INDIVIDUAL DIFFERENCES IN CARDIOVASCULAR RESPONSES TO HEAD DOWN TILT AND ORTHOSTATIC STRESS WITH AND WITHOUT FLUID LOADING

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ABSTRACT: Susceptibility of healthy astronauts to orthostatic hypotension and presyncope is exacerbated upon return from spaceflight. Buckey, et al. (1996) reported that up to 64% of astronauts experience post-flight orthostatic hypotension. Meck, et al. (2001) found that 14 day flights resulted in 20% of astronauts experiencing presyncope, whereas the rate rises to 83% following longer duration missions (129-190 days). Hypovolemia is suspected to play an important role in cardiovascular deconditioning following exposure to spaceflight, which may lead to increased peripheral resistance, attenuated arterial baroreflex, and changes in cardiac function. The effect of altered gravity during space flight and planetary transition on human cardiovascular function is of critical importance to maintenance of astronaut health and safety. A summary of the results of studies performed in space on Skylab, the Space Shuttle, and Russian spaceflight indicates that echocardiography data collected during lower body negative pressure is a fairly good predictor of the cardiovascular response to entry and landing. Operational impracticalities of echocardiography include the inability to take measurements while crew are conducting EVA’s, the need for trained technician to obtain measurements in addition to the crew person, and it cannot be used for continuous monitoring throughout extended periods of altered gravity exposure. An alternative method for measuring cardiac function is impedance cardiography. This equipment is small, noninvasive, unobtrusive, and simple to operate. Researchers at Ames Research Center have extensive experience in monitoring human physiology in extreme environments that include spaceflight and laboratory studies of orthostatic tolerance (Cowings, et al. 2007). In one study participants were subjected to 60 degrees head up tilt and other autonomic nervous system (ANS) function tests. High correlations were found between echocardiography and impedance cardiography on measures of stroke volume and cardiac output (r values =0.90 and 0.82). A promising countermeasure for post-flight orthostatic intolerance is fluid loading used to restore lost plasma volume by giving crew salt tablets and water prior to re-entry. This study will assess individual differences in the effects of this countermeasure and will also examine the potential value of impedance cardiography as a means of providing crewmembers with information on their own susceptibility to orthostatic intolerance. Eight men and eight women will be tested during 4 hour exposures to six degree head down tilt (HDT). Each subject will be given two exposures to HDT, one with and one without fluid loading (one liter of 0.9% saline solution) on separate days. Before and after each test, subjects will perform a stand test (orthostatic challenge): 3 minutes standing, 3 minutes sitting, 3 minutes supine.

