Paper ID: 87036
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IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IP)

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UNDERSTANDING MECHANISMS AND UNVEILING COUNTERMEASURES FOR THE BEDREST-INDUCED DECREASE IN CEREBRAL BLOOD FLOW

Abstract

While studying the cerebral circulation in actual or simulated microgravity remains difficult, a common finding of bedrest studies is a decrease in cerebral blood flow. Because the brain has an extraordinarily high metabolic demand, but very limited energy storage and does not tolerate fluctuations in oxygen delivery well, this decrease in blood flow may have an impact on cognitive functions of astronauts, or bedridden patients. Indeed, evidence for cognitive impairment has been seen during experimental bedrest and hospitalisation.

However, previous data has shown that blood flow to the brain is lower simply when standing upright compared to the supine posture. Moreover, we have recently observed that the reduction in cerebral blood flow with short-term bedrest is similar to the upright posture (under review). Ultimately, these data imply that decreased cerebral blood flow during bedrest may not be negative and linked to cognitive dysfunction, but simply a reflex adjustment to prolonged periods in the supine posture or microgravity.

To identify if the decrease in cerebral blood flow is caused by reflex adjustments to changes in posture, we are currently examining the impact of changing posture (upright versus supine) and 2 days of bedrest on cerebral blood flow. With 3 different experimental protocols, we aim to isolate potential reflex mechanisms causing a reduction in blood flow: 1) The increased concentration of red cells (i.e. increased oxygen carrying capacity) due to fluid shifts and a loss in plasma volume, 2) hyperventilation-induced hypocapnia, 3) cerebral autoregulation causing vasoconstriction to combat fluid shifts and the higher gravitational pressure gradient at brain level in the supine posture. Data collection is ongoing and includes cerebral blood flow via ultrasound of the internal carotid, vertebral and middle cerebral artery, haemoglobin concentration, continuous haemodynamic measurements, and end-tidal CO2.

We hypothesize that *(protocol 1)* normalizing the bedrest-induced haemoconcentration will account for 50% of the reduction in cerebral blood flow. Raising the head during bedrest *(protocol 2)* will avoid the fluid shift towards the brain and prevent autoregulation causing cerebral vasoconstriction, thus accounting for the remaining 50% reduction in cerebral blood flow. Finally, daily exercise *(protocol 3)* is expected to increase plasma volume and thus may be a simple and effective countermeasure to prevent a haemoconcentration-induced decrease in cerebral blood flow.

By exploring the underlying mechanisms and finding countermeasures to the decrease in cerebral blood flow, our study is an important step towards ensuring astronauts' safety during future long-distance space missions.