

Fluid Shifts

**PI: Michael Stenger, Ph.D., Alan Hargens, Ph.D.,
Scott Dulchavsky, M.D., Ph.D.**

Science Symposium

January 2014

**Fluid shifts before, during and after prolonged
space flight and their association with
intracranial pressure and visual impairment**

Fluid Shifts



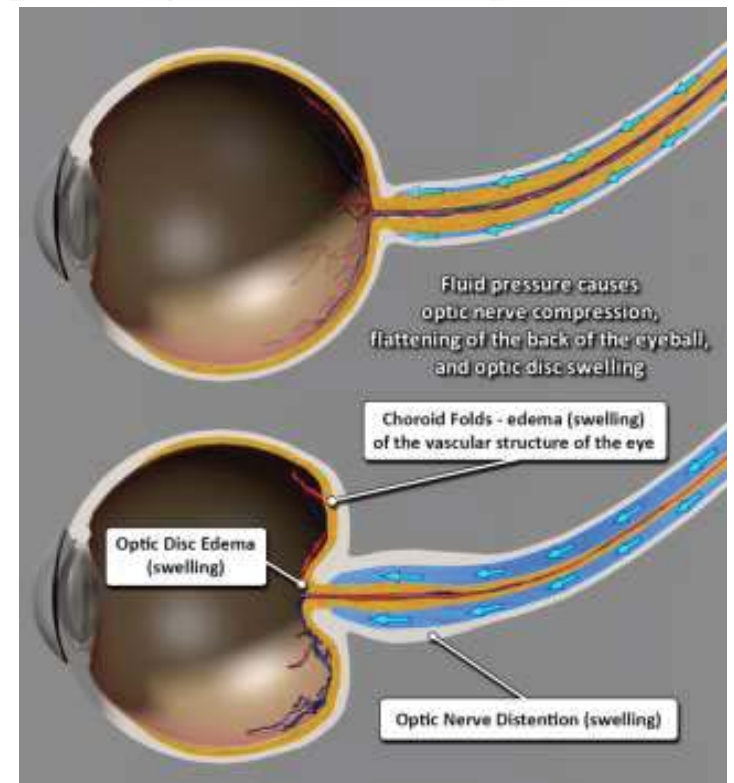
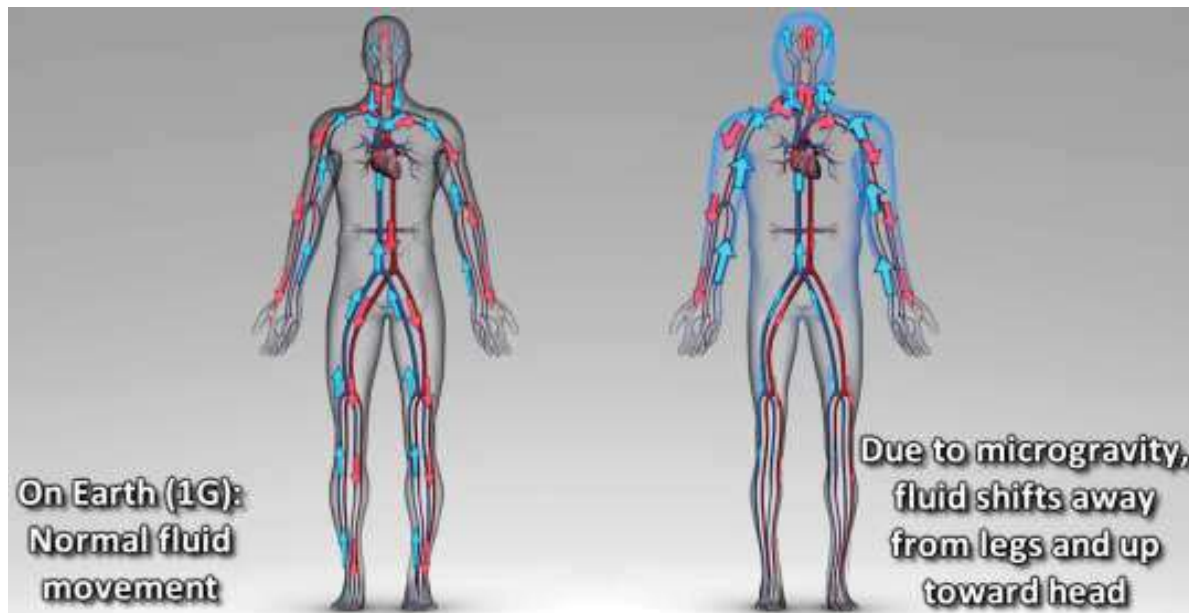
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Science Background

Future human space travel will primarily consist of long duration missions onboard the International Space Station or exploration class missions to Mars, its moons, or nearby asteroids.

Current evidence suggests that long duration missions might increase risk of permanent ocular structural and functional changes, possibly due to increased intracranial pressure resulting from a spaceflight-induced cephalad (headward) fluid shift.



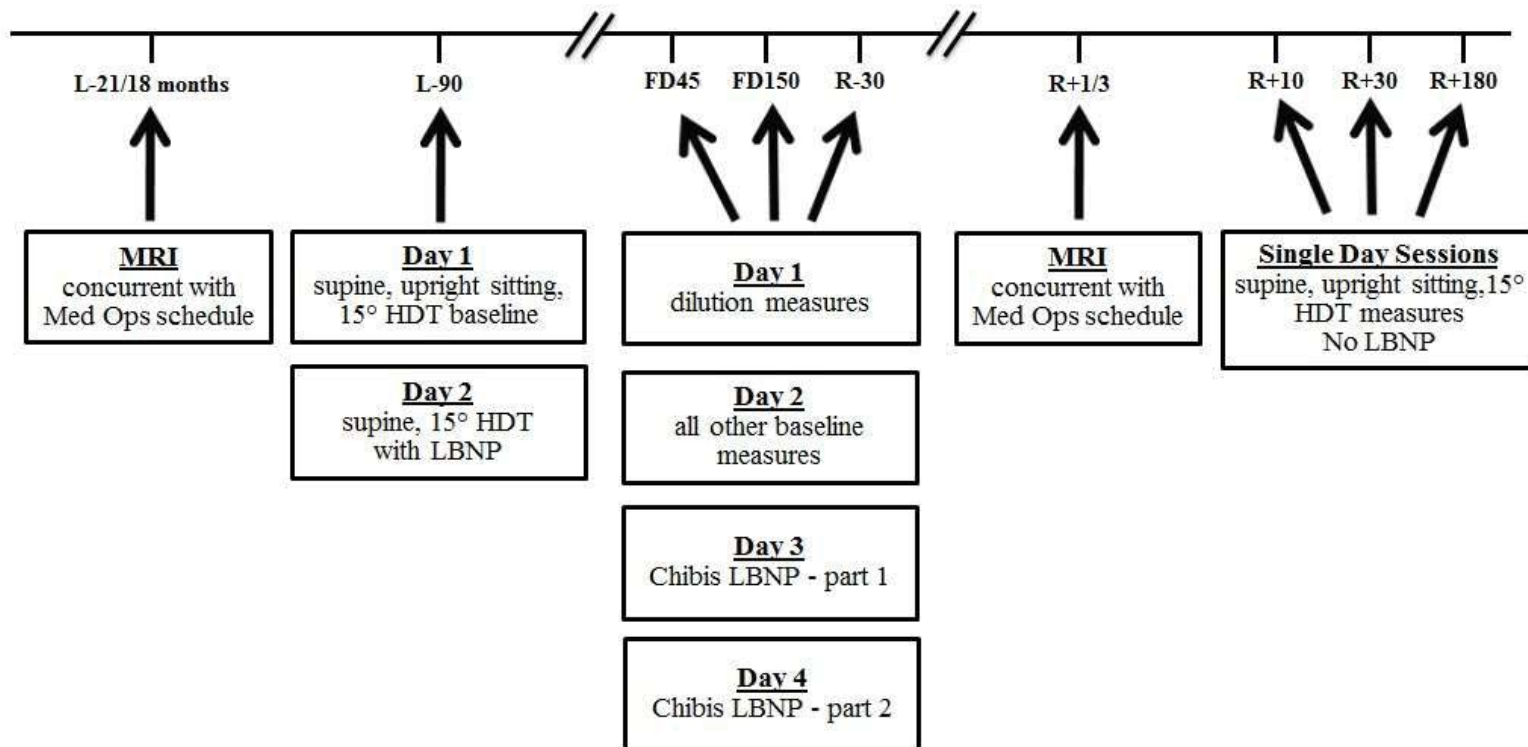
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- **Specific Aim I:** To characterize fluid distribution and compartmentalization before, during and after long-duration space flight.
- **Specific Aim II:** To correlate in-flight alterations of eye structure, ocular vascular parameters, and vision with headward fluid shifts, vascular dimensions and flow patterns.
- **Specific Aim III:** To determine systemic and ocular factors of individual susceptibility to the development of ICP elevation and/or vision alterations



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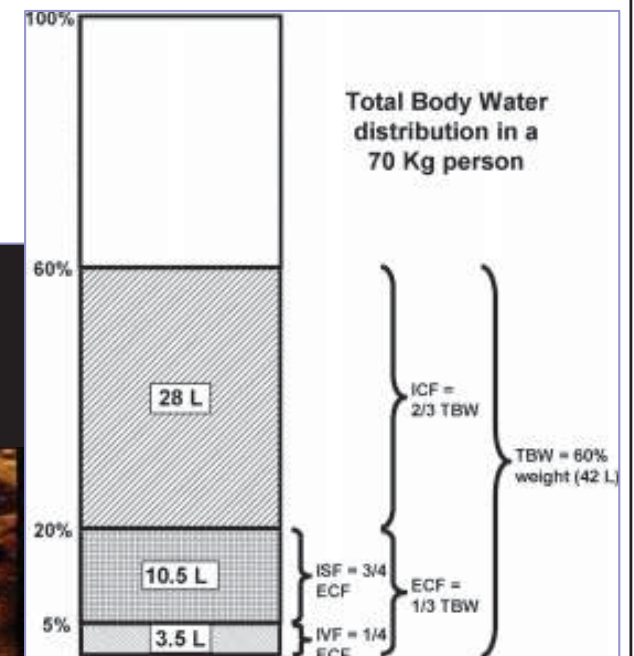
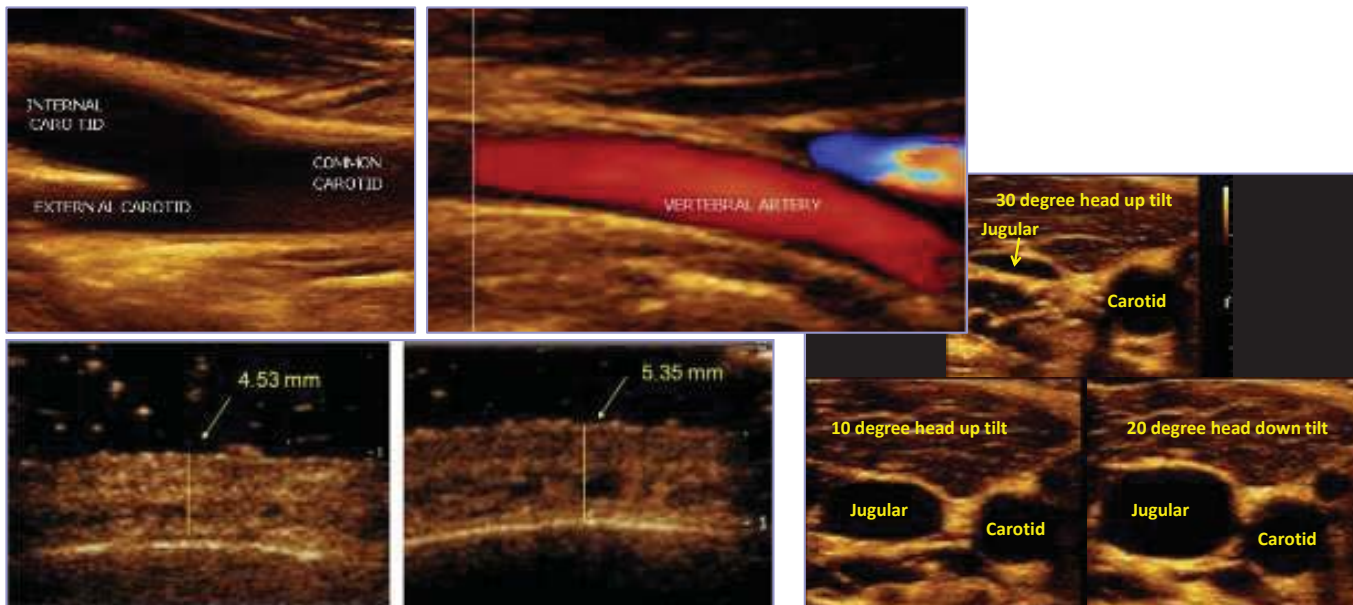
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Fluid compartmentalization/distribution measures:

- Total Body Water (D_2O dilution, saliva and urine collection)
- Extracellular Fluid Volume (NaBr, dilution, blood and urine collection)
- Intracellular Fluid Volume (Calculated)
- Plasma Volume (Carbon Monoxide rebreathing, blood collection)*
- Interstitial Fluid Volume (Calculated)*
- Vascular Ultrasound Assessment / MRI



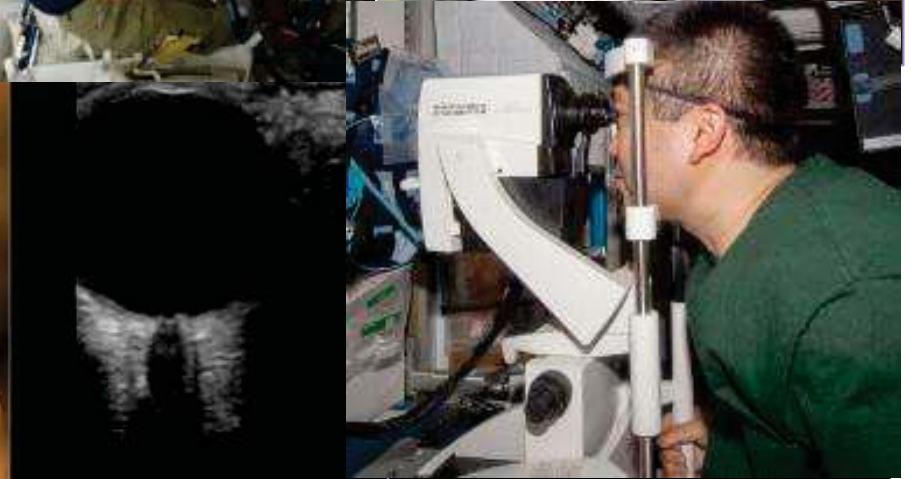
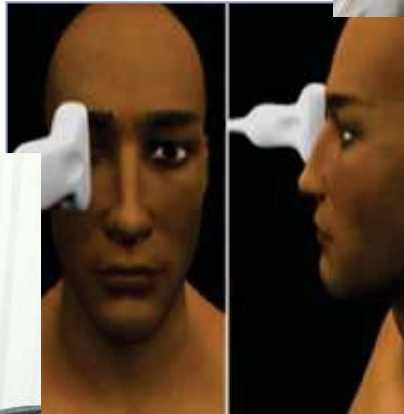
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Optical Coherence Tomography (OCT)
Cerebral and Cochlear Fluid Pressure (CCFP)
Otoacoustic Emissions (OAE)
Tonometry / Ultrasound / MRI
Data Sharing w/ Med Ops



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Lower Body Negative Pressure

Ultrasound measures of fluid shifts:

- Arterial and venous measures of head and neck
- Cardiac, ophthalmic, and portal vein measures
- Tissue thickness upper body

Other physiological measures:

- Intracranial Pressure (CCFP/DPOAE)
- Intraocular Pressure (Tonopen/iCare and Ultrasound)
- Ocular Structure (OCT)
- Blood Pressure / Heart Rate / Vascular Resistance

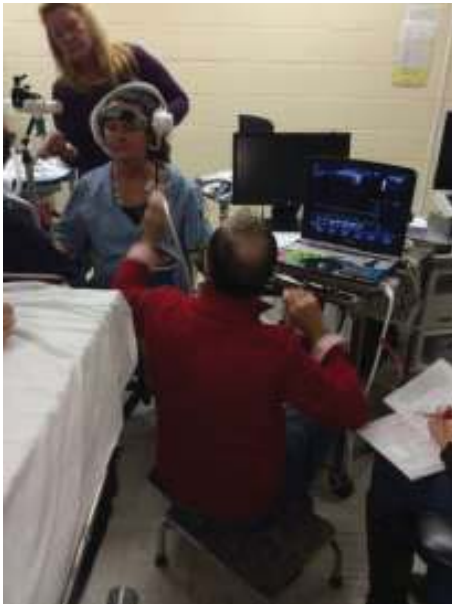
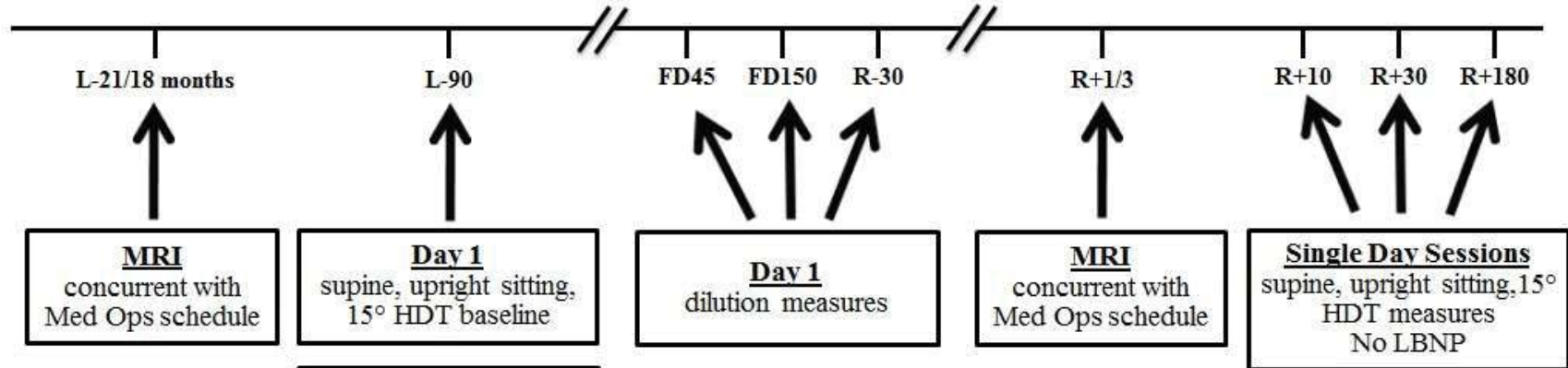


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Benefits

- This investigation will determine, for the first time, whether the well-known fluid shifts and cardiovascular adaptations associated with stays in microgravity are the predominant factors contributing to the development of visual impairment and the hypothesized increase in intracranial pressure and whether these can be temporarily alleviated by reversing fluid shifts. This information will guide the development of countermeasures and/or treatment protocols.
- Knowledge gained from this study also may inform medical professionals treating and studying patients suffering from idiopathic intracranial hypertension, a debilitating condition with some characteristics in common with that experienced by astronauts.