Fiscal Year:	FY 2013	**Task Last Updated:**	FY 07/11/2012
PI Name:	Shea, Steven Ph.D.		
Project Title:	Identification of cardiometabolic vulnerabilities caused by effects of synergistic stressors that are commonly encountered during space missions		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Cardiovascular**:Risk of Cardiovascular Adaptations Contributing to Adverse Mission Performance and Health Outcomes		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Web Page:			
City:	Boston	**State:**	MA
Zip Code:	02115-5804	**Congressional District:**	8
Comments:	NOTE: PI currently at Oregon Health & Science University as of June 2016.		
Project Type:	GROUND	**Solicitation / Funding Source:**	2009 Crew Health NNJ09ZSA002N
Start Date:	10/01/2010	**End Date:**	09/30/2014
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:**	NASA JSC
Contact Monitor:	Villarreal, Jennifer	**Contact Phone:**	281-483-7306
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	Since the last annual report, the following staff members have left the group: Yusef Mohamed and Viqar Hussein (role: research assistant). The following staff members have been added to the study: Samantha Meyers and Adriana Tzelcheva (role: research assistants).		
COI Name (Institution):	Barger, Laura (Brigham And Women's Hospital, Inc.) Lockley, Steven (Brigham And Women's Hospital, Inc.) Scheer, Frank Ph.D. (Brigham And Women's Hospital, Inc.) Wang, Wei (Brigham And Women's Hospital, Inc.) Rueger, Melanie Ph.D. (Brigham and Women's Hospital, Inc.)		
Grant/Contract No.:	NNX10AR10G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The risk of adverse cardiac events has been listed as Priority 1 in the NASA Bioastronautics Roadmap (Risk Areas 5 and 6; 2005; http://bioastroroadmap.nasa.gov). Under extremely physiologically challenging circumstances, i.e. microgravity, astronauts are expected to perform tasks that add additional physical and mental stress to their cardiovascular system such as space walks or robotic operations during EVAs. To date we know little to nothing about the synergetic effects of chronic sleep restriction, circadian misalignment, and physical and mental stressors on cardiovascular functioning. The main goals of this four year NASA project are (1) to characterize the alterations (and potential maladaptations) of cardiovascular function (i.e. hemodynamic, autonomous nervous functioning, cardiac vulnerability) associated with chronic sleep restriction and circadian misalignment potentially occurring during space missions; (2) to characterize the effects of different types of stressors (postural, exercise, and mental stressors; except microgravity) on cardiovascular functioning; and (3) to identify the synergetic effects of chronic sleep restriction, circadian misalignment, and different stressors, potentially identifying in vulnerable periods with an increased likelihood of adverse cardiac events during space missions. During space missions astronauts are exposed to unusual light-dark cycles (e.g. Martian day length: 24.65 hrs) that would be expected to cause circadian misalignment resulting in sleep disturbances, sleep loss, and poor quality sleep. In addition, almost all astronauts report chronic sleep curtailment due to mission requirements such as working 'slam shifts' before EVAs and extended shifts during EVAs. The sleeping conditions on the ISS, e.g. cramped crew quarters, noise, and heat, also add to the reported sleep curtailment. Data from laboratory and epidemiological studies have shown that chronic sleep curtailment and circadian misalignment changes endocrine, inflammatory, and cardiovascular function; changes that potentially result in adverse health events, including cardiac arrhythmias, myocardial and peripheral vascular dysfunction, risk of syncope, hypertension, diabetes, and metabolic syndrome. Moreover, adverse cardiac events show a clear day-night pattern, with a peak in the morning. In addition, it is well know than microgravity itself impacts cardiovascular functioning resulting in decreased circulating blood volume, decreased central venous blood pressure, increased stroke volume and increased cardiac output, potentially leading to cardiac rhythm disturbances that have been documented during spaceflight previously. With the anticipated return of humans to the moon in 2020 and the preparation for human explorations of Mars and other destinations in the solar system it becomes imperative to determine the cardiovascular risks for crew members on these missions, and develop countermeasures to limit or alleviate those risks.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The risk of adverse cardiac events has been listed as Priority 1 in the NASA Bioastronautics Roadmap (Risk Areas 5 and 6; 2005; http://bioastroroadmap.nasa.gov). Several factors impact cardiovascular functioning in space, microgravity, sleep loss, physical and mental stress amongst them. The project will identify the independent contributions of sleep loss, circadian misalignment, and varied stressors on cardiovascular alterations, as well as their synergetic effects, thereby simulating many of the physiological stresses that occur throughout long missions. Characterizing these effects on hemodynamic and autonomic function may help us to develop appropriate countermeasures to limit and/or alleviate adverse cardiovascular function during long and short duration space missions. Identifying vulnerable periods in which sleep deprivation, circadian misalignment, and different stressors lead to vulnerabilities of the cardiovascular system will also be beneficial to improving work schedules and life-style interventions for shift workers as circadian misalignment and sleep deprivation are hallmarks of shift work.
Task Progress:	After obtaining IRB approval and completion of staff training, to date we have actively recruited 73 subjects who gave their consent to start the screening procedures. 62 of these 73 subjects were found to be ineligible based on tests and/or examinations results and in a few cases because of a subject's inability or unwillingness to liberate the many weeks of free time required for successful participation in the study. The remaining 11 subjects all gave informed consent for participation in the intensive research phase of the study. Two of these 11 subjects were later excluded because the maximal oxygen consumption test prior to the laboratory stay revealed possible abnormalities in their EKGs. These subjects received their test results in report form and were advised to follow-up with their Primary Care Physicians. A third subject was excluded due to insufficient and inconsistent actigraphy data in the week leading up to the in-patient study. Losing these three subjects after they successfully completed all other screening procedures put us behind schedule in the first quarter of 2012 as we had all visits booked for the subjects and no back-ups could be immediately recruited to fill their places. Due to the nature of the study, i.e. two 11 day in-laboratory stays, at least 3 weeks apart, bookings for maximal oxygen consumption tests, brachial and cardiac ultrasound tests must be made a month in advance and subjects also rely on fixed dates for their planning and time commitment. Based on this experience we now try to ensure that we have a back-up 'alternate' subject that is at the same stage in the screening process and indicates flexibility to potentially fill the spot of a subject who drops out or is excluded based on screening test results. We initiated in-patient studies in six of the remaining eight subjects. Of these, one subject withdrew from the study due to nausea and light-headedness during the tilt table test (this withdrawal was previously reported in the first annual report). Since the last progress report, a separate subject developed high blood pressure during the first in-laboratory stay and was withdrawn from the study as medical precaution. An adverse event report regarding this subject was filled to the NASA and Partners' IRB and both institutions deemed that no changes to the protocol were necessary. The remaining four subjects successfully completed both 11-day in-laboratory stays and all other study requirements. The last two consented subjects are on the schedule to complete their in-patient stays mid July and mid August and end of August and mid September, respectively. Thus, we anticipate that we will have completed 6 of the total of 16 subjects through the entire protocol by the end of the second year. Thus, we are slightly behind schedule. Our research group is comprised of research staff who work on numerous protocols simultaneously, and our group recently completed two other major protocols and will be working on only one additional project in the foreseeable future. This will enable us to focus much more effort on this current study. Thus, we are confident that we will be able to catch up to the expected enrollment rate within the next 12-18 months.
Bibliography Type:	Description: (Last Updated: 08/14/2018)

Abstracts for Journals and Proceedings	Ruger M, Scheer FAJL, Barger LK, Lockley SW, Wang W, Johnston SL 3rd, Crucian B, Shea SA. "STUDY DESIGN: Identification of cardiometabolic vulnerabilities caused by effects of synergistic stressors that are commonly encountered during space missions." Presented at the 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14-16, 2012. 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14-16, 2012. , Feb-2012