Stepping stones to NASA's human missions beyond

January 21 2015, by Laurie Abadie

NASA astronaut Scott Kelly (center), Russian cosmonaut Mikhail Kornienko (right), and Russian cosmonaut Gennady Padalka, participate in an emergency scenario training session in an International Space Station mock-up/trainer in the Space Vehicle Mock-up Facility at NASA's Johnson Space Center. Credit: NASA

"That's one small step for (a) man; one giant leap for mankind." When Neil Armstrong took his first steps on the moon, many strides came before to achieve that moment in history. The same is true for a human mission to Mars. One step towards that journey begins in March 2015, when NASA astronaut Scott Kelly will make history as the first American to spend a year in space.

"This will be a significantly different experience; being aboard the International Space Station more than twice the duration of my previous flights will not be easy, but I am looking forward to the challenge," said Kelly, a veteran of three space flights.

This one-year mission will be a stepping stone to human exploration beyond low-Earth orbit. Scott Kelly and Russian Federal Space Agency (Roscosmos) cosmonaut Mikhail Kornienko will embark on the first joint U.S.-Russian one-year mission, underscoring the "international" in International Space Station as the partners exemplify multilateral cooperation with regard to science.

How will their bodies react to a year of weightlessness? NASA's Human Research Program is about to find out.

"The one-year expedition will be a focused effort to reach across international and technological boundaries to enhance integrated science on the station," said John Charles, NASA Human Research Program associate manager for international science.

Researchers expect the mission's investigations to provide data on physical and mental changes and challenges astronauts may face when they embark on longer-duration missions, like those to an asteroid, Mars, or beyond.

"It's not always easy for the body to adapt to microgravity," said Kelly.

"The conditions in a weightless environment take getting used to."

NASA and Roscosmos recently selected several collaborative investigations for this mission to evaluate the effects of long-duration spaceflight on humans. Each of the U.S. investigations will be grouped into one of seven categories: functional, behavioral health, visual impairment, metabolic, physical performance, microbial, and human factors.

The "functional" category will include investigations that will study the changes in performance of functional tasks for lunar and Mars operations. The Field Test and Functional Task Test are two investigations in the "functional" category. After returning to Earth, some astronauts have difficulty with movements like standing up straight. These investigations will examine what happens to the body when astronauts return to Earth's gravity after 12 months of weightlessness. Researchers hope to develop a recovery timeline for crew members and to evaluate methods to help retrain the body's ability to do those tasks. "These tests will mimic potential astronaut activities and their capability to perform them after they trek the six or eight months to Mars," Charles said. Results of these investigations may be applicable to patients recuperating from a long period of bed rest.

Japan Aerospace Exploration Agency astronaut Koichi Wakata, Expedition 38 flight engineer, wears ultrasound gear around his legs while performing the Integrated Resistance and Aerobic Training Study (Sprint) experiment in the Columbus laboratory of the International Space Station. Credit: NASA

The "behavioral health" category will include studies to learn more about our brain and how it relates to stress and fatigue in space. In Cognition and Sleep Monitoring, researchers will test how astronauts manage their sleep and how fatigued they become during long-duration missions. From this data researchers plan to develop software that tests the crew's comprehension, memory, attention and reasoning. The results of these studies will be helpful for the larger international medical community by learning more about the effects of stress and fatigue, and more importantly, how to combat it.

The NeuroMapping investigation will use MRI before launch and after landing back on Earth to look at how changes in gravity affect the brain's ability to control movements after a year in space.

The Journals study will analyze the astronauts' diaries to gather data on how crew members adjust emotionally to their spaceflight environment, and how they perceive their ability to perform tasks during long-duration missions.

The Reaction Self Test will provide objective feedback and inform researchers of astronauts' level of cognitive performance while on space station missions. It also seeks to evaluate effects of sleep loss and circadian disruption.

The "visual impairment" category will include the Fluid Shifts and Ocular Health investigations to study what happens when fluids shift into the upper body during weightlessness. This shift may cause changes in vision. Physiological data will be collected using non-invasive tools to study visual impairment and intracranial pressure caused by prolonged weightlessness. Patients on Earth suffering from similar problems, such as Idiopathic Intracranial Hypertension (IIH), may benefit from research of this syndrome and the increased focus on non-invasive measurement techniques.

Experiments in the "metabolic" category will study the effects of long-duration spaceflight on body chemistry, the heart and immune systems. The Biochemical Profile study will result in a database of biomedical data before, during and after flight to share among investigators and medical personnel.

The Cardio Ox investigation will provide insight into the role of oxidative stress on the body. It will also look at how these biological markers may pose a risk for plaque build-up in arteries following extended stays in space.

The Integrated Immune studies will look at the effects of spaceflight on human immunology, and validate an immune monitoring strategy. Although there is evidence that the immune system can become dysfunctional during spaceflight, the cause is unknown. These studies may have potential applications for the monitoring of immune functions of people on Earth with altered immunity.

The "physical performance" category includes studies that will enhance our knowledge of the effects of weightlessness on bones, muscles and heart. The Sprint investigation, currently ongoing on station, evaluates a new exercise regimen involving less frequent, higher intensity tasks, to minimize loss of muscle, bone, and cardiovascular functions that can occur over long periods in space. The Hip QCT study will help define the risks for early onset osteoporosis and bone fracture due to long duration spaceflight, as well as for individuals on Earth.

Included in the "microbial" category is the Microbiome investigation. This ongoing study will continue during the one year mission to help researchers determine what happens when microbial species, which help to manage the body's health, live in space for long periods. The study will also evaluate potential impact on a crew member's health. Samples of crew members' saliva, blood, perspiration and stool will be collected, as well as surface samples from air vents, sleep quarters, exercise equipment, water dispensers and the lavatory. These samples will be correlated with hygiene and environmental factors such as temperature and humidity. By sampling the microbiome of astronauts on Earth and comparing it to their microbiome in space, researchers will be able to define how the body responds to various aspects of space travel.

The "human factors" category will include investigations to assess how astronauts interact with the space station environment. The Fine Motor Control study will determine the effects of long-duration weightlessness on fine motor performance by using a tablet computer that measures tasks of pointing, dragging, pinch-rotating, and tracing. The Habitability investigation will determine how livable the station is with crew members' observations in periodic questionnaires, crew-collected video footage and videos of key areas of the orbiting complex. This data will aid in the design of future space vehicles and habitats.

During the Training Retention study, researchers will collect data at three-month intervals on the astronaut's ability to retain training techniques in space, examine how much assistance will be needed from the ground, and compare training retention on a long-duration mission with that on Earth.

"These studies will help us determine if crews could go to Mars and return to Earth safely," Kelly said.

The research to be conducted on this one-year mission will help NASA and the international community better understand the effects of spaceflight on the human body. This is a key stepping stone to ensuring the health of our astronauts as NASA makes its next giant leap for humanity.

Provided by NASA

Citation: Stepping stones to NASA's human missions beyond (2015, January 21) retrieved 26 April 2024 from https://phys.org/news/2015-01-stones-nasa-human-missions.html