Fiscal Year:	FY 2014	**Task Last Updated:**	FY 03/19/2014
PI Name:	Dulchavsky, Scott A. M.D., Ph.D.		
Project Title:	Fluid Shifts		
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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Zip Code:	48202-2608	**Congressional District:**	13
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	2011 Crew Health NNJ11ZSA002NA
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No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
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Flight Program:	ISS		
Flight Assignment:			
Key Personnel Changes/Previous PI:	none		
COI Name (Institution):	Ebert, Douglas (Wyle Laboratories, Inc.) Garcia, Kathleen (Wyle Laboratories, Inc.) Hamilton, Douglas (Wyle Laboratories, Inc.) Killu, Keith (Henry Ford Health System) Sargsyan, Ashot (Wyle Laboratories, Inc.)		
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Task Description:

Editor's Note (7/11/2013): NOTE THIS IS A CONTINUATION OF FUNDING FOR NNX13AB42G (Microgravity Associated Compartmental Equilibration (MACE)) WITH THE SAME PRINCIPAL INVESTIGATOR.
Recent evidence suggests that a preexisting subclinical pathology or risk factor may determine whether microgravity fluid shifts alone or in combination with other factors cause pathological increases in intracranial pressure (ICP) and sequelae thereof (visual acuity changes, cognitive impairment, retinal pathology). Furthermore, this malady may persist in some crewmembers beyond the rehabilitation phase after flight. Space medicine is therefore facing an occupational medical hazard, with a number of contributing factors challenging to quantify and examine independently (i.e., resistive exercise vs. microgravity fluid shifts).

Over years, the U.S. and the Russian space programs have implemented extensive research to understand the alterations in neurological and cardiovascular physiology secondary to fluid shifts that are induced by microgravity. The investigator team proposes to meet, through this study, the challenge of "how do we understand the effect of fluid shift on cerebrospinal fluid (CSF) dynamics when gold-standard terrestrial technologies are invasive and the true magnitude of microgravity fluid shifts and their pathophysiological effects are not well understood?"

Recent on-orbit long duration studies performed by this team have shown that cephalad venous fluid shifts are permanent in all crewmembers and that external jugular pressures are increased, so that aggressive intra-thoracic pressure maneuvers (i.e., Mueller maneuver) have very little effect on extracranial venous dimensions in all crewmembers examined in space (n=6). Preliminary data from the Braslet Investigation Grant ground experiment (ongoing) find terrestrial supine position to be very different in this regard.

In microgravity, cephalad fluid shifts seem to cause a relative extra-cranial (and therefore intracranial) venous insufficiency and subsequent lymphedema (facial puffiness, loss of olfactory and gustatory sense); several crew members have anecdotally mentioned that Russian thigh venous occlusion cuffs (Braslet, Kentavr nauka, Russian Federation) improve these changes and "help think clearer and perform procedures better." In our experience, venous insufficiency indeed improved when the cuffs were worn for at least 15 minutes: Mueller maneuver was much more readily causing a decrease in jugular venous dimension; cardiac preload was significantly diminishing when measured with echocardiography on-orbit.

The venous thigh occlusion cuffs therefore, though altering the fluid shifts and reducing venous insufficiency, also may effect a change in CSF dynamics in space (that would explain the improvement in cognition and well-being).

The investigators plan to use multiple non-invasive technologies to assess fluid shifts quantitatively, with a commensurate focus on the likelihood and severity of ocular and CSF fluid dynamic changes in microgravity, and identify markers of susceptibility to the development of pathological changes.

Research questions/ Specific Aims:

1. Determining the magnitude and time course of fluid in continuous microgravity.

2. Determining the physiological and potential health effects of microgravity-associated fluid redistribution on the cardiovascular and central nervous (CNS) systems.

3. Assessing the acute fluid volumetric effects of the Braslet and Lower Body Negative Pressure (LBNP) countermeasures on central, peripheral vascular systems, and CNS/ocular systems.

4. Determining best combinations of non-invasive technologies related to fluid shifts and ICP elevation that are most predictive in estimating the absolute ICP and trends thereof during space flight.

NOTE: This study was merged with investigations from Dr. Alan Hargens (Fluid distribution before, during and after prolonged space flight) and Dr. Michael Stenger (Distribution of Body Fluids during Long Duration Space Flight and Subsequent Effects on Intraocular Pressure and Vision Disturbance) 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:

Current means of measuring increased intracranial pressure require an invasive monitoring system with skilled medical personnel. The techniques outlined in this proposal, if verified, would provide a rapid, accurate, non-invasive, and scalable solution to measure increases in intracranial pressure for a number of critical medical conditions.

Task Progress:

We have successfully completed integration of the Dulchavsky, Hargens, and Stenger proposals into one comprehensive experimental document. We have developed experimental milestones, budget items, and have focused on reducing non-essential tests to limit crew training and experimental time on the International Space Station (ISS). The PI teams are continuing work on the BDC (baseline data collection) development activities.
Major accomplishments:

o Completed the Payload Training Dry Run (PTDR) (certification) events for the Fluid Shifts Science Overview and Ultrasound (USND) training classes. First training is targeted for Scott Kelly on 3/18.

The PI teams have met regularly to review overlapping specific objectives and have attempted to simplify crew training and operative times. We have consolidated the over-arching experiment considerably and are working on finalizing equipment and operational procedures. Specific highlights are included below.

Provided “final” list of modifications to Manometer (tube length and filter for mouthpieces)

· Upcoming Activities/Actions:

o Baseline Data Collection (BDC) Shakedown TRR (Test Readiness Review) on Friday, March 7

o USND flight-like run through with remote guidance, Tuesday March 11

o Finalization of Distortion-Product Otoacoustic Emission (DPOAE) unit settings for data collection, week of March 10

	o Ops Assessment with crew office week of March 17 o Fluid Shifts Implementation TIM April 17 o Dilution Measures training PTDR April 18 The Fluid Shifts Implementation TIM (CDR-like) has been moved to April 17 to deconflict with Planning, Programing, Budget and Execution (PPBE) and Twin Study discussions. We are working within the 3 PI teams to develop input for this meeting in the coming weeks. The plan will be to update the Fluid Shifts ED and Hardware document to "final" requirements for flight implementation.
Bibliography Type:	Description: (Last Updated: 03/14/2025)