| | |
|---|---|
| **Fiscal Year:** | FY 2016 |
| **Task Last Updated:** | FY 05/19/2016 |
| **PI Name:** | Dinges, David F. Ph.D. |
| **Project Title:** | Standardized Behavioral Measures for Detecting Behavioral Health Risks during Exploration Missions |
| **Division Name:** | Human Research |
| **Program/Discipline:** | |
| **Program/Discipline-- Element/Subdiscipline:** | HUMAN RESEARCH--Behavior and performance |
| **Joint Agency Name:** | |
| **TechPort:** | No |
| **Human Research Program Elements:** | (1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H) |
| **Human Research Program Risks:** | (1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders<br>(2) **Team**:Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team |
| **Space Biology Element:** | None |
| **Space Biology Cross-Element Discipline:** | None |
| **Space Biology Special Category:** | None |
| **PI Email:** | dinges@pennmedicine.upenn.edu |
| **Fax:** | FY |
| **PI Organization Type:** | UNIVERSITY |
| **Phone:** | 215-898-9949 |
| **Organization Name:** | University of Pennsylvania |
| **PI Address 1:** | Department of Psychiatry |
| **PI Address 2:** | 423 Service Dr., 1013 Blockley Hall |
| **PI Web Page:** | |
| **City:** | Philadelphia |
| **State:** | PA |
| **Zip Code:** | 19104-4209 |
| **Congressional District:** | 2 |
| **Comments:** | |
| **Project Type:** | FLIGHT,GROUND |
| **Solicitation / Funding Source:** | 2013-14 HERO NNJ13ZSA002N-BMED Behavioral Health & Performance |
| **Start Date:** | 07/21/2015 |
| **End Date:** | 07/20/2018 |
| **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:** | 1 |
| **No. of Bachelor's Degrees:** | 0 |
| **No. of Bachelor's Candidates:** | 0 |
| **Monitoring Center:** | NASA JSC |
| **Contact Monitor:** | Williams, Thomas |
| **Contact Phone:** | 281-483-8773 |
| **Contact Email:** | thomas.j.will1@nasa.gov |
| **Flight Program:** | ISS |
| **Flight Assignment:** | NOTE: Element change to Human Factors & Behavioral Performance; previously Behavioral Health & Performance (Ed., 1/18/17) |
| **Key Personnel Changes/Previous PI:** | |
| **COI Name (Institution):** | Basner, Mathias  M.D. ( University of Pennsylvania )<br>Kayser, Matthew  M.D. ( Hospital of the University of Pennsylvania )<br>Mollicone, Daniel  Ph.D. ( Pulsar Informatics, Inc. )<br>Stuster, Jack  Ph.D. ( Anacapa Sciences, Inc. )<br>Strangman, Gary  Ph.D. ( Harvard Medical School )<br>McGuire, Sarah  Ph.D. ( University of Pennsylvania )<br>Stahn, Alexander  Ph.D. ( Charite University, Berlin ) |
| **Grant/Contract No.:** | NNX15AK76A |

| Performance Goal No.: | |
| --- | --- |
| **Performance Goal Text:** | |

| **Task Description:** | Isolated and confined environments anticipated during exploration missions will include stressors such as small teams living and working in extreme conditions for prolonged periods separated from family, friends; loss of the day/light cycle; loss or delay of communications with ground; partial gravity; and limited space, privacy, and food selection. NASA's Behavioral Health and Performance Element seeks to maintain and enhance behavioral health and performance in such environments. The behavioral risk (Risk of Adverse Behavioral Conditions and Psychiatric Disorders) is a high priority within the NASA Human Research Program (HRP) because it has face validity, but lacks sufficient evidence due to a deficiency in measurement of the risk. Thus, there is concern that the behavioral health of the crew will be challenged in a Mars mission; however, there is no standardized method to detect and quantify the magnitude of the risk or its likelihood. The overarching goal of this project is to build on a successful record of software-based measurement of behavioral health indicators (e.g., mood, cognitive function, performance, physical and mental fatigue, sleep quality) to develop a complementary standardized suite of behavioral core measures (BCM) that would be quite feasible to implement within the constraints of spaceflight research, ground-based analogs (both short- and long-duration), and prolonged missions in isolated, confined, extreme environments lasting up to 12 months or longer. Achievement of this goal would permit a more rapid and reliable assessment and quantification of the Risk of Adverse Behavioral Conditions Psychiatric Outcomes for exploration class missions. The standardized behavioral medicine measures we are developing will be similar to the guidelines for standardization for bed rest studies. Defining standardized measures will not only allow for the systematic collection of data across multiple analogs, but it will also facilitate risk characterization for the Behavioral Medicine (BMed) risk. Without a standardized suite of behavioral health measures, the unknown BMed risk for exploration-class missions will continue to be estimated based on anecdote and conjecture.<br><br>Most elements of the BCM will be implemented on a Windows platform and will include the following:<br><br>(1) The Cognition test battery (a suite of 10 brief neuropsychological tests specifically designed for astronauts), (2) software integration of actigraphy sleep/wake data, (3) several visual analog scales and brief questionnaires with proven validity and utility in space and space analog environments, (4) Journals (Audio/Video and/or typed), (5) software integration of results derived from a robotic arm training task, (6) Team Measure Questionnaires designed to measure aspects of crew performance, team processes, team climate, team cohesion, and group living.<br><br>Data acquisition feasibility and flexibility, and user acceptability of BCM will be assessed in a short duration analog ((4 HERA (Human Exploration Research Analog), missions, N=16 subjects)), in a long-duration analog (one 12-14 month winter-over in the Antarctic Neumayer station, N=9 subjects), and on the International Space Station (ISS) feasibility (during 6-12 month missions, N=2 astronauts). During the HERA missions, a number of mission controllers will be offered to participate in the team measures questionnaires. |
| --- | --- |

| **Rationale for HRP Directed Research:** | |
| --- | --- |

| **Research Impact/Earth Benefits:** | This project will deliver a Behavioral Core Measures Tool (BCM) that will be tested for its feasibility, flexibility, and acceptability in research studies in both short and long duration space analog environments and on the ISS. With the BCM, it will be possible for NASA's BHP program to much better assess and quantify the Risk of Adverse Behavioral Conditions and Psychiatric Outcomes for exploration class missions.<br>With the proposed work we will relevantly contribute to HRP's goal to provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration. More specifically, the BCM will constitute an important technology to provide mission planners and system developers with strategies for monitoring and mitigating crew health and performance risks. |
| --- | --- |

| **Task Progress:** | Cognition: At the end of the reporting period for the first year we will have deployed and collected data on N=8 crewmembers during two out of the four Campaign 3 missions in NASA's Human Exploration Research Analog (HERA) facility. In HERA research participants perform the Cognition test battery on the Apple iPad; however, through discussions with the International Space Station Medical Program (ISSMP) it was determined that the iPad is not a feasible platform for data collection on ISS. Thus a Windows PC version of the Cognition software will be used on-board the ISS and in the Neumayer III Antarctic station.<br>Self Report and Visual Analog Scale Measures: During the first year of the project, work was done to identify several visual analog scales and brief questionnaires with proven validity and utility in space and space analog environments that could be used to evaluate several key aspects of behavioral health and crew interaction. This set of measures evaluates perceived mental and physical exhaustion, fatigue, sleepiness and stress, self-desirability bias, sleep quality and duration, mood, depression, and perceived conflict among crewmembers and between crewmembers and mission control. The final set of selected measures were transposed into the University of Pennsylvania's REDCap electronic web based survey tool. The REDCap versions of the survey have been deployed in HERA and at the end of the reporting period data will have been collected data on N=8 crewmembers. We are preparing to deploy these measures in the Neumayer III Antarctic station. With the assistance of ISSMP, we are in the process of determining the most feasible way to deploy these measures on ISS.<br><br>Journals: At the end of the reporting period, journal entries from two of the four HERA simulated asteroid rendezvous missions (N=8 crewmembers) will have been completed successfully; these audio/video journals are currently being transcribed in preparation for analysis. Journals will be completed using Microsoft Word in the Neumayer III Antarctic station and on-board ISS.<br><br>ROBoT: In the first year of the ROBoT project, we worked with the NASA DST lab (original developers of ROBoT) and the NASA astronaut trainers for ROBoT to make the planned software modifications. As part of these, we began to develop a quantitative performance scoring system based on the trainers' current practices in astronaut evaluation. A first version of this system, with a draft performance scoring system, was tested in the 30-day HERA Campaign 3, Mission 1 in February 2016. No significant difficulties were encountered in the deployment of the modified ROBoT, and all crewmembers found the task both challenging and enjoyable. Performance generally improved over the course of the mission, as would be expected from a task with a substantial learning curve. Following Mission 1, a notable re-design |
| --- | --- |

of the scoring system was implemented, to make the scoring align much more closely with current trainer procedures. As with Mission 1, 4 new subjects were pre-trained for Mission 2 at the end of April 2016, and entered the HERA facility for the 30-day Mission 2 on May 2, 2016. Missions 3 and 4 in HERA are planned for later in 2016. In parallel, ROBoT hardware is (1) being readied for shipment to Charite, Berlin, Germany for transfer to the Neumayer Antarctic station for testing in 2017, and (2) being evaluated by ISSMP for any needed payload certifications for deployment of the enhanced ROBoT software onboard the ISS in 2018.

Team Measure Questionnaires: In October 2015, the NASA Behavioral Health and Performance (BHP) Element convened a Team Risk Standardized Measures Workshop featuring multiple subject matter experts and stakeholders from the research and operations communities to discuss and nominate empirically-supported team measures for the Behavioral Core Measures (BCM) project. The Workshop considered various theoretical frameworks and available measurement tools applicable to the team risks of long-duration missions in isolated, confined, and extreme environments. Drawing largely from the Organizational Psychology and Behavioral Health literatures as well as the NASA BHP Team Risk research portfolio, a broad Input-Process-Output model of team performance was adopted, and various measures were selected to efficiently capture a wide variety of critical team-relevant constructs and topics. The measurement targets include personality, demographics, conflict, task and social cohesion, performance effectiveness, mission strategy/planning, performance monitoring, cooperation, communication, coordination, team climate, social support, and group living competencies. At the end of the reporting period, data from the initial battery of Team Measures will have been collected in two four-person crews (N=8) throughout two 30-day missions in the HERA facility, and are scheduled for collection in remaining two HERA missions for this year. Preliminary quantitative analyses of the HERA data, thematic analysis of the initial Team Measures battery, and assessment of operational acceptability led to recommendations for a reduced and modified Team Measures battery and data collection schedule for long-duration missions in operational environments. This iteration of the Team Measures battery will be deployed and evaluated in forthcoming long-duration missions at Neumeyer Station in Antarctica and the International Space Station (ISS). With the assistance of ISSMP, we are determining the most feasible way to deploy these measures on ISS.

| Bibliography Type: | Description: (Last Updated: 04/24/2024) |
|---|---|