Pressure is on to find the cause for vision changes in space

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NASA astronaut Michael Hopkins, Expedition 37 flight engineer, performs ultrasound eye imaging in the Columbus laboratory of the International Space Station. European Space Agency astronaut Luca Parmitano, flight engineer, assists Hopkins. Credit: NASA

A change in your vision is great when referring to sparking a creative idea or a new approach to a challenge. When it refers to potential problems with sight, however, the cause and possible solutions need to be identified.

The human body is approximately 60 percent fluids. During spaceflight, these fluids shift to the upper body and move across blood vessel and cell membranes differently than they normally do on Earth.

One of the goals of the Fluid Shifts investigation, launching to the International Space Station this spring, is to test the relationship between those fluid shifts and a pattern NASA calls visual impairment and intracranial pressure syndrome, or VIIP. It involves changes in vision and the structure of the eyes and indirect signs of increased pressure in the brain, and investigators say more than half of American astronauts have experienced it during long spaceflights.

Improved understanding of how blood pressure in the brain affects eye shape and vision also could benefit people on Earth who have conditions that increase swelling and pressure in the brain or who are put on extended bed rest.

"Our first aim is to assess the shift in fluids, to see where fluids go and how the shift varies in different individuals," says Michael B. Stenger, Ph.D., Wyle Science Technology and Engineering Group, one of the principal investigators. "Our second goal is to correlate fluid movement with changes in vision, the structure of the eye, and other elements of VIIP syndrome."

Expedition 36/37 Flight Engineer Luca Parmitano in the Chibis lower body negative pressure device aboard the International Space Station. Credit: NASA

A third aim is to evaluate application of negative pressure to the lower body to prevent or reverse fluid shifts and determine whether this prevents vision changes. Researchers are collaborating with Roscosmos (the Russian Federal Space Agency) on that part of the study because the Russians have a lower body negative pressure device, the Chibis suit, aboard the station. Recently published ground-based data show that applying negative pressure over the lower body helps shift fluids away from the head during simulated spaceflight, adds co-investigator Brandon Macias, Ph.D., of the University of California San Diego.

For a variety of reasons, the Chibis suit cannot be moved from the Russian Service Module of the space station. Therefore, to conduct these unique experiments, crew members will transport medical research equipment from the U.S. side of the station to the Russian module. Moving things around in space is a lot more complicated than it is on the ground, says co-investigator Douglas Ebert, Ph.D., of Wyle Laboratories. In this case, it will take more than four hours of crew time to move and set up the equipment, one or two hours for the experiment itself, and another four or so hours to move everything back.

That effort will pay off though, in terms of new and important data that may lead to the answers of how and why VIIP happens and how to prevent or treat it during spaceflight.

"It's important to know what is happening because we may have to tailor preventive measures to each individual," Stenger says. "We also may find that an exercise that is good for bone or muscle is bad for elevated intracranial pressure. Exercise is great for preserving work capacity and the musculoskeletal system but may be a contributor to increased pressure in the head."

Currently, Russian cosmonauts only use Chibis as part of their preparation for re-entry. But if it turns out that lower body negative pressure helps reverse fluid shifts toward the head and prevent VIIP symptoms, then crew members may use it earlier and more frequently on long missions.

Another unique aspect of the investigation is its first subjects are Scott Kelly from NASA and Mikhail Kornienko from Roscosmos, space travel veterans chosen for the one-year mission. The pair will spend 12 months aboard the station, twice as long as a typical crew member. They'll have measurements taken for the Fluid Shifts investigation early in their flight, at its mid-point, and roughly 45 days before they return. The results will help give researchers a comprehensive look at what is happening with VIIP.

Finally, the investigation also tests noninvasive techniques for measuring changes in pressure in the brain. "That would be a great advantage for testing patients on Earth," says principal investigator Alan R. Hargens, Ph.D., University of California San Diego.

Clearly, (no pun intended!) this is a complex investigation, combining multiple measurements, a number of goals, two countries, commutes across the space station, and a mission spanning an entire year. Given all that, those involved may be feeling the pressure of pulling off such an effort, but their work could relieve (intracranial) pressure for astronauts and people on Earth.

Provided by NASA

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