FIELD TEST: RESULTS OF TANDEM WALK PERFORMANCE FOLLOWING LONG-DURATION SPACEFLIGHT

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BACKGROUND

Coordinated locomotion has proven to be challenging for many astronauts following long duration spaceflight. As NASA's vision for spaceflight points toward interplanetary travel, we must prepare for unassisted landings, where crewmembers may need to perform mission critical tasks within minutes of landing. Thus, it is vital to develop a knowledge base from which operational guidelines can be written that define when astronauts can be expected to safely perform certain tasks. Data obtained during the Field Test experiment (FT) will add important insight to this knowledge base. Specifically, we aim to develop a recovery timeline of functional sensorimotor performance during the first 24 hours and several days after landing.

METHODS

FT is an ongoing study of 30 long-duration ISS crewmembers. Thus far, 9 have completed the full FT (5 U.S. Orbital Segment [USOS] astronauts and 4 Russian cosmonauts) and 4 more consented and launching within the next year. This is in addition to the eighteen crewmembers that participated in the pilot FT (11 USOS and 7 Russian crewmembers). The FT is conducted three times preflight and three times during the first 24 hours after landing. All crewmembers were tested in Kazakhstan in either the medical tent at the Soyuz landing site (~one hour post-landing), or at the airport (~four hours post-landing). The USOS crewmembers were also tested at the refueling stop (~12 hours post-landing) and at the NASA Johnson Space Center (~24 hours post-landing) and a final session 7 days post-landing. Crewmembers are instrumented with 9 inertial measurement unit sensors that measure acceleration and angular displacement (APDM's Emerald Sensors) and foot pressure-sensing insoles that measure force, acceleration, and center of pressure (Moticon GmbH, Munich, Germany) along with heart rate and blood pressure recording instrumentation. The FT consists of 12 tasks, but here we will focus on the most challenging task, the Tandem Walk, which was also performed as part of pilot FT. To perform the Tandem Walk, subjects begin with their feet together, their arms crossed at their chest and eyes closed. When ready, they brought one foot forward and touched the heel of their foot to their toe, repeating with the other foot, and continuing for about 10 steps. Three trials were collected with the eyes closed and a fourth trial was collected with eyes open. There are four metrics which are used to determine the performance level of the Tandem Walk. The first is percent correct steps. For a step to be counted as correct, the foot could not touch the ground while bringing it forward (no side stepping), eyes must stay closed during the eyes closed trials, the heel and toe should be touching, or almost touching (no large gaps) and there shouldn't be more than a three second pause between steps. Three judges score each step and the median of the three scores is kept. The second metric is the average step speed, or the number of steps/time to complete them. Thirdly, the root mean squared (RMS) error in the resultant trunk acceleration is used to determine the amount of upper body instability observed during the task. Finally, the RMS error of the mediolateral center of pressure as measured by the Moticon insoles is used to determine the mediolateral instability at the foot level. These four parameters are combined into a new overall Tandem Walk Parameter.

RESULTS

Preliminary results show that crewmembers perform the Tandem Walk significantly worse the first 24 hours after landing as compared to their baseline performance. We find that each of the four performance metrics is significantly worse immediately after landing. We will present the results of tandem walk performance during the FT thus far. We will also combine these with the 18 crewmembers that participated in the pilot FT, concentrating on the level of performance and recovery rate.

CONCLUSION

The Tandem Walk data collected as part of the FT experiment will provide invaluable information on the performance capabilities of astronauts during the first 24 hours after returning from long-duration spaceflight that can be used in planning future Mars, or other deep-space missions with unassisted landings. FT will determine the average sensorimotor recovery timeline and inform return-to-duty guidelines for unassisted landings.