

DECOMPRESSION SICKNESS DURING SIMULATED LOW PRESSURE EXPOSURE IS INCREASED WITH MILD AMBULATION EXERCISE

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INTRODUCTION – Musculoskeletal activity accelerates inert gas elimination during oxygen breathing prior to decompression (prebreathe), but may also promote bubble formation (nucleation) and increase the risk of decompression sickness (DCS). The timing, pattern and intensity of musculoskeletal activity are likely critical to the net effect. The NASA Prebreathe Reduction Program (PRP) combined oxygen prebreathe and exercise preceding a 4.3 psia exposure in non-ambulatory subjects (a microgravity analog) to produce two protocols now used by astronauts preparing for extravehicular activity - one employing cycling and non-cycling exercise (CEVIS: 'cycle ergometer vibration isolation system') and one relying on non-cycling exercise only (ISLE: 'in-suit light exercise'). Current efforts investigate whether light exercise normal to 1 G environments increases the risk of DCS over microgravity simulation.

METHODS – The current studies replicate the CEVIS protocol, each with a single exception, all matched for total metabolic output. Experiment 1 (E1) added intermittent, controlled ambulation (stepping in place: 4 min at 80 steps/min x 7 cycles) at ground level immediately preceding prebreathe (saturated inert gas state) and at 4.3 psia (spacesuit pressure, oxygen breathing, supersaturated state) instead of remaining non-ambulatory throughout. Experiment 3 (E3) restricted ambulation to the ground level period only. Study endpoints included symptomatic DCS. Fisher Exact Tests were used to compare groups (significance accepted at $p < 0.05$). **RESULTS** – E1 (21 person-trials [16 male, 5 female]) yielded 4/20 (20%) DCS, significantly more than CEVIS (0/45 DCS [0%]) trials ($p = 0.004$). E3 (35 person-trials [26 male, 9 female]) yielded 2/35 (6%) DCS, not significantly different from CEVIS ($p = 0.094$), but trending towards being significantly lower than E1 ($p = 0.070$). **CONCLUSION** – The risk of DCS at spacesuit pressure is increased by mild ambulation conducted sequentially at ground level in a saturated state and a subsequent supersaturated state, but it appears that exercise in a supersaturated state has the greater impact.

Learning Objectives:

- 1 To understand how exercise can accelerate inert gas elimination during oxygen breathing.
- 2 To appreciate how exercise may promote bubble formation and increase decompression stress.
- 3 To comprehend how inert gas saturation may play a role in exercise-induced bubble formation.

MOC Questions

How is the risk of decompression sickness affected by ambulation exercise during exposure to low atmospheric pressure?

- A. Reduced by exercise
- B. Unchanged by exercise

C. Increased by exercise

- D. Increased only if conducted in first 10 minutes of exposure
- E. Increased only if conducted in first 30 minutes of exposure

Oxygen breathing prior to decompression to high altitude reduces decompression stress by

- A. Increasing tissue oxygen stores

- B. Decreasing metabolic rate
- C. Stimulating antioxidant defenses
- D. Reducing tissue inert gas stores**
- E. Increasing metabolic rate

Circulating bubbles observed with aural Doppler or transthoracic echo imaging are graded on what type of scale?

- A. Nominal
- B. Ordinal**
- C. Interval
- D. Logarithmic
- E. Ratio