

Abstract #A10

June 3, 2010: 10:48-11:00

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Nitrogen yield during nitrogen washout preceded by exercise.

Pendergast, D.R., Senf, C., Lundgren, C.E.G.

**Center for Research and Education in Special
Environments, (CRESE)**

**Department of Physiology and Biophysics
School of Medicine and Biomedical Sciences
University at Buffalo
Buffalo, NY 14214**

dpenderg@buffalo.edu (716-829-3830)

clundgre@buffalo.edu (716-829-2310)





BACKGROUND: DCS



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There are several steps at play in the mechanistic cascade leading to DCS:

- **Bubble formation: promote/hinder via clinically silent intravascular gas bubbles**
- **Inflammatory reactions, epithelial damage**
- **Inert-gas dynamics: wash-in and wash-out by circulatory gas transport, which are influenced by:**
 - a. different inhaled oxygen pressures**
 - b. immersion: increased cardiac output and shifts in blood distribution**
 - c. temperature effects: vasomotor tone**
 - d. physical activity: autonomic nervous activity, increased cardiac output, vasomotor tone, and humoral factors**



BACKGROUND: **Enhanced N2 Elimination**

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- **Breathing oxygen (or oxygen-enriched gas mixtures)**
- **Boosting blood perfusion by physiological mechanism**

Immersion in water, acting via increased cardiac output and tissue blood flow

Supine or Head-down tilt positions

Negative pressure breathing and recumbence

Thermal environment

Exercise



Background: Exercise



- **Passive or active exercise pre-dive or during decompression can increase bubbles (Harvey 1954, Vann '87,92) or reduce them (Jankowski '03)**
- **Exercise may increase N2 elimination and bubbles (Radermaker '93, Flook '97, Jankowski '97, Dujic '05, Dujic '06)**
- **Physical fitness may increase N2 elimination (Rattner '79, Ronning '99)**
- **Physical fitness does not effect N2 elimination (Lundsett '06)**
- **Exercise 20-24 hrs at 85-90%max pre-dive reduced bubbles (Wisloff '01, Dujic '04) and DCS**
- **Exercise 2 hrs pre-dive decreases bubbles (Blatteau '05, Blatteau '07)**
- **Exercise 48, 10, 5, 0.5 hrs. before a dive had no effect on bubbles (Wisloff '04, Berge '05, Loset '06, Gennser '2008)**



Protocol



- The present project studied, at one atmosphere, the effect of exercise introduced at 24 Hrs and 2 Hrs before nitrogen unloading, compared to control, in 8 male subjects.
- Subjects reported to the laboratory at the same day and time of the day with at least one week in between conditions.
- Conditions were randomly assigned and conducted two experiments were conducted for each condition.
- Subjects heart rate and O₂ saturation were measured continuously along with N₂ washout.
- Data were fit statistically and extrapolated to determine the total N₂ washed out. From these data the kinetics of the wash out was determined as the $\frac{1}{2}$ time of washout.

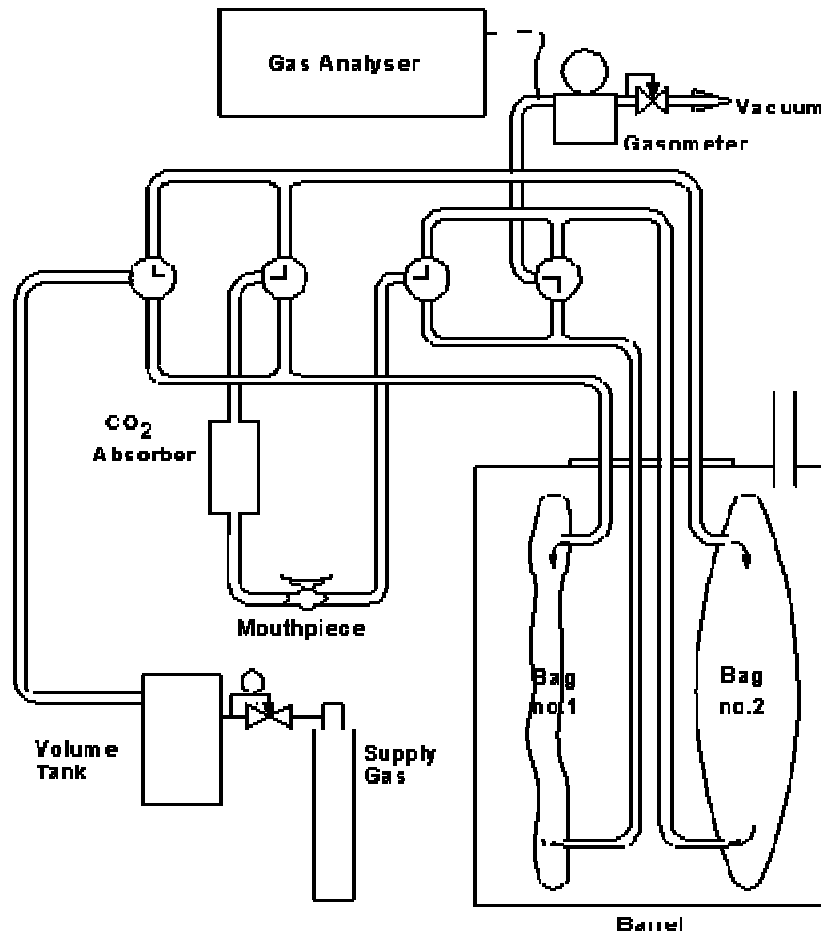


Exercise Protocol



- Pulmonary function, including RV
- Cycle ergometer, leg pedaling VO_2max
- Cycle at 85% of VO_2max for 60 min
- 24 hrs or 2 hrs later determine N_2 washout (repeated)
- Control experiment: no exercise (repeated)

Method: N₂ Washout

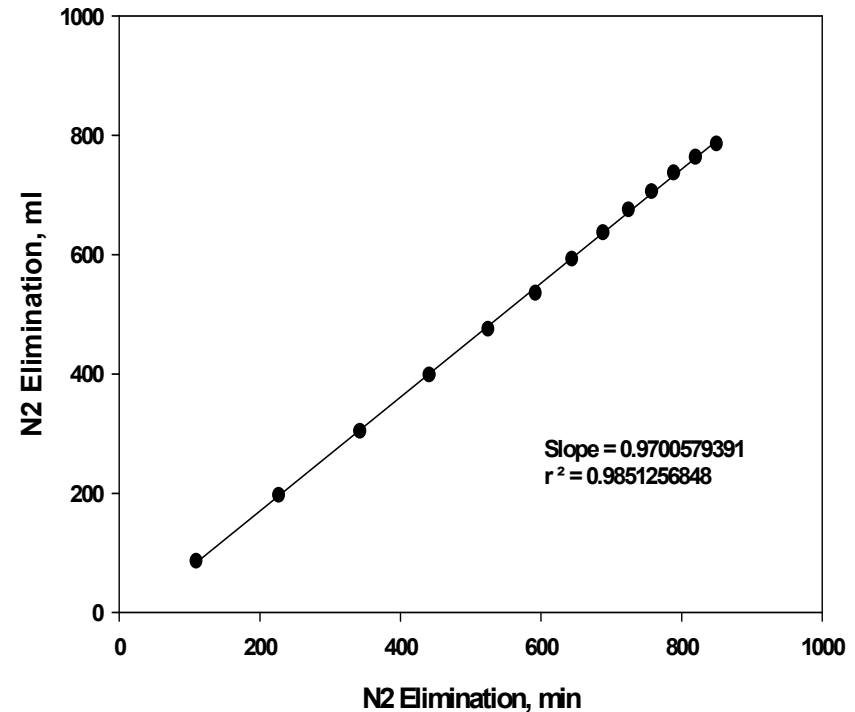
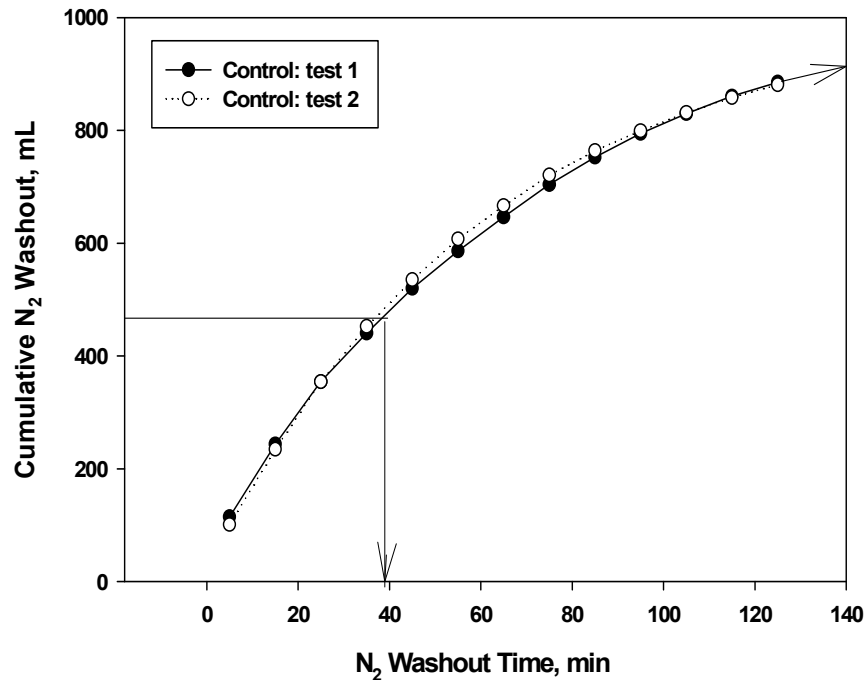


- Closed circuit
- Bag-in-Box
- O₂ (21%)/Argon:
O₂ add system
- CO₂ scrubber
- Subject in tent: Argon
to prevent N₂ uptake
through skin
- N₂ by Gas
Chromatograph
- Vol: wet- spirometer
- Collection at 5" and
the 10" intervals
- First collection is
corrected for lung N₂



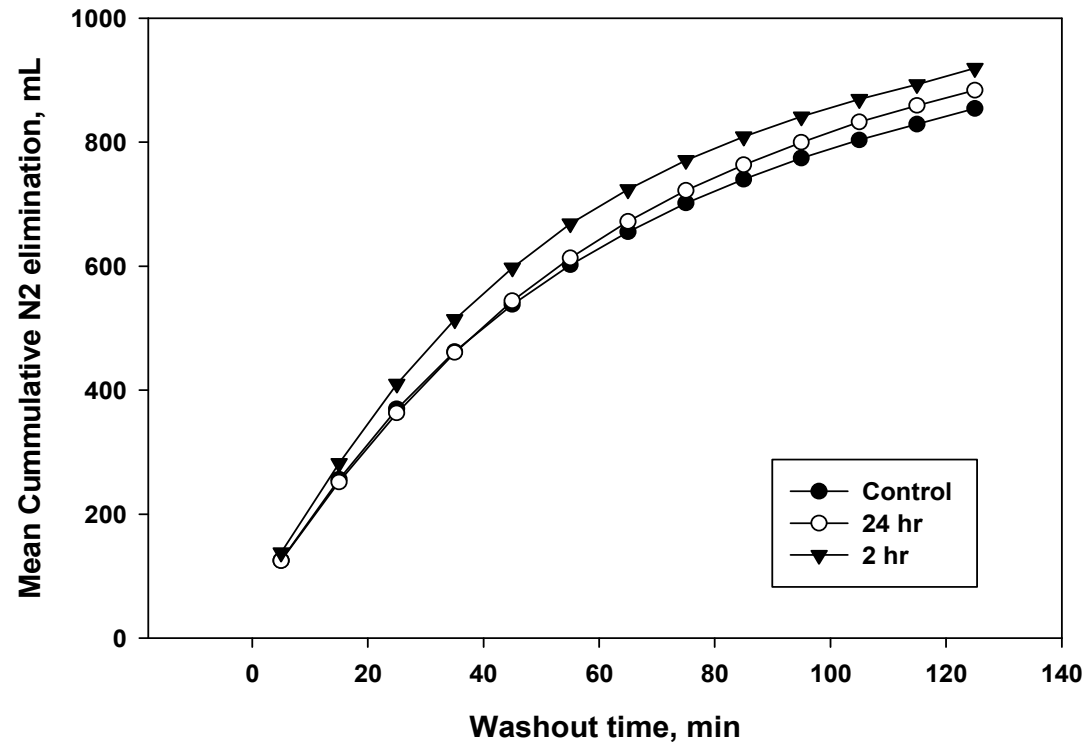


Method: N₂ Washout



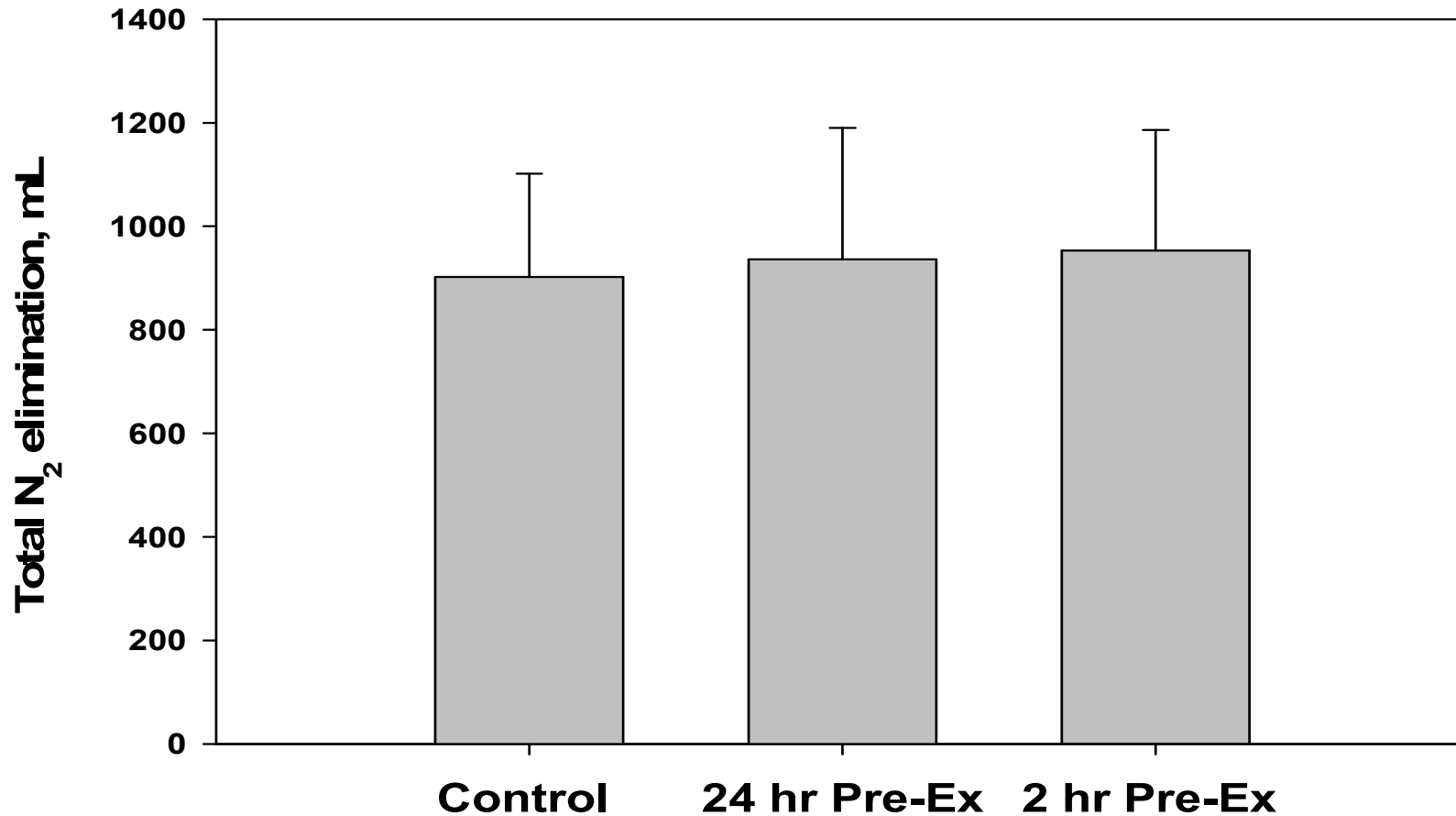
- Calculations: total N₂ elimination and one-half time
- Inclusion criteria: Exponential rise to asymptote
Total N₂ eliminated proportional to body mass
- Method highly reliable based on test-retest data
- Repeat measures taken under each condition

Results: N₂ Washout



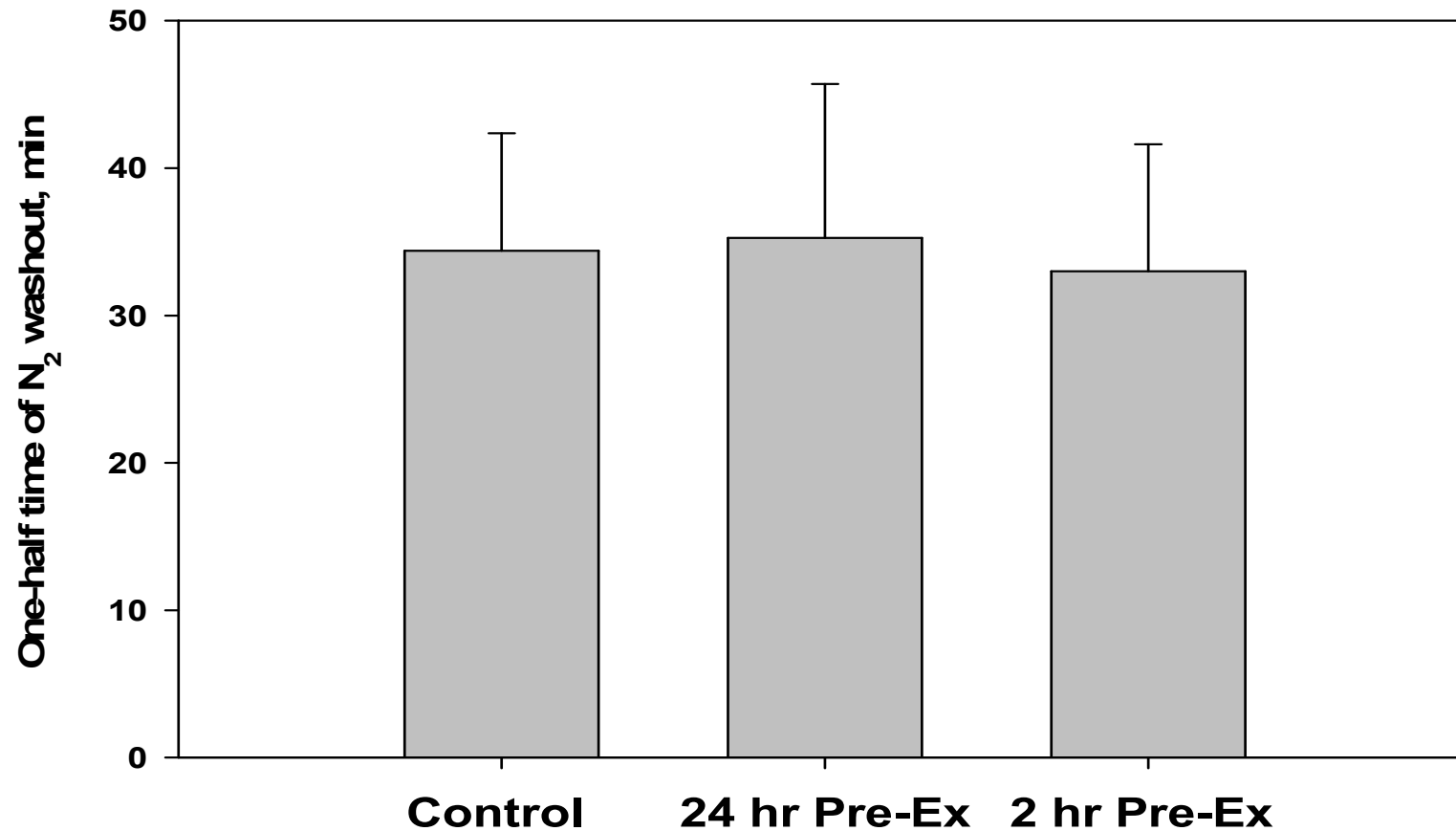
- Cumulative N₂ elimination was not effected by exercise 24hrs prior to the washout

Results: Total N₂ elimination



- Total N₂ elimination was not effected by exercise 24 hrs or 2 hrs pre-washout ($p = 0.32$).

Results: $\frac{1}{2}$ Time of N_2 elimination



- One-half time of N_2 elimination was not effected by exercise 24 hrs or 2 hrs pre-washout ($p = 0.41$).



Summary



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- The current data would suggest that exercise 24 hr or 2 hr pre-dive does not facilitate N₂ elimination during decompression.
 - These data suggest that the reported decrease in VGB and DCS as a result of pre-exercise 24 hr and 2 hr pre-dive were due to mechanisms other than N₂ elimination.
(i.e. biochemical, vascular, inflammatory etc.)
 - Alternatively, one recent study found no benefit from pre-exercise 24 hr pre-dive in naïve divers (Gennser UHMS, 2008), as used in this study.