MITIGATING HEADWARD FLUID SHIFTS WITH VENOCONSTRICTIVE THIGH CUFFS DURING SPACEFLIGHT

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INTRODUCTION

Venoconstrictive thigh cuffs (VTC) are a mechanical countermeasure capable of attenuating the spaceflight induced headward fluid shift, and thus may be a viable spaceflight associated neuro-ocular syndrome (SANS) countermeasure. Crewmembers can use VTC to mitigate the headward fluid shift to aid in adapting to spaceflight. However, data are needed to determine if VTC affect ocular structures.

PURPOSE

The purpose of this study is to determine the efficacy of long duration use of VTC application to mitigate the spaceflight-induced headward fluid shift. We hypothesize that a VTC countermeasure will temporarily reverse the headward fluid shift and attenuate spaceflight-induced changes of internal jugular vein (IJV) cross-sectional area, IJV pressure, stroke volume, cardiac output, intraocular pressure (IOP), and optic nerve head and retinal morphology.

METHODS

This study will evaluate the effectiveness of VTC countermeasure application on the headward fluid shift, as well as cardiovascular and ocular variables. VTC during spaceflight will be worn for an extended duration (up to 6 hours) with data collected at three time points (30 minutes, 3 hours, and 6 hours) to characterize the temporal profile of key fluid shift outcome measures of the vascular fluid shift, IOP, and ocular structure changes. Ten astronauts will be recruited to participate and will be studied before and during approximately 180-day International Space Station (ISS) spaceflight missions. Baseline data collection will occur approximately 90-days before launch (Figure). Preflight, each leg of the crewmember will be measured to determine the VTC cuff size and a cuff fit check session will occur prior to the preflight baseline ground imaging to verify the appropriate fit measured via a surface contact pressure. Prior to donning the VTC, baseline measures without VTC will be collected seated, supine, and supine followed by data collection with the VTC. The baseline data collection will include ultrasound (IJV area and pressure, stroke volume and cardiac output), brachial blood pressure and heart rate, optical coherence tomography (OCT) imaging (total retinal thickness and choroid thickness), and IOP. An inflight cuff fit check session, same as the preflight fit check, will occur prior to VTC use on ISS. The inflight VTC experiment will be conducted early (FD45) and late (R-45) to determine if mission duration affects VTC fit and the efficacy of fluid redistribution. A system usability scale comfort questionnaire will be included in each VTC session to capture feedback from crewmembers regarding the comfort and usability of the VTC.

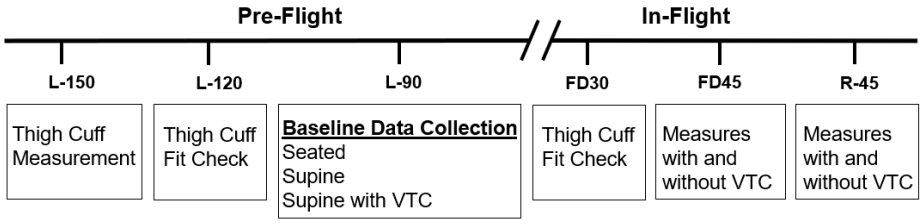

Figure. *Detailed Testing Schedule. Baseline data collection at L-90 will be performed in a randomized order of position.*

SCIENTIFIC & MISSION IMPACT

Results will narrow knowledge gaps described in the Human Research Roadmap to mitigate the headward fluid shift during spaceflight and help NASA to 1) determine the efficacy of extended use VTC application to mitigate the spaceflight-induced headward fluid shift and 2) further the understanding of the use of VTC on vascular fluid shifts, IOP, and ocular structure during spaceflight.

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