PILOT SENSORIMOTOR AND CARDIOVASCULAR RESULTS FROM THE JOINT RUSSIAN/U.S. FIELD TEST

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INTRODUCTION

While the unloading paradigms associated with dry immersion and bed rest serve as acceptable flight analogs, testing of crew responses following the long-duration flights has not previously been possible until a minimum of +24 hours after landing. As a result, it has not been possible to estimate the nonlinear trend of the early (<24 hours) recovery process nor has it been possible to accurately assess the full impact of the decrements associated with long-duration flight. To overcome these limitations, both the Russian and U.S. programs have implemented testing at the Soyuz landing site. By joint agreement, this research effort has been identified as the functional *Field Test* (FT). For operational reasons the FT has been divided into two phases: the full FT and a preliminary pilot version (PFT) of the FT that is reduced in both length and scope.

RESEARCH

The primary goal of this research is to determine functional abilities associated with long-duration space flight crews beginning as soon after landing as possible (< 2 hours) with an additional two follow-up measurements sessions on the day of landing. This goal has both sensorimotor and cardiovascular elements, including evaluations of NASA's new anti-orthostatic compression garment and the Russian Kentavr garment. Functional sensorimotor measurements will include, but are not limited to, assessing hand/eye coordination, standing from a seated position (sit-to-stand), walking normally without falling, measurement of dynamic visual acuity, discriminating different forces generated with both the hands and legs, recovering from a fall (standing from a prone position), coordinated walking involving tandem heel-to-toe placement, and determining postural ataxia while standing. The cardiovascular portion of the investigation includes measuring blood pressure and heart rate during a timed stand test in conjunction with postural ataxia testing (quiet stance sway) as well as cardiovascular responses during the other functional tasks. In addition to the immediate post-landing collection of data for the full FT, postflight data is being acquired twice more within the 24 hours after landing and will continue over the subsequent weeks until functional sensorimotor and cardiovascular responses have returned to preflight normative values.

The PFT represents a initial evaluation of the feasibility of testing in the field, and is comprised of a jointly agreed upon subset of tests from the full FT and relies heavily on Russia's Institute of Biomedical Problems Sensory-Motor and Countermeasures Laboratories for content and implementation. The PFT has been collected on several ISS missions. Testing on the U.S. side has included: (1) a sit-to-stand test, (2) recovery from a fall where the crewmember began in the prone position on the ground and then stood for 3 minutes while cardiovascular stability was determined and postural ataxia data were acquired, and (3) a tandem heel-to-toe walk test to determine changes in the central locomotor program. Video, cardiovascular parameters (heart rate and blood pressure), data from body-worn inertial sensors, and severity of postflight motion sickness were collected during each test session. Our Russian investigators have added measurements associated with: (a) obstacle avoidance, (b) muscle compliance and (c) postural adjustments to perturbations (push) applied to the subject's chest area.

SUMMARY

The level of functional deficit observed in the crew tested to date is typically beyond what was expected and is clearly triggered by the acquisition of gravity loads immediately after landing when the demands for crew intervention in response to emergency operations will be greatest. Clearly measureable performance parameters such as ability to perform a seat egress, recover from a fall or the ability to see clearly when walking, and related physiologic data (orthostatic responses) are required to provide an evidence base for characterizing programmatic risks and the degree of variability among crewmembers for exploration missions where the crew will be unassisted after landing. Overall, these early functional and related physiologic measurements will allow the estimation of nonlinear sensorimotor and cardiovascular recovery trends that have not been previously captured.