Fiscal Year:	FY 2015	**Task Last Updated:**	FY 07/16/2015
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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		
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Zip Code:	77058	**Congressional District:**	36
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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 medical officer (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. For the proposed research, a two-tiered approach will be used. 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 medical outcomes when physician versus non-physician CMOs perform 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 as to 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 procedures. A module providing expanded functionality will be added to the 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. 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. Further, this research will yield refined procedural training tools 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 spent considerable effort designing all five simulation testing modules to ensure that each has specifically identified and measurable elements, while preserving procedure flow. Modules have been streamlined to focus on testing the skill in question. Procedures are in near final form and translation into the just-in-time (JIT) training/testing software is underway. Recording of video content for software is scheduled for May 2015. Specific metrics for all modules have been defined. The approach has been refined to streamline data collection, management, analysis, and interpretation. The study will generate large volumes of data requiring distillation into meaningful elements. Metrics have been divided into four categories: 1) the rollup metric (procedure successful?), 2) sub-metrics (procedure milestones), 3) time, and 4) subjective notation. A reasonable fundus camera choice was required for the fundoscopy module. Space Medicine trainers indicated that previous operational solutions were difficult to use, and current operational hardware was discontinued. The team forged collaboration with UC (University of California) Berkeley to use their Optical CellScope, an iPhone 5 based fundoscope. The CellScope is simple to use, can be used for non-dilated exams in some subjects (important for study logistics), and is handheld. The team worked with the CellScope extensively and developed the required training and data handling procedures. Concepts and content for the diagnostic module were developed. Medical conditions and presentations were chosen for the training, baseline, and re-test cases to optimize training and equalize difficulty level. This module is a limited clinical decision support tool designed with a balance of guidance to the subject without making the medical judgment decision, providing insight into the medical decision making process. The team has chosen to use two tablet devices for the diagnostic module-- the guidance software will be built into the JIT software on one device, while a separate patient simulator app will run on another. The team has identified data collection techniques and designed technical solutions to collect all data elements. Based on experiences with synchronization and analysis of video recordings post-collection, the team has chosen to record test sessions using quad-screen recording (Epiphan Pearl). This will allow simultaneous recording of four video feeds, including two cabin views, the ultrasound or fundoscope, and the subjects' view via wireless forehead-mounted GoPro. In this manner real-time observations can be confidently tallied and recordings archived for further analysis. The team has also chosen to use Morae software to

	monitor JIT software use. Morae monitors all on-screen interaction, displaying and recording on a remote monitoring computer. The team has tested the software on multiple tablet/PC systems required for data collection. Click-tracking will be incorporated into JIT software.
Bibliography Type:	Description: (Last Updated: 03/03/2016)