

## EFFECTS OF SPACEFLIGHT ON VENOUS AND ARTERIAL COMPLIANCE

L. C. Ribeiro<sup>1</sup>, S. S. Laurie<sup>1</sup>, S. M. C. Lee<sup>1</sup>, B. R. Macias<sup>1</sup>, D. S. Martin<sup>1</sup>,  
R. Ploutz-Snyder<sup>2</sup>, M. B. Stenger<sup>1</sup>, S. H. Platts<sup>3</sup>

<sup>1</sup>KBRwyle Science, Technology & Engineering Group, Houston, TX; <sup>2</sup>University of Michigan, Ann Arbor, MI, and <sup>3</sup>NASA Johnson Space Center, Houston, TX

### BACKGROUND

The visual impairment and intracranial pressure (VIIP) syndrome is a spaceflight-associated set of symptoms affecting more than 50% of American astronauts who have flown International Space Station (ISS) missions. VIIP is defined primarily by visual acuity deficits and anatomical changes to eye structures (e.g. optic disc edema, choroidal folds, globe flattening) and is hypothesized to be related to elevated intracranial pressure secondary to a cephalad fluid shift. However, ocular symptoms have not been replicated in subjects completing prolonged bed rest, a well-accepted spaceflight analog. Altered vascular compliance along with spaceflight factors such as diet, radiation exposure, or environmental factors may cause alterations in the cardiovascular system that contribute to the manifestation of ocular changes. Loss of visual acuity could be a significant threat to crew health and performance during and after an exploration mission and may have implications for years post-flight. The overall objective of this project is to determine if spaceflight alters vascular compliance and whether such an adaptation is related to the incidence of VIIP. This objective will be met by completing three separate but related projects.

### METHODS

To determine whether the combination of two factors not previously studied in relation to VIIP, older age and high sodium intake associated with space flight food systems, contribute to the development of VIIP symptoms, we studied eleven men (25-35 yr, n=7; 45-55 yr, n=4) prior to, during, and following 14-day of 6° head-down tilt bed rest. NASA standard bed rest conditions were maintained except that sodium intake was higher (~40%) than consumed in previous bed rest campaigns. Hemodynamic (stroke volume and blood pressure), ocular (tonometry (IOP) and ocular ultrasound), venous (supratrochlear, jugular, and vertebral), and arterial (middle cerebral, common, internal and external carotid, and vertebral) parameters were acquired across a range of tilt angles (20°, 10°, 0°, -10°, -20°) before and immediately after bed rest. Additionally, internal jugular venous pressure was measured (compression sonography) in a subset of subjects (n=6). Optical coherence tomography (OCT) measures were obtained in subjects seated upright before and within 30 min following bed rest.

The objective of the second project is to identify parameters that may increase an astronaut's susceptibility to developing VIIP by retrospectively analyzing data obtained from the Lifetime Surveillance of Astronaut Health archives. Medical history, family history, spaceflight history and related exposures, and history of high-performance jet aircraft exposure are being examined to identify potential relationships with VIIP-related ocular outcomes.

The third project will characterize vascular parameters in astronauts before they participate in a spaceflight mission; almost all astronauts previously studied for VIIP already had spaceflight experience, and therefore there is no true understanding of an astronaut's condition before flight. Using procedures similar to those in our bed rest, we will perform a comprehensive evaluation of the vasculature of the head, neck, and eyes in 8 astronauts with no spaceflight experience. Hemodynamic (stroke volume and blood pressure), ocular (tonometry (IOP) and ocular ultrasound), and venous and arterial parameters will be acquired while seated upright and across a range of tilt angles (+10°, 0°, -10°, -15°). OCT measures will be obtained seated, supine, and during 15° head-down tilt.

### RESULTS/DISCUSSION

Bed rest did not produce VIIP symptoms in any of the subjects, despite inclusion of older subjects and a higher sodium diet than previous bed rest campaigns. Additionally, while jugular vein pressure and diameter increased with decreasing tilt angle before and after bed rest, bed rest did not appear to have an effect on this relationship. Certain ocular structures appear to be different between older and younger subjects before bed rest, but these did not change during the course of bed rest in either group. These preliminary results suggests that the addition of a high salt diet to standard bed rest conditions for 14 d of bed rest was not sufficient to produce ocular changes as measured using OCT, ultrasound, and IOP.

The retrospective analysis of astronaut data received from LSAH and the study of astronauts who have never flown in space is ongoing.