Fiscal Year:	FY 2014	**Task Last Updated:**	FY 09/03/2013
PI Name:	Ethier, Christopher Ph.D.		
Project Title:	Microgravity-driven Optic Nerve/Sheath Remodeling Simulator (MONSTR Sim)		
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) **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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Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2012 Crew Health NNJ12ZSA002N
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No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA GRC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Best, Lauren (NASA Glenn Research Center) Gleason, Rudolph (Georgia Institute of Technology) Myers, Jerry (NASA Glenn Research Center) Samuels, Brian (Indiana University) Nelson, Emily (NASA Glenn Research Center)		
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Task Description:	Visual Impairment/Intracranial Pressure (VIIP) syndrome occurs in a significant fraction of astronauts undergoing long-duration space flight. VIIP is characterized by a spectrum of ophthalmic changes, including optic nerve sheath distention and kinking, optic disc edema, choroidal folds, and flattening of the posterior eye globe. Most significantly, astronauts with VIIP can suffer permanent loss of visual acuity. The cause(s) of VIIP are not well understood, but the syndrome has ophthalmic features similar to those seen in patients with idiopathic intracranial hypertension, strongly suggesting that elevations in intracranial pressure and/or reductions in intraocular pressure play an important role in VIIP. Notably, observations in VIIP are consistent with a major alteration in the pressure difference across the lamina cribrosa. Given the probable role of these altered pressures in VIIP, any VIIP computational model should include biomechanical models of the relevant ocular tissues. Importantly, VIIP develops slowly (over weeks); further, the anatomic changes observed in ocular connective tissues (e.g. the optic nerve sheath) appear to be permanent in some cases. This strongly suggests that tissue remodeling is an important aspect of VIIP, and thus any attempt to understand VIIP must consider remodeling effects. In view of the above, we hypothesize that cephalad fluid shifts in microgravity affect intracranial pressure (ICP) and intraocular pressure (IOP), leading to altered biomechanical loads on the tissues of the posterior globe and optic sheath. This altered biomechanical environment in turn causes connective tissue remodeling, an important contributing factor to vision changes in the VIIP syndrome. We will develop modeling tools to allow the above hypothesis to be tested, and which will provide a test bed for identification of which clinically observable attributes play key roles in the development of the VIIP syndrome. These tools will be developed through 4 specific aims: SA1: Develop validated tools for computing IOP and ICP in microgravity. These tools will be based on modeling of fluid shifts between the eye and various compartments in the cardiovascular, cerebrospinal and lymphatic systems. SA2: Develop validated finite element-based tools for computing the biomechanical environment and subsequent connective tissue remodeling in the optic nerve head, optic nerve sheath, and posterior globe. These tools will be complemented by a model of the eye's optical performance. SA3: Integrate the models from SA1 and SA2 to produce a unified, open and extensible software package that can predict ocular biomechanics and ocular connective tissue remodeling under microgravity conditions. SA4: Use the integrated model of SA3 to study clinically observable attributes and determine the role they may play in the development of VIIP. This proposal directly addresses an explicit requirement of NASA Research Announcement NNJ12ZSA002N, namely to "… develop and deliver numerical model(s) of the visual system quantifying the biomechanical pathways by which gravitational unloading could affect the distribution of hydrodynamic pressures within the CVS and CNS, and their impact on the structure of the eye." Our models will provide a powerful platform for better understanding VIIP and, eventually, for suggesting VIIP screening and mitigation strategies, thus contributing to astronaut health. Our team has highly complementary skills that together address all relevant aspects of this complex, interdisciplinary problem. In addition to Ethier (PI at Georgia Tech; expertise in modeling optic nerve head and ocular biomechanics), co-investigators include Myers, Best, and Nelson (NASA Glenn; expertise in cephalad fluid shift models and space physiology); Samuels (Indiana; expertise in clinical ophthalmology and neuroscience); and Gleason (Georgia Tech; expertise in soft tissue biomechanics and tissue remodeling).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2014.
Bibliography Type:	Description: (Last Updated: 11/26/2021)