Fiscal Year:	FY 2017	**Task Last Updated:**	FY 02/05/2018
PI Name:	Yule, Steven J. Ph.D.		
Project Title:	Developing and Validating Specific Medical Event Management Training Protocols for Flight Crews on Deep Space, Long-Duration Space Exploration Missions		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Human Factors and Performance Team		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	syule@partners.org	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	781-960-3228
Organization Name:	Brigham and Women's Hospital/Harvard Medical Center		
PI Address 1:	75 Francis Street		
PI Address 2:	STRATUS Center for Medical Simulation		
PI Web Page:			
City:	Boston	**State:**	MA
Zip Code:	02115-6110	**Congressional District:**	7
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2015-16 HERO NNJ15ZSA001N-Crew Health (FLAGSHIP, NSBRI, OMNIBUS). Appendix A-Crew Health, Appendix B-NSBRI, Appendix C-Omnibus
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No. of Post Docs:	1	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
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Flight Program:			
Flight Assignment:	NOTE: Element change to Human Factors & Behavioral Performance; previously Space Human Factors & Habitability (Ed., 1/19/17)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Lipsitz, Stuart Sc.D. (Brigham And Women's Hospital/Harvard Medical School) Pozner, Charles M.D. (Brigham And Women's Hospital) Doyle, Thomas Ph.D. (Non-U.S. Co-PI: McMaster University, Canada) Musson, David M.D., Ph.D. (Non-U.S. Co-PI: Northern Ontario School of Medicine)		
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Task Description:	1) Original Project aims and objectives: The success of the next phase of space exploration is dependent on the ability of training programs to prepare crews to manage a range of events, medical and technical, which may occur during spaceflight. Long-duration exploration missions (LDEMs) will require crewmembers to be more autonomous than on previous missions, making the development of countermeasures to mitigate the effects of in-flight medical events essential to both survival and mission success. In line with the research topic, "Operationalize Customized Refresher and Just-In-Time Training Products for Deep Space, Long Duration Spaceflight Crews," the project had two specific aims to add to knowledge about the risk of team performance errors resulting from a lack of medical focused non-technical skills, as follows: Specific aim 1: Identify objective measures of non-technical skills that enhance crew management of in-flight medical emergencies Specific aim 2: Develop a simulated spacecraft medical bay, and run a series of simulation scenarios to measure crew behavior during high acuity, low frequency medical emergencies To achieve these aims, we recruited a panel of 28 experts from the fields of Space Medicine, Teamwork, Human Factors, and Emergency Medicine. They participated in online tasks as well as a 2-day in person panel meeting at the Lunar and Planetary Institute, Houston. This study was exploratory in nature, as team performance during medical emergencies has not been extensively studied in simulated spaceflight environments. However, based on the experience from developing similar tools in other industries and in prior studies, a unique set of specific behaviors relevant to the demands of the profession have always been identified. Our guiding hypothesis was that we can optimize outcomes, including task success in medical events, and the outcome of the patient, by supporting crew non-technical skills in a deliberate and strategic fashion. The project adopted a quasi-experimental design that allowed us to test the hypothesis that it is possible to identify a unique set of objective measures of crew non-technical skills to manage medical emergencies. 2) Key findings and their impact on hypotheses, technology requirements, objectives and specific aims of the original proposal: The key finding in specific aim 1 was development of a non-technical skills taxonomy and objective measurement tool (called ASTRONOTSS) that identifies the essential astronaut crew behaviors for effective medical emergency management. This includes a set of objective measures for onboard training of the specific skills that enhance crew cohesion, performance, and safety when faced with an unanticipated medical emergency in flight. The expert panel recommended developing separate skills taxonomies for each medical event. This also allowed us to identify common behavioral skills across medical events which were: (i) Situation Assessment; (ii) Crew-Ground Communication; (iii) Stress Management; (iv) Team Coordination; (v) Calling for Help; (vi) Conflict Management; and (vii) Leadership Transition. We were also able to gain consensus on other LDEM specific features relevant to in-flight medical care such as training of Crew Medical Officer (CMO), the duration of training, crew composition, inflight vs ground training, just-in-time training, measurement scale for behavioral skills, and retention/ decay of skills training. The key finding in specific aim 2 was development of a simulation-based training platform to replicate the spacecraft environment and provide crews with valid medical emergency scenarios on which to gain experience. We built the simulation platform at the STRATUS Center for Medical Simulator at Brigham & Women's Hospital in Boston. We also set up a simulated Mission Control desk to include interactions of the in-flight crew with Capcom and the flight surgeon, which allows us to focus on the key behavioral skills required for effective communication between crew and the ground. During this process we identified the main technological requirements to set up a spacecraft medical simulator with sufficient fidelity for training drills in medical event management. To demonstrate the capabilities of the simulator and for the purpose of reliability testing, we storyboarded, scripted, and filmed four diverse potential medical events: Cardiac Arrest, Toxic Exposure, Eye injury and Pneumothorax. We incorporated input on space and medical contexts from expert panelists to ensure the scenarios were clinically relevant and authentic. 3) Impact of key findings on hypotheses, technology requirements, objectives and specific aims of the original proposal: Our initial plan was to demonstrate quantitative assessment of generic set of behaviors but after discussions with the expert panel, it was determined that to best support for crew health, a specific set of behavior markers for key medical emergencies would be most applicable. To this end, we created the ASTRONOTSS taxonomy, which depicts specific medically focused behaviors in line with current spaceflight crew resource management framework. Video examples of behavior and clinical training scenarios that could be used for drills to enhance team management and debriefing on performance were also created. 4) Proposed research plan for the coming year: Our intention is to establish inter-rater reliability of observers using the ASTRONOTSS taxonomy. We will achieve this using the video scenarios filmed in the space simulator and also test for the impact of time delay on crew-ground coordination during management of medical events. This will allow us to demonstrate which behaviors are observable, reproducible, and lead to better outcomes during management of in-flight medical events before implementing in HERA (Human Exploration Research Analog) and other space analogue environments.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The benefits gained from the development of the objective measures and simulation scenarios have Earth applications to other teams working in rural and remote settings, such as military, marine, and industrial applications where limited onsite expertise and reliance on tele-medical support are characteristic. For example, in maritime and military teams medical events occur sporadically and cannot always be managed by specifically trained personnel such as trauma teams. Therefore, equipping non-medical teams with the essential non-technical skills for medical management can greatly enhance outcomes for affected personnel. The benefits of these project outcomes also extend to dedicated health care teams operating under rare and stressful situations, such as those dealing with mass casualty events.

Task Progress:	1) Work Package 1: Identifying objective measures of non-technical skills: 1.1 WP1a: Identify preliminary set of astronaut non-technical skills: • Completed a comprehensive review of both peer-reviewed and non peer-reviewed publications on NTS for managing medical emergencies in space. 1.2 WP1b: Delphi process with expert panel: • Recruited 28 experts from the fields of Space Medicine, Teamwork training in Space, Astronauts, Human Factors and Psychology, and Emergency Medicine; • Conducted a one and a half daylong meeting at the Lunar and Planetary Institute, University Space Research Association (USRA), Houston, on Nov 3-4, 2016; • Before the meeting, panel members completed an online survey to rate the 30 medical events on three parameters: impact on mission success, survivability, and role of non-technical skills in management; • During meeting, we identified: 4 scenarios to simulate; Key behaviors crew should demonstrate to respond to those events to identify the NTS taxonomy; Space context features; Medical capability for LDEMs; Challenges likely to be encountered on LDEMs; other LDEM specific features that will be relevant to in-flight medical events and might influence NTS of the crew; Measurement scale for the rating tool; the retention and decay of training with need for just-in-time training. 1.3 WP1c: Develop prototype measurement tool: • Developed the measurement approach for the rating scale . 2) Work Package 2: Develop three spacecraft medical bay simulations. 2.1 WP2a: Design a spacecraft medical bay simulation platform: • Designed and built the medical bay simulation platform based on the CHeCS manual and ISS models; • Set up a segment of MCC for filming interactions of the in-flight crew with the MCC staff, particularly with the flight surgeon, to focus on the key NTS required for effective communication with the ground; • Set up AV functionality for medical bay and MCC simulator. 2.2 WP2b: Modify existing medical simulations to the spaceflight context: • Storyboarded the 4 identified medical scenarios. 2.3 WP2c: Film space emergency micro-scenarios series: • Identified actors to play the role of in-flight crew and MCC based flight surgeon to reflect a multicultural crew of 4 astronauts; • Filmed the scenarios in 360-degree and 2D aspects; • The process of creating 16 micro scenarios from these 4 videos to conduct a reliability study in ongoing. 2.4 WP2d: Reliability study and psychometric testing: • Developed a web-based secure application to host videos for guiding the raters to rate the videos for the NTS behaviors; • The process of testing the appropriateness of the tool and observability of behavior observations has commenced with the project team and we will then extend to our expert panel members. This will be conducted online using the web-based platform developed.
Bibliography Type:	Description: (Last Updated: 11/09/2023)
Articles in Peer-reviewed Journals	Robertson JM, Dias RD, Gupta A, Marshburn T, Lipsitz SR, Pozner CN, Doyle TE, Smink DS, Musson DM, Yule S. "Medical event management for future deep space exploration missions to Mars." J Surg Res. 2020 Feb;246:305-14. Epub 2019 Nov 12. https://doi.org/10.1016/j.jss.2019.09.065 ; PMID: 31731248 , Feb-2020