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Project Title:	Validation of On-Orbit Methodology for the Assessment of Cardiac Function and Changes in the Circulating Volume Using Ultrasound and Braslet-M Occlusion Cuffs, SDTO 17011 U/R (Braslet)		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Operational and clinical research		
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Human Research Program Risks:	(1) Cardiovascular: Risk of Cardiovascular Adaptations Contributing to Adverse Mission Performance and Health Outcomes (2) Medical Conditions: Risk of Adverse Health Outcomes and Decrements in Performance Due to Medical Conditions that occur in Mission, as well as Long Term Health Outcomes Due to Mission Exposures		
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Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Key Personnel Changes/Previous PI:	V.V. Bogomolov is the Russian Co-PI for this investigation		
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Performance Goal Text:**Task Description:**

Validation of On-Orbit Methodology for the Assessment of Cardiac Function and Changes in the Circulating Volume Using Ultrasound and Braslet-M Occlusion Cuffs (Braslet) is Station Development Test Objective (SDTO) 17011 sponsored by NASA and Russian Federal Space Agency (FSA). Braslet is testing the ability of ultrasound to detect cardiovascular changes in response to volume distribution changes that are induced by the Braslet occlusion cuffs. Understanding the effects of this countermeasure on cardiovascular function in a microgravity environment will be useful for both medical operations and future research.

See also <http://www.nasa.gov/>

Rationale for HRP Directed Research:**Research Impact/Earth Benefits:****Space Applications**

This SDTO will provide refinements in remote guidance techniques which will allow detailed ultrasound exams to be performed in space with remote guidance by technicians and physicians on the ground. This will enhance the diagnostic and research capabilities of the ISS ultrasound. Data will also be collected regarding the utility and potentially expanded uses of the Braslet-M device for both ISS and exploration class missions. A more detailed understanding of the cardiovascular response to microgravity-induced fluid shifts will also be gained from this work.

Earth Applications

Refinements in remote guidance techniques provided by Braslet will similarly allow detailed ultrasound exams to be performed in terrestrial locations remote from experienced ultrasound technicians and physicians. Examples include rural clinics, disaster areas, and military applications. Additionally, during this SDTO data will be collected regarding the physiological responses to altered circulatory volume distribution which may lend insight to the diagnosis and treatment of terrestrial conditions (such as cardiovascular disease) which result in altered fluid status.

Protocol Development:

Following appropriate board approvals and flight selection, the Braslet Station Developmental Test Objective (SDTO) team undertook an intensive period of protocol development. Using the mockup of the US laboratory module (Destiny) at JSC, which houses an operational, flight-like ultrasound unit and the capability to simulate remote guidance, the team developed data collection techniques and ergonomics to allow the most streamlined collection of data on-orbit. A checklist and data log was produced that insures that data collection proceeds in a standardized manner. Reference images of target ultrasound images were also produced and uplinked to ISS. These image documents proved to be highly effective and complementary to remote guidance during on-orbit operations.

Training:

One crewmember from each planned Expedition was chosen as the ultrasound operator. The operator can also serve as a subject due to the development of self-scanning techniques. Operator crewmembers received 1-2 hours didactic and hands-on remote guidance training several months prior to the start of their increment. A short training video (~3 min) was also produced and uplinked to ISS for review within a day of performing the first scanning session. Subjects received no Braslet SDTO specific training, so this video was also instrumental in familiarizing subjects with breathing techniques and the experimental protocol.

On-orbit Data Collection:

The Braslet SDTO is a Medical Operations “reserve activity”, which means that time for the project is not scheduled prior to the beginning of each increment. In coordination with mission planners and biomedical engineers, the team must match usable blocks of crew time. Many times this involves capitalizing on slips in mission schedules, such as the delay of a Shuttle launch. These constraints require the team and the crew to be flexible with the timing of scanning sessions and with the total available data collection sessions with each Expedition.

During Increment 16, data was collected on four crewmembers during six scanning sessions. One session was incomplete due to an on-orbit hardware problem. Due to mission constraints only one of completed scans was a repeat scan on the same crewmember. At the end of Expedition 16, the Braslet SDTO team had collected 1 complete paired data set and 3 individual data sets.

During Increment 18, data was collected on 3 crewmembers during five scanning sessions. Two of these crewmembers participated twice, resulting in 2 additional paired data sets. The final subject was unable to schedule another session prior to the end of the mission.

Task Progress:

In summary, at the end of Increment 18 a total of 3 paired scan sets and 4 individual data sets had been collected. An additional 2 pairs of scans are planned (but not scheduled) during Expedition 20.

Preliminary Results:

- Internal jugular and femoral vein measurements of area and diameter across the minor and major axis were taken throughout the cardiac cycle. These correspond with expected Jugular Venous Pressures (JVP).
- In 0G, internal jugular diameter at baseline, modified Valsalva and modified Mueller maneuver were diminished after Braslet-M application.
- In 0G, common femoral vein diameters increased in diameter after Braslet-M application.
- In 0G, resting cardiac dimensions were reduced after Braslet-M application.
- Early diastolic Doppler across the mitral valve demonstrates progressive changes to the deceleration times with maneuvers both before and after Braslet has sequestered blood in the lower extremities.
- Early diastolic velocities of Tissue Doppler (relatively load independent measure) were reduced by both maneuvers and after Braslet application.

	<p>Conclusion:</p> <p>The Braslet-M device reduces cardiac preload by reducing venous return and cardiac output. Terrestrially, Valsalva causes transient increases in right atria pressure and a Mueller maneuver will cause temporary reduction in right atria pressure. The modified respiratory maneuvers used in this SDTO likewise reveal similar physiologic changes in long duration crewmembers in 0g.</p> <p>Initial analysis indicates that with Braslet application, internal jugular vein variations in size and area in response to Valsalva and Mueller are diminished. Common femoral vein areas nearly double after the sequestering effects produced by Braslet-M application. The Braslet-M device appears to adequately reduce preload and augment cardiac and vascular physiologic responses in crewmembers with space-acclimatized hearts.</p> <p>Taken together, these data support the notion that remotely-guided ultrasound exams can be used to monitor a variety of cardiovascular parameters that are altered with acute fluid and pressure modifications.</p>
Bibliography Type:	Description: (Last Updated: 08/30/2018)
Abstracts for Journals and Proceedings	<p>Bogomolov VV, Duncan JM, Alferova I IV, Dulchavsky SA, Ebert D, Hamilton DR, Matveev VP, Sargsyan AE. "Validation of On-Orbit Methodology for the Assessment of Cardiac Function and Changes in the Circulating Volume Using Ultrasound and "Braslet-M" Occlusion Cuffs." Presented at the NASA Human Research Program Investigator's Workshop 2008, League City, TX, Feb 4-6, 2008.</p> <p>NASA Human Research Program Investigator's Workshop 2008, League City, TX, Feb 4-6, 2008. , Feb-2008</p>
Abstracts for Journals and Proceedings	<p>Bogomolov VV, Duncan JM, Alferova I IV, Dulchavsky SA, Ebert D, Hamilton DR, Garcia KM, Matveev VP, Sargsyan AE. "Validation of On-Orbit Methodology for the Assessment of Cardiac Function and Changes in the Circulating Volume Using Ultrasound and "Braslet-M" Occlusion Cuffs." Presented at the NASA Human Research Program Investigator's Workshop 2009, League City, TX, Feb 2-4, 2009.</p> <p>NASA Human Research Program Investigator's Workshop 2009, League City, TX, Feb 2-4, 2009. , Feb-2009</p>
Papers from Meeting Proceedings	<p>Hamilton DR, Sargsyan AE, Fincke EM, Magnus SH, Lonchakov YV, Alferova I IV, Dulchavsky SA, Ebert D, Garcia K, Martin D, Matveev VP, Voronkov YI, Melton SL, Duncan JM, Bogomolov VV. "Right Ventricular Tissue Doppler Assessment in Space During Circulating Volume Modification using the Braslet-M Device" 17th IAA Humans in Space Symposium, International Academy of Astronautics, Moscow, Russia, June 7-11, 2009.</p> <p>17th IAA Humans in Space Symposium Proceedings, International Academy of Astronautics, June 2009. , Jun-2009</p>