code, subjects were balanced among the three test groups based on prioritized parameters.

Bibliography Type:	Description: (Last Updated: 03/03/2016)