PROSPECTIVE OBSERVATIONAL STUDY OF OCULAR HEALTH IN ISS ASTRONAUTS – THE OCULAR HEALTH STUDY

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INTRODUCTION
The visual impairment intracranial pressure (VIIP) syndrome is currently NASA’s number one human spaceflight risk. The syndrome, which is related to microgravity exposure, manifests with changes in visual acuity (hyperopic shifts, scotomas) and in eye structure (optic disc edema, choroidal folds, globe flattening, and distended optic nerve sheaths). In some cases, elevated cerebrospinal fluid pressure has been documented postflight, reflecting increased intracranial pressure (ICP). While the eye appears to be the main affected end organ of this syndrome, the ocular manifestations are thought to be caused by the interaction of several physiologic systems, including the eye, the cardiovascular system, and the central nervous system. The leading hypotheses for the development of VIIP involve microgravity-induced head-ward fluid shifts and CO2 related vasodilation, along with a loss of gravity-assisted drainage of venous blood from the brain, leading to cephalic venous congestion and increased ICP. Although only 4 of 5 crewmembers who had undergone postflight lumbar puncture had a documented elevated ICP, 76% of tested crewmembers have manifested clinical signs or symptoms of the VIIP syndrome; therefore it is assumed that the majority of astronauts exposed to microgravity have some degree of ICP elevation in flight. Prolonged elevations of ICP can cause long-term reduced visual acuity and affect the peripheral vision, and has been reported to cause mild cognitive impairment in the analog terrestrial population of idiopathic intracranial hypertension. These potentially irreversible health consequences underscore the importance of identifying and then mitigating the factors that lead to this syndrome.

METHODS
The Ocular Health study expands on the required in-flight medical testing of long-duration crewmembers who are assigned to an International Space Station (ISS) mission. The current required testing includes 5 sessions over a 2-year period, and those are expanded to 13 sessions over a 3-year period for crewmembers that are enrolled as subjects in this study. Pre and postflight evaluations include functional eye exams (vision testing), structural eye exams (fundoscopy, ocular ultrasound, optical coherence tomography [OCT] and biomicroscopy), intraocular pressure (tonometry), cardiovascular compliance (via ultrasound with concurrent ECG and blood pressure), noninvasive intracranial pressure (via pulsatility index, measured by transcranial Doppler [TCD]), and brain anatomy via magnetic resonance imaging (MRI). In-flight evaluations include visual testing with vision questionnaire, fundoscopy, tonometry, ultrasound, cardiovascular compliance, TCD, and OCT. Both vascular compliance and TCD are additions to the study and are not a standard component of the medically required testing. As of November 2013, 7 crewmembers have signed up to participate (out of an anticipated total of 12 subjects). Preflight data collection has been completed on 6 subjects, and in-flight data collection has been completed on 2 and is underway for the third and fourth enrolled crewmembers.

DISCUSSION
This prospective study aims to define the temporal pattern for the appearance of signs and symptoms, delineate the association between duration of weightlessness and severity of symptoms (i.e., the dose-response), establish preflight baseline characteristics, characterize the nature of in-flight changes, document changes from pre to postflight, document postflight time course for recovery to baseline, and determine the impact of persisting changes on crew health. Data from this study will improve the understanding of VIIP incidence, signs, symptoms, susceptibilities, timeline for development and recovery, and aid in guiding development of countermeasures and targeted treatments for preventing the VIIP syndrome and its complications.