Gradient Compression Garments as a Countermeasure to Post-Space Flight Orthostatic Intolerance: Potential Interactions with the Maximum Absorbency Garment

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INTRODUCTION

Astronauts and cosmonauts may experience symptoms of orthostatic intolerance during re-entry, landing, and for several days post-landing following short- and long-duration spaceflight. Presyncopal symptoms have been documented in ~20% of short-duration and greater than 60% of long-duration flyers on landing day specifically during 5-10 min of controlled (no countermeasures employed at the time of testing) stand tests or 80° head-up tilt tests. Current operational countermeasures to orthostatic intolerance include fluid loading prior to and whole body cooling during re-entry as well as compression garments that are worn during and for up to several days after landing. While both NASA and the Russian space program have utilized compression garments to protect astronauts and cosmonauts traveling on their respective vehicles, a "next-generation" gradient compression garment (GCG) has been developed and tested in collaboration with a commercial partner to support future space flight missions.

Unlike previous compression garments used operationally by NASA that provide a single level of compression across only the calves, thighs, and lower abdomen, the GCG provides continuous coverage from the feet to below the pectoral muscles in a gradient fashion (from ~55 mm Hg at the feet to ~16 mmHg across the abdomen). The efficacy of the GCG has been demonstrated previously after a 14-d bed rest study without other countermeasures and after short-duration Space Shuttle missions. Currently the GCG is being tested during a stand test following long-duration missions (~6 months) to the International Space Station. While results to date have been promising, interactions of the GCG with other space suit components have not been examined. Specifically, it is unknown whether wearing the GCG over NASA's Maximum Absorbency Garment (MAG; absorbent briefs worn for the collection of urine and feces while suited during re-entry and landing) will interfere with the effectiveness of the GCG or conversely whether the GCG will reduce the fluid absorption capabilities of the MAG.

METHODS

This operational, directed study, will (1) determine whether the effectiveness of the GCG is affected by the MAG with regard to cardiovascular responses to head-up tilt, the standard orthostatic intolerance test employed for astronauts and bed rest subjects; (2) determine whether the effectiveness of the MAG is compromised by the GCG tested by injecting a standard fluid volume (950 ml in 3 separate simulated "urine voids") at a standardized rate (30 ml/sec); and (3) determine whether comfort is affected by wearing the MAG under the GCG using a standardized questionnaire. Results from this study will guide future development and operational use of the GCG and MAG to maximize crew health, safety, and comfort.