ABSTRACT

Susceptibility of healthy astronauts to orthostatic hypotension and presyncope is exacerbated upon return from spaceflight. Hypo-volemia 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 of human cardiovascular function is of critical importance to maintenance of astronaut health and safety. A promising countermeasure for post-flight orthostatic intolerance is fluid loading used to restore lost fluid volume by giving crew salt tablets and water prior to re-entry. Eight men and eight women will be tested during two, 6-hour exposures to 6° Head Down Tilt (HDT): 1) fluid loading, 2) no fluid loading. Subjects will be instructed to limit their dietary salt intake to 2300 mg per day for 3 days before each HDT session. There will be a 7-day interval between each session and the test order will be counterbalanced. Subjects will be tested between 8AM and 4PM. The standard fluid loading protocol used with astronauts will be followed for this study (see table below).

METHODS

Participants: Eight men and eight women, unpaid healthy volunteers (ages of 18 and 65) will participate in this study. Each participant will be evaluated during two, 6-hour exposures to 6° Head Down Tilt (HDT): 1) fluid loading; 2) no fluid loading. Subjects will be instructed to limit their dietary salt intake to 2300 mg per day for 3 days before each HDT session. There will be a 7-day interval between each session and the test order will be counterbalanced. Subjects will be tested between 8AM and 4PM. The standard fluid loading protocol used with astronauts will be followed for this study (see table below).

BACKGROUND

Approximately 64% of all astronauts experience post-flight orthostatic hypotension (Buckley, et al. 1996). Following 14 day flights 20% of astronauts experience presyncope, whereas the rate rises to 83% following longer duration missions of 129-190 days (Mcos, et al. 2001). Six-degrees-head-down bed rest (HDBR) has been shown to be an analogue to spaceflight as it removes the gravity vector directed from the head to the feet and induces a similar cephalad fluid shift as seen in spaceflight (Förtmeyer Schneider and Greenleaf 1998; Charles and Bungo 1991).

Currently, echocardiography is the only non-invasive method for measuring cardiac responses during exposure to microgravity. Thoracic impedance cardiography provides an alternative method for observing cardiac responses that can be measured continuously. If impedance measures accurately reflect changes in orthostatic tolerance than this methodology may be used to monitor crew during planetary transitions when accurate measures of cardiac function are critical. Our highest priority is to know the course of changes of fluid and salt loading on cardiac pre-load, so that in the future we can advise the astronauts as to how long before re-entering the atmosphere is optimal.

OBJECTIVES

1. Define the temporal profile of cardiac responses to 6° Head Down Tilt (HDT) with fluid loading and without fluid loading.
2. Examine HDT effects on orthostatic tolerance with and without fluid loading.
3. Examine individual differences (e.g., gender and age effects) to HDT and fluid loading.
4. Correlate impedance and echocardiography measures obtained during HDT and orthostatic stress tests.

CONTACTS

Principal Investigator, Patricia Cowings
Email: patricia.c.cowings@nasa.gov
Co-Investigator, William Toscano
Email: bill.toscano@nasa.gov

Acknowledging the help of student research assistants: Cameron Mar, Arissha Ravikumar, Spencer Ruscitto, and Sabrina Cismas

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<table>
<thead>
<tr>
<th>Subject</th>
<th>Number of 8 oz. Water Bottles</th>
<th>Number of 1 gram Salt Tablets</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;120 LBS.</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>120-155</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>155-290</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>&gt;290 LBS.</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Procedure: 1) 10-minute sitting baseline; 2) 3-minute stand test to assess orthostatic tolerance; 3) begin 6-hour exposure to 6° HDT; 4) The calculated amount of fluid and salt will be ingested in 4 equal portions every 15 min over the first 1-hour period; 5) and 6° HDT after 6-hours; 6) 3-minute stand test to assess changes in orthostatic tolerance. Urine sodium intake will be measured before and after each HDT test. Subjects will not be permitted to use the rest room during HDT sessions. External latex catheters will be provided for men and disposable diapers for women.

Measures: Echocardiography measures (stroke volume and cardiac output) will be obtained during pretext sitting baseline, each stand test, and at 30 minute intervals over the 6-hours of HDT. Each cardiac scan will be 1-minute in duration. Stroke volume is calculated as the product of the aortic blood velocity area and the velocity time integral of Doppler flow. Velocity time integral will be obtained using pulse Doppler of ascending aorta velocity at the supercristal notch.

CONCLUSIONS

These preliminary data (n=4) show large individual differences in cardiac responses to HDT and the fluid loading countermeasure. Significant correlations were observed between impedance and echocardiography measures of cardiac output: during no fluid and fluid HDT conditions (n=4). Stroke volume was also significantly correlated for the two measures but only during the no fluid condition. This research is ongoing.

REFERENCES