MITIGATING HEADWARD FLUID SHIFTS WITH VENO-CONSTRICTIVE THIGH CUFFS DURING SPACEFLIGHT (FLIGHT THIGH CUFF STUDY)

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INTRODUCTION

Astronauts experience a chronic headward fluid shift in weightlessness as evidenced by increased cardiac output, decreased leg volume, a redistribution of venous fluid, and venous congestion in the upper body. Alterations in cerebrospinal fluid hydrodynamics and changes in cerebral venous pressure secondary to the headward fluid shift may contribute to ocular changes associated with spaceflight-associated neuro-ocular syndrome (SANS). Veno-constrictive thigh cuffs (VTCs), called Braslets, provided to Soyuz crewmembers alleviate symptoms of the headward fluid shift during the first weeks of spaceflight and have been documented to reduce internal jugular vein (IJV) distension during weightlessness. Subsequently, members of the NASA Johnson Space Center Cardiovascular and Vision Laboratory (CVL) and Clemson Textile Laboratory at Clemson University designed and manufactured a set of VTCs similar in function to the Braslets that were documented to mitigate changes in choroid thickness, intraocular pressure, and IJV area during posture-induced headward fluid shifts on Earth, and were subsequently used in a bed rest study. The purpose of this study is to evaluate the efficacy of using the NASA VTC to reverse the headward fluid shift during spaceflight and inform use of VTC as a potential SANS countermeasure.

METHODS

CVL and the Research Operations and Integration (ROI) Flight Hardware Engineering group modified the VTC to incorporate a bladder for assessment of skin contact pressure. We will assess the efficacy of the VTC to mitigate the headward fluid shift in 10 astronauts before and during 6-month spaceflight missions to the ISS. Prior to launch, crewmembers will participate in a fit check and measurement session, where skin contact pressure, thigh circumference, and ultrasound imaging of venous flow in the legs will be assessed to verify appropriate VTC fit. Similar assessments will occur before and during VTC use during spaceflight. In a baseline data collection session 90-days before spaceflight, participants will be studied while seated, supine, and supine while wearing VTC; at flight days 45 and 150 participants will be studied before and 30 minutes, 3 hours, and 6 hours after donning the VTC. Intraocular pressure, ultrasound measurements of stroke volume, cardiac output, IJV cross-sectional area and pressure, and optical coherence tomography images of the retina will be collected during these sessions. Crewmembers will provide feedback on comfort and operational use of the VTC during spaceflight.

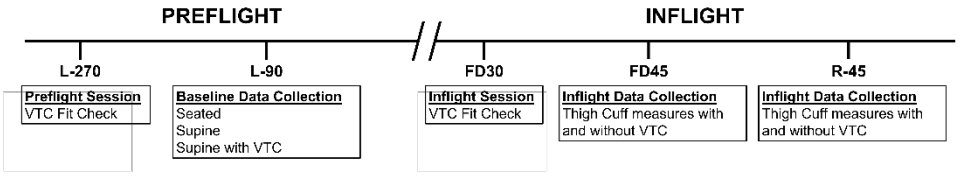

Figure 1. *Detailed Testing Schedule. Baseline data collection at L-90 will be performed in a randomized order of*

RESULTS AND DISCUSSION

The NASA JSC IRB has approved this protocol. To date, 2 crewmembers have enrolled in the study, completed their preflight fit check and baseline data collection measurement sessions and completed their crew training classes for in-flight operations. Collaboration between the CVL, ROI Flight Hardware Engineering group, and Clemson Textiles has resulted in certification of the VTCs for use on ISS and procurement of both ground and flight units. The first inflight data collections are scheduled for 2024.

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