DEFINING THE RELATIONSHIP BETWEEN BIOMARKERS OF OXIDATIVE AND INFLAMMATORY STRESS AND THE RISK FOR ATHEROSCLEROSIS IN ASTRONAUTS DURING AND AFTER LONG-DURATION SPACEFLIGHT

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BACKGROUND

Future human space travel will consist primarily of long-duration missions onboard the International Space Station (ISS) or exploration-class missions to Mars, its moons, or nearby asteroids. These missions will expose astronauts to increased risk of oxidative and inflammatory damage from a variety of sources, including radiation, psychological stress, reduced physical activity, diminished nutritional status, and hyperoxic exposure during extravehicular activity. Evidence exists that increased oxidative damage and inflammation can accelerate the development of atherosclerosis.

PURPOSE

The purpose of this investigation is to determine whether biomarkers of oxidative and inflammatory stress are elevated during and after long-duration spaceflight and investigate if a relation exists between levels of these biomarkers and structural and functional indices of atherosclerotic risk measured in the carotid and brachial arteries. This is the first study to propose assessing atherosclerotic risk using biochemical, structural, and functional measures before, during, and immediately after spaceflight, and structural and functional measures for up to 5 years after landing.

METHODS

We will study 12 astronauts before, during, and up to 5 years after long-duration ISS missions. A panel of biomarkers of oxidative and inflammatory stress will be measured twice before flight, early (flight days 15 and 60) and late (2 weeks before landing) during the mission, and early in the postflight recovery phase (~3 days after landing). Arterial structure and vascular compliance will be measured at the same times and also at 1, 3, and 5 years after landing (surveillance). Arterial function will be measured using the same preflight, postflight, and surveillance schedule as arterial structure and vascular compliance measures, but will not be measured inflight.

Biomarkers, some of which we have previously shown to be elevated with spaceflight, will be measured in venous blood samples and 24-h (in-flight) and 48-h (pre- and post-flight) urine pools. Arterial structure will be assessed from measures of carotid intima-media thickness, which have been shown to be better indicators of atherosclerotic than the Framingham Risk Score. Arterial function will be assessed using brachial flow-mediated dilation, a well-validated measure used to assess endothelium-dependent vasodilation and is a sensitive predictor of atherosclerotic risk. Arterial pulse pressure measured in the brachial artery and stroke volume measured from cardiac ultrasound will be used to assess hemodynamic status, cardiac function, and systemic vascular compliance.

Three astronauts are actively participating in the preflight data collection and training activities. One astronaut has completed all preflight activities and will participate in the first in-flight data collection sessions by the end of 2013. The first post-flight data collection sessions will occur in the spring of 2014.

EXPECTED RESULTS

We hypothesize that biomarkers of oxidative and inflammatory stress will increased with spaceflight and will correlate with increased carotid intima-media thickness during and after flight and with decreased flow-mediated dilation after the mission. Furthermore, we hypothesize that measures of oxidative stress will return to baseline after flight, but biomarkers of inflammatory stress and vascular indices of atherosclerotic risk will remain elevated.