# Cardiovascular Adaptations to Six-Degree Head-Down Tilt Bed Rest

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Orthostatic hypotension is a recognized risk for crew members returning from space. Vascular and cardiac dysfunction may be the mechanism for this effect. We studied arterial and cardiac function in six-degree head-down tilt bed rest, which is the most widely accepted ground-based analog of spaceflight. We tested the hypothesis that arteries in the arm and leg would remodel during bed rest. Additionally, we tested the hypothesis that they would follow different patterns of remodeling during head-down bed rest, based on literature from animal models.

## Methods

This study included 11 subjects (eight men and three women). We limited data analysis to the first 49 days of bed rest and compared it to pre-bed-rest baseline data. We measured plasma volume using a carbon monoxide re-breathing technique that was previously published. Using ultrasound, we collected data on arterial diameters and flows at baseline, during reactive hyperemia, and following administration of nitroglycerin. Systolic and diastolic function as well as ventricular mass and diameter were measured by echocardiography.

## Results

Plasma volumes were significantly decreased at all time points (days 7, 21, 30, and 49) compared to pre-bed rest. There were no differences in reactive hyperemic response in the arm at any time point. However, the hyperemic response in the leg increased significantly at day 49. Arterial responses to nitroglycerin did not change over the duration of bed rest (day effect) in either the arm or the leg, but a significant difference existed between arm and leg responses. There was a statistically significant decrease in anterior tibial intimal-medial thickness at days 21, 35, and 49. Several cardiac functional parameters, including osovolemic relaxation time, Mitral e-wave, ejection time, velocity of circumferential shortening, and myocardial performance index, were significantly changed following 49 days of bed rest, suggesting a decrease in diastolic function during that time.

## Conclusions

These data show that some cardiovascular measures change during bed rest while others do not. The challenge is to elucidate which parameters may translate into functional decrements on long-duration spaceflight. Flow-mediated dilation; intimal-medial thickness, and myocardial performance index were clinically relevant indicators of dysfunction in patients exhibiting disease. Further study is needed to determine whether these measures can provide any insight into the effects of bed rest, or spaceflight, on cardiovascular performance in otherwise healthy subjects.