Fiscal Year:	FY 2004	**Task Last Updated:**	FY 07/21/2006
PI Name:	Buckey, Jay C. M.D.		
Project Title:	Improved Bubble Detection for EVA		
Division Name:	Human Research		
Program/Discipline:	NSBRI Teams		
Program/Discipline--Element/Subdiscipline:	NSBRI Teams--Technology Development Team		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **DCS**:Risk of Decompression Sickness [inactive]		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	jay.buckey@dartmouth.edu	**Fax:**	FY 603-650-6013
PI Organization Type:	UNIVERSITY	**Phone:**	603-650-6012
Organization Name:	Dartmouth College		
PI Address 1:	Department of Medicine		
PI Address 2:	1 Medical Center Drive		
PI Web Page:			
City:	Lebanon	**State:**	NH
Zip Code:	03756-0001	**Congressional District:**	2
Comments:	Address updated 9/2008		
Project Type:	GROUND	**Solicitation / Funding Source:**	2003 Biomedical Research & Countermeasures 03-OBPR-04
Start Date:	07/01/2004	**End Date:**	06/30/2008
No. of Post Docs:	0	**No. of PhD Degrees:**	
No. of PhD Candidates:	0	**No. of Master' Degrees:**	
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Magari, Patrick (Creare) Kenton, Marc (Creare) Knaus, Darin (Creare)		
Grant/Contract No.:	NCC 9-58-TD00402		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Assembly of the International Space Station (ISS) and future space exploration require extensive and unprecedented extra-vehicular activity. Current spacecraft and suit designs force astronauts to move between different pressure environments, making decompression sickness (DCS) a potential risk. DCS risk mitigation strategies reduce operational efficiency. The objective of this effort is to improve EVA efficiency and safety by developing and validating new bubble detection technology using dual-frequency ultrasound. The Creare dual-frequency instrument (CDFI) can detect and size bubbles through the chest wall as they move through the heart. Also, signals consistent with bubbles can be detected in tissue. Potentially, this technology could be used to: (a) characterize bubble dynamics during decompression sickness (DCS), (b) detect the earliest stages of DCS, (c) develop and evaluate non-compressive countermeasures for DCS, (d) diagnose DCS in tissue or joints, and (4) mitigate DCS risk by improving preventive strategies such as oxygen pre-breathing and limiting activity at particular times. Detecting and sizing bubbles intravascularly (a new and unique capability) allows for bubble size histograms to be constructed during the development and treatment of DCS. The change of bubble size distribution during decompression stress may indicate the progression of DCS. Preliminary data indicate the CDFI may identify bubbles earlier than current Doppler or imaging ultrasound techniques. One goal of this project is to demonstrate the capabilities of the CDFI in DCS. Experiments using anesthetized swine after decompression will be performed to test the CDFI. An accurate and reliable way to assess intravascular bubbles may offer a way to evaluate non-compressive therapies, such as perfluorocarbons, for DCS. Studies on the effect of perfluorocarbons on bubble size and frequency during DCS will be performed in swine exposed to decompression stress. Tissue bubble detection is also a unique capability. The CDFI can potentially detect very small bubbles (the possible precursors of larger bubbles in tissue or blood) and to identify larger bubbles in areas with symptoms of pain or discomfort consistent with DCS. A goal of this project is to validate tissue bubble detection for both very small (50 micron) bubbles. In-vitro tests and studies using swine exposed to compression and decompression will be performed to validate the CDFI in tissue.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This technical approach offers an improved way to detect bubbles in blood. The ability to detect bubbles in tissue, once validated, would be a completely new capability.. In addition to its NASA application, this technology could be used to improve the safety and efficiency of diving operations.
Task Progress:	The objective of this project is to improve EVA efficiency and safety through the in-vivo validation of a unique ultrasonic bubble-sizing and detection instrument. This instrument exploits bubble resonance by using two frequencies of ultrasound (dual-frequency ultrasound) to detect and size bubbles in tissue and blood. The original aims of the project were to: (a) establish the appropriate transducer configurations, electronic settings and instrument enhancements to detect and size bubbles reliably in-vivo, (b) compare the new bubble monitoring technique to Doppler, and use it to investigate decompression sickness and (c) develop the capability to size small bubbles in tissue. a. establish the appropriate transducer configurations, electronic settings and instrument enhancements to detect and size bubbles reliably in-vivo--experiments demonstrated that bubbles could be detected as they move through the right ventricle and right atrium. These experiments established the technical knowledge (transducer position relative to anatomical features, equipment settings, etc.) needed to monitor bubbles during subsequent decompression experiments. b. compare the new bubble monitoring technique to Doppler, and use it to investigate decompression sickness -- aim has been advanced by comparing the signals obtained with the dual frequency device to a standard clinical ultrasound instrument. c. develop the capability to size small bubbles in tissue-- aim has been advanced through a variety of in vitro and in vivo studies. The newly developed ability to construct bubble size histograms has a major impact on our research. The histograms provide a novel way to study the time course and treatment of decompression sickness as it is manifested in the bubbles that form in the vasculature. Currently, no other technique exists that allows for bubble size histograms to be constructed during decompression stress.
Bibliography Type:	Description: (Last Updated: 03/18/2024)