Biomedical Monitoring for Scientist Astronauts

Erik Seedhouse[1], Brian Shiro[1], Jason Reimuller[1], Ravi Komatireddy[2,3], Paddy Barrett[3], Sean Casey[4],
([1]Astronauts for Hire, Tampa FL; [2] West Wireless Health Institute, La Jolla, CA; [3]Scripps Research Institute, La Jolla, CA; [4]Universities Space Research Association, Moffett Field, CA)

Summary: Scientist astronauts (SAs) engaged in regular suborbital missions may fly at rates up to several times per month. yet there is no biomedical data addressing the risks of multiple flights. It is suggested biomedical testing will increase the knowledge of how suborbital flights affect the human body. The purpose of these tests is to provide the suborbital research community with guidance as to how the commercial space flight industry may define risks required for disclosure to SAs and proactively develop corrective actions to reduce such risks.

Methods: Based on a review of NASA's Longitudinal Study of Astronaut Health database [1], it was determined that the most important parameters to be monitored before, during, and after flight are cardiac, respiratory, musculoskeletal, and neurovestibular systems.

Discussion: The cardiovascular system will be immediately affected by suborbital flight [2] and is therefore the most significant physiological system that should be monitored. Monitoring will, when possible, include longitudinal assessment during centrifuge training and in-flight observation of cardiac function. The suborbital cabin altitude pressurization limit is likely to be 8,000 ft above Mean Sea Level pressure [3], which may adversely affect the respiratory system of older SAs who may have inadequate arterial oxygen levels to function effectively at that pressure.

The dynamic force environment of suborbital space flight will also manifest itself with effects on the neurovestibular system. This is particularly relevant as SAs are likely to have an active role in aspects of vehicle operations related to health and safety. Avoiding adverse neurovestibular effects is important to ensure SAs are able to comply with safety instructions. For example, SAs will be expected to return to their designated seats after weightlessness and reattach their own harness for reentry. In addition, they may be expected to egress the vehicle without assistance upon landing, or take action in an emergency situation.

The degree to which SAs will take part in data acquisition will be determined after they have been evaluated according to space flight operator procedures. Adopting the recommendations from the FAA Guidance for Medical Screening of Commercial Aerospace Passengers [4], candidate SAs will be subject to a medical history and physical examination.

Parameter assessed	System	Rationale
ECG, Heart rate, Blood pressure,	Cardiovascular	Identify preflight potential pathology such as hypertension, dysrhythmia, CAD. Establish preflight (centrifuge), inflight, and postflight cardiovascular responses.
Oxygen saturation	Respiratory	Identify preflight potential pulmonary pathology (spirometry). Establish preflight, inflight, and postflight respiratory responses.
Orthostatic Tolerance/ Stand test	Neurovestibular	Establish preflight and postflight neuro-vestibular responses

Flight Testing: Through a successful proposal submitted to the NASA Flight Opportunities Program, A4H members will help conduct the first set of ground and microgravity flight tests on biomedical monitoring hardware developed by its partner Vital Space in May 2012 [5].

References: [1] Longnecker, D. E., *et al.* (Eds.) (2004). *Review of NASA's Longitudinal Study of Astronaut Health*, National Academics Press, Washington, 79pp. [2] McKenzie & K. Gillingham, (1993). Incidence of Cardiac Dysrhythmias Occurring During Centrifuge Training. I., *Aviation, Space, and Environmental Medicine*, 64(8), 687-691. [3] Muhm J. M. (2004). Predicted Arterial Oxygenation at Commercial Cabin Altitudes, *Aviat Space Environ Med*, 75(10), 905-912. [4] FAA Office of Commercial Space Transportation (2005). *Draft Guidelines for Commercial Suborbital Reusable Launch Vehicle Operations with Space Flight Participants*. Version 1. 12pp. [5] Komatireddy, *et al.* (2012). Noninvasive Biometric Monitoring of Spaceflight Participants, *3rd Next Gen Suborbital Res Conf.*