Fiscal Year:	FY 2022	**Task Last Updated:**	FY 06/28/2023
PI Name:	Hargens, Alan R. Ph.D.		
Project Title:	Fluid Distribution before, during and after Prolonged Space Flight		
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 (2) **SANS**:Risk of Spaceflight Associated Neuro-ocular Syndrome (SANS)		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	La Jolla	**State:**	CA
Zip Code:	92037-0863	**Congressional District:**	52
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2011 Crew Health NNJ11ZSA002NA
Start Date:	04/05/2013	**End Date:**	01/30/2022
No. of Post Docs:	2	**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	1
No. of Master's Candidates:	2	**No. of Bachelor's Degrees:**	3
No. of Bachelor's Candidates:	3	**Monitoring Center:**	NASA JSC
Contact Monitor:	Stenger, Michael	**Contact Phone:**	281-483-1311
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Flight Program:	ISS		
Flight Assignment:	NOTE: End dt chgd to 1/30/2022 per NSSC information (Ed., 6/29/22) NOTE: Extended to 1/31/2022 per NSSC information (Ed., 1/6/21) NOTE: Extended to 1/31/2021 per NSSC information (Ed., 10/16/18)		
Key Personnel Changes/Previous PI:	March 2021 report: Dr. Steven Laurie is now Co-Principal Investigator on the project.		
COI Name (Institution):	Arbeille, Phillipe M.D., Ph.D. (CERCOM, France) Liu, John Ph.D. (University of California, San Diego) Macias, Brandon Ph.D. (NASA Johnson Space Center) Stenger, Micheal Ph.D. (NASA Johnson Space Center) Ebert, Douglas Ph.D. (KBR/NASA Johnson Space Center) Laurie, Steven Ph.D. (KBR/NASA Johnson Space Center)		
Grant/Contract No.:	NNX13AJ12G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Editor's Note (4/24/2013): NOTE THIS IS A CONTINUATION OF FUNDING FOR NNX12AL66G WITH THE SAME TITLE AND PRINCIPAL INVESTIGATOR. We will use state-of-the-art, non-invasive technologies to quantify upper-body compartmental volumes and pressures in crewmembers before, during, and after prolonged space flight. Importantly, we will correlate these data with vision deficits that occur in order to establish pathophysiologic mechanisms that will serve as a basis for future countermeasure development. After successful completion of our investigation, we will deliver a comprehensive database of microgravity-induced, head-ward volume and pressure changes (type and magnitude), and a prioritization of these changes as to their deleterious effects on vision in crewmembers during and after prolonged space flight. We are proposing a well-documented and validated battery of non-invasive or minimally-invasive, image-based tests developed to identify and quantify microgravity-induced, head-ward volume and pressure changes. We hypothesize that prolonged microgravity-induced, head-ward volume and pressure shifts are responsible for elevating intracranial pressure (ICP) and producing deficits in crewmembers' vision. Our project directly addresses Critical Path Roadmap Risks and Questions regarding "Risk of Spaceflight Associated Neuro-ocular Syndrome (SANS)" (previously called "Risk of Microgravity-Induced Visual Alterations and Intracranial Pressure"), specifically Integrated Research Plan (IRP) Gap Cardiovascular (CV) 7: How are fluids redistributed in-flight? and IRP Gap We do not know the etiological mechanisms and contributing risk factors for ocular structural and functional changes seen in-flight and postflight (SANS1) [previoulsy VIIP 1: What is the etiology of visual acuity and ocular structural and functional changes seen in-flight and post-flight?]. Our first specific aim is to study periocular fluid volumes, intraocular pressure (IOP), upper-body compartment volumes before, during, and after prolonged microgravity exposure. The second specific aim is to measure jugular vein dimensions and blood flow using ultrasound before, during, and after prolonged microgravity exposure. The third specific aim is to quantify ventricular and cerebrospinal volumes using ultrasound before, during, and after prolonged microgravity exposure. A fourth specific aim is to perform retinal imaging to observe retinal venous distension in space. Tests of ocular structure will include optic nerve head tomography, nerve fiber layer thickness, axial length, and orbital retrolaminar subarachnoidal space. Tests of ocular function will include visual acuity, total retinal blood flow, and capillary blood flow in the optic nerve head and macula. Finally, changes in ICP, IOP, and ocular structures and functions will be investigated while applying a purely-mechanical countermeasure of low-level lower body negative pressure or thigh cuffs to counteract the head-ward fluid shift in space. To our knowledge, this study will be the first to provide detailed and non-invasive measures of compartmental volume and pressure changes in the upper body induced by prolonged microgravity and to correlate these specific changes with decrements in vision for crewmembers. The proposed techniques represent the best available, state-of-the-art tools to quantify and document features that are clinically suspected as vision deficit generators. By correlating volume and pressure changes with vision problems, we expect to identify factors that will later motivate targeted development of effective physiologic countermeasures such as low-level lower body negative pressure exposure or thigh cuffs in space. This project has the potential to prevent loss of vision in crewmembers exposed to prolonged space flight and upon return to Earth. NOTE: This study was merged with investigations from Dr. Michael Stenger who was replaced by Steve Laurie (Distribution of Body Fluids during Long Duration Space Flight and Subsequent Effects on Intraocular Pressure and Vision Disturbance) and Dr. Scott Dulchavsky (Microgravity associated compartmental equilibration) resulting in a comprehensive study titled "Fluid Shifts Before, During and After Prolonged Space Flight and Their Association with Intracranial Pressure and Visual Impairment" (short title: Fluid Shifts).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Our proposed tests represent a comprehensive set of state-of-the-art, noninvasive technologies to quantify upper-body compartmental volumes and vascular parameters in crewmembers before, during, and after prolonged space flight. Importantly, we will correlate these data with vision deficits that occur in order to establish pathophysiologic mechanisms that will serve as a basis for future countermeasure development. After successful completion of our investigation, we will deliver a database of microgravity-induced, head-ward volume and vascular changes (type and magnitude) and a prioritization of these changes as to their deleterious effects on vision in crewmembers during and after prolonged space flight. Finally, our project includes use of lower body negative pressure (LBNP), which is known to sequester fluid in lower body tissues and counteract head-ward fluid shifts. Importantly, these procedures have the potential to reduce intracranial pressure and counteract papilledema, even if the proposed countermeasure acts transiently. This research has strong Earth benefits such as development and validation of a noninvasive ICP device and greater understanding of glaucoma using the latest technology for measuring intraocular and intracranial pressures.
Task Progress:	Final Report/Progress Update per Principal Investigator (PI): We have made significant progress over the past 10 years on possible mechanisms of Spaceflight Associated Neuro-ocular Syndrome (SANS); all approvals were received and experimental schedules were optimized. We have completed our project NNX13AJ12G (entitled, "Fluid Distribution before, during and after Prolonged Space Flight") by testing 13 astronauts. Moreover, we have updated and renewed our NASA and University of California San Diego (UCSD) Institutional Review Board (IRB) approvals. To date, all pre/in/post-flight data collection are completed on 13 subjects for this experiment. Results from our spaceflight and other related investigation are available as part of three publications and three chapters. (Ed. Note: See Cumulative Bibliography).
Bibliography Type:	Description: (Last Updated: 10/31/2023)
Articles in Peer-reviewed Journals	Jasien JV, Laurie SS, Lee SMC, Martin DS, Kemp DT, Ebert DJ, Ploutz-Snyder RJ, Marshall-Goebel K, Alferova IV, Sargsyan AE, Danielson RW, Hargens AR, Dulchavsky SA, Stenger MB, Macias BR. "Noninvasive indicators of intracranial pressure before, during, and after long-duration spaceflight." J Appl Physiol. 2022 Sep 1;133(3):721-31. https://doi.org/10.1152/japplphysiol.00625.2021 ; PMID: 35861522; PMCID: PMC9484990 , Sep-2022

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Articles in Peer-reviewed Journals	Arbeille P, Zuj KA, Macias BR, Ebert DJ, Laurie SS, Sargsyan AE, Martin DS, Lee SMC, Dulchavsky SA, Stenger MB, Hargens AR. "Lower body negative pressure reduces jugular and portal vein volumes and counteracts the elevation of middle cerebral vein velocity during long-duration spaceflight." 2021 Sep 9. https://doi.org/10.1152/japplphysiol.00231.2021 ; PMID: 34323592; PMCID: PMC8461809 , Sep-2021
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