'Balancing' the one-year mission risks

September 30 2013, by Andrea Dunn, Laurie Abadie

The Soyuz TMA-08M spacecraft with Expedition 36 Commander Pavel Vinogradov of the Russian Federal Space Agency (Roscosmos), Flight Engineer Alexander Misurkin of Roscosmos and Flight Engineer Chris Cassidy of NASA aboard, lands in a remote area near Dzhezkazgan, Kazakhstan, on Sept. 11, 2013. Credit: NASA/Bill Ingalls

If you've ever stumbled out of bed in the middle of the night, fallen out of a yoga pose or had trouble "finding your legs" after hopping off a rollercoaster or a boat, then you know getting your balance can be challenging. This is even truer for astronauts who have just returned from extended spaceflight in microgravity.

Spaceflight causes changes in physiological systems that can affect things like balance, strength, vision and endurance. Although NASA scientists have studied how these changes impact astronaut performance a few days after returning to Earth, a new test promises to provide scientists with data about these changes just moments after crew

members exit the spacecraft. This information is increasingly important as NASA moves closer to sending an astronaut to the International Space Station for one year and, eventually, to asteroids and Mars.

An ongoing research study called the Functional Task Test allows scientists to measure the changes in astronaut performance after spaceflight. The test documents astronaut responses to a set of physical challenges that represent mission-critical tasks and measures changes in physiological function to help scientists objectively assess crew functional capabilities immediately after landing and identify key factors that contribute to reductions in performance. These assessments will lead to better human factors designs that will aid astronauts landing in remote locations such as Mars. They will also help scientists develop countermeasures to offset the deficits that would otherwise pose a risk to crew members attempting to perform mission-critical tasks on long-duration missions.

"Exploration-class missions beyond low-Earth orbit are challenging the human experience on every level," says John Charles, Ph.D., chief of the International Science Office in NASA's Human Research Program. "We are evaluating risks associated with travel to Mars because they encompass the range of risks that astronauts are likely to encounter during other missions leading up to the Mars mission."

NASA has not routinely gathered data immediately after landing on long-duration missions – until now.

According to Senior Research Scientist Jacob Bloomberg, Ph.D., the most profound deficits in the human body occur immediately after landing. "This is important because landing is the most operationally significant period during missions," says Bloomberg. "Testing immediately after landing allows us to conduct an operational assessment of capabilities during a time when astronauts need to land and leave the

vehicle."

To that end, investigators from the Human Research Program and the Russian Academy of Sciences Institute of Biomedical Problems are conducting a series of pilot field tests. The first of these tests occurred on Sept. 11 when three astronauts returned to Earth after 166 days aboard the space station.

"Conducting tests after six-month missions is helping us prepare for landing on Mars," said Charles. "The transit to Mars is four to seven months, so six-month missions provide the best model for going to Mars. The pilot field test is the prime venue for gathering this kind of information."

Astronauts performed up to three tasks during the pilot field test: sit-to-stand, which tests the ability of astronauts to exit the spacecraft from a seated position; recovery from a simulated fall; and a tandem heel-to-toe walk test, a test of dynamic balance control and the ability to walk without falling. Performing these activities after a rollercoaster ride might be difficult; after six months in space they are incredibly challenging.

"These tasks were chosen because of their increasing level of difficulty," says Bloomberg. "We start with the basic tasks like standing and increase the level of difficulty to walking – testing dynamic balance."

According to Mill Reschke, Ph.D., chief scientist for NASA Neuroscience, these tests tie to any planetary expedition with long-duration flight where there is deconditioning of physiological and sensorimotor systems. Sensorimotor function describes how the brain interprets and integrates sensory information to produce appropriate motor output.

"It's important to understand the changes that are occurring and how long they last," says Reschke. "The astronauts must exit the capsule at some point and we need to know when it is safe to do so."

Landing-site testing on crew members Chris Cassidy of NASA and Alexander Misurkin of the Russian Federal Space Agency occurred inside a medical tent to accommodate crew member privacy.

"This pilot field test is a demonstration, a proof of concept," says Charles. "We are going through the paces to see what's possible so we can have the best full-up test possible in 2016 for the one-year mission return."

This investigation, which is a subset of tasks performed in the functional task test, is a precursor to the field test NASA plans to begin in 2014 in preparation for the one-year mission landing in 2016.

The field test will include an expanded set of tests including those used in the pilot field test and others like a push test, which looks at whether crew members can maintain balance in an upright position while being gently but persistently forced backwards. A hand/eye coordination test will also take place. Scientists will assess things like intra-ocular pressure, intra-cranial pressure and muscle tone, as well.

This investigation was coordinated by the Multilateral Human Research Panel for Exploration, a working group representing all of the International Space Station partner space agencies to increase the scientific return from space station experiments through multinational cooperation.

"The field test is a joint investigation with our colleagues from the Russian Academy of Sciences Institute of Biomedical Problems in Moscow," says Bloomberg. "It offers an opportunity for a unique,

collaborative study."

Dr. Inessa Kozlovskaya, the institute's lead investigator, brings decades of experience and knowledge to this joint U.S.-Russian investigation. She and her colleague Dr. Elena Tomilovskaya have overseen the Russian implementation of the investigation including experiment team training in Russia, transportation to the landing site and data collection in the field.

Scientists already know there is great variation in individual capabilities following flight. According to Reschke, they can use these variations to design the appropriate countermeasures that may put crew members on equal footing and reduce risk.

This research has Earth-based implications as well. Data can be used to design interventions and rehabilitation programs for subsets of the population like the elderly who experience changes in multiple physiological systems that lead to a decline in functional performance and increased risk of falling.

In this way, the benefits of NASA research continue to provide balance to humans in space and on Earth.

Provided by NASA/Johnson Space Center