

<b>Fiscal Year:</b>	FY 2019	<b>Task Last Updated:</b>	FY 10/30/2018
<b>PI Name:</b>	Petersen, Lonnie M.D., Ph.D.		
<b>Project Title:</b>	Mobile Gravity Suit (an Integrative Countermeasure Device)		
<b>Division Name:</b>	Human Research		
<b>Program/Discipline:</b>			
<b>Program/Discipline-- Element/Subdiscipline:</b>			
<b>Joint Agency Name:</b>		<b>TechPort:</b>	Yes
<b>Human Research Program Elements:</b>	(1) <b>HHC:</b> Human Health Countermeasures		
<b>Human Research Program Risks:</b>	None		
<b>Space Biology Element:</b>	None		
<b>Space Biology Cross-Element Discipline:</b>	None		
<b>Space Biology Special Category:</b>	None		
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<b>Zip Code:</b>	92037-1337	<b>Congressional District:</b>	52
<b>Comments:</b>			
<b>Project Type:</b>	GROUND	<b>Solicitation:</b>	2017 HERO 80JSC017N0001-Crew Health and Performance (FLAGSHIP1, OMNIBUS). Appendix A-Flagship1, Appendix B-Omnibus
<b>Start Date:</b>	10/04/2018	<b>End Date:</b>	10/03/2020
<b>No. of Post Docs:</b>		<b>No. of PhD Degrees:</b>	
<b>No. of PhD Candidates:</b>		<b>No. of Master' Degrees:</b>	
<b>No. of Master's Candidates:</b>		<b>No. of Bachelor's Degrees:</b>	
<b>No. of Bachelor's Candidates:</b>		<b>Monitoring Center:</b>	NASA JSC
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<b>Flight Program:</b>			
<b>Flight Assignment:</b>	NOTE: End date changed to 10/3/2020 per NSSC information (Ed., 10/28/19)		
<b>Key Personnel Changes/Previous PI:</b>			
<b>COI Name (Institution):</b>	Hargens, Alan Ph.D. ( University of California, San Diego ) Levine, Benjamin M.D., Ph.D. ( University of Texas Southwestern Medical Center at Dallas )		
<b>Grant/Contract No.:</b>	80NSSC19K0020		
<b>Performance Goal No.:</b>			
<b>Performance Goal Text:</b>			

	<p>Because all parts of human physiology are affected by microgravity, an integrative countermeasure strategy is needed. Loss of muscle and bone mass along with deconditioning of the heart and vessels are well described effects of microgravity. More recently structural and functional changes of the eye, experienced by some astronauts during long-term missions, have been described and summarized in the Spaceflight Associated Neuro-ocular Syndrome (SANS). While the exact etiology of SANS remains unknown, the microgravity induced headward fluid shift is likely part of the pathophysiology and countermeasures that can reverse this fluid shift are prioritized. Based on our experimental data from short-term microgravity by parabolic flights and 24-hour simulated microgravity, we suggest that fluid redistribution in space may not give rise to a pathological increase in intracranial pressure, but rather the lack of diurnal fluctuations in intracranial volume and pressures may be responsible for the remodeling of the eye. In ambulatory neurosurgical patients with pressure sensors inserted in the brain tissue, we therefore demonstrated the feasibility of lower body negative pressure to reduce intracranial pressure as means of re-introducing diurnal pressure variability. Extending on this, in a recent 3-day, 6° head-down tilt bedrest trial we applied lower body negative pressure (LBNP) for 8 hours every day, to demonstrate safety and efficacy to significantly reduce long-term swelling at the back of the eye believed to be early symptoms of SANS.</p> <p>At the University of California San Diego we have developed and tested a fully mobile "Gravity Suit" comprised of pressurized-trousers and attached vest. The suit simulates the effects of gravitational stress by application of low-levels lower body negative pressure to re-introduce an Earth-like fluid shift while at the same time inducing a ground reaction force at the bottom of the feet and a mechanical load along the entire body axis. Preliminary tests involving healthy human subjects in simulated microgravity have demonstrated the efficacy of 20 mmHg lower body negative pressure within the suit to reduce internal jugular vein cross-sectional area by some 45% and induce mechanical load of 57% bodyweight.</p> <p>The intravehicular suit is comfortable enough to wear 8-10 hours a day and flexible enough to be combined with daily activity and even exercise with the overall aim to provide an integrative countermeasure. As an overall long-term aim, we suggest that use of the Gravity Suit will 1) re-introduce the diurnal variability of intracranial pressure and volume to help prevent development of SANS; 2) stimulate the cardiovascular system to maintain cardiac muscle mass and vascular compliance; 3) counteract loss of postural muscle mass and bone density; 4) finally, the axial loading will preserve curvature of the spine, paraspinal muscle, and disc morphology to both ameliorate in-flight back pain, and reduce risk of post-flight disc herniation.</p> <p>Within the scope of this proposal, we will finalize and further test our prototype by integrating vacuum- and monitoring systems within the waist-belt to increase safety and allow for free and un-tethered movement. Comfort, range of motion, and gait will be assessed during relevant activities simulating daily work tasks on the International Space Station and in combination with resistive exercise device relevant for cislunar and deep space missions. High levels and/or prolonged exposure to lower body negative pressure can potentially compromise blood flow to the brain; however, activity and use of the muscle pump increases orthostatic tolerance. To establish a safe range and optimize the user scenario, we will test cardiovascular responses and cerebral perfusion during graded lower body negative pressure with and without a combined ground reaction force and in combination with rowing exercise. Successful funding of this proposal will bring our Gravity Suit to Countermeasure Readiness Level 7.</p>
<b>Task Description:</b>	
<b>Rationale for HRP Directed Research:</b>	
<b>Research Impact/Earth Benefits:</b>	
<b>Task Progress:</b>	New project for FY2019.
<b>Bibliography Type:</b>	Description: (Last Updated: 02/11/2020)