Canadian Chapter UHMS
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What Divers Can Do to Speed up Nitrogen Elimination

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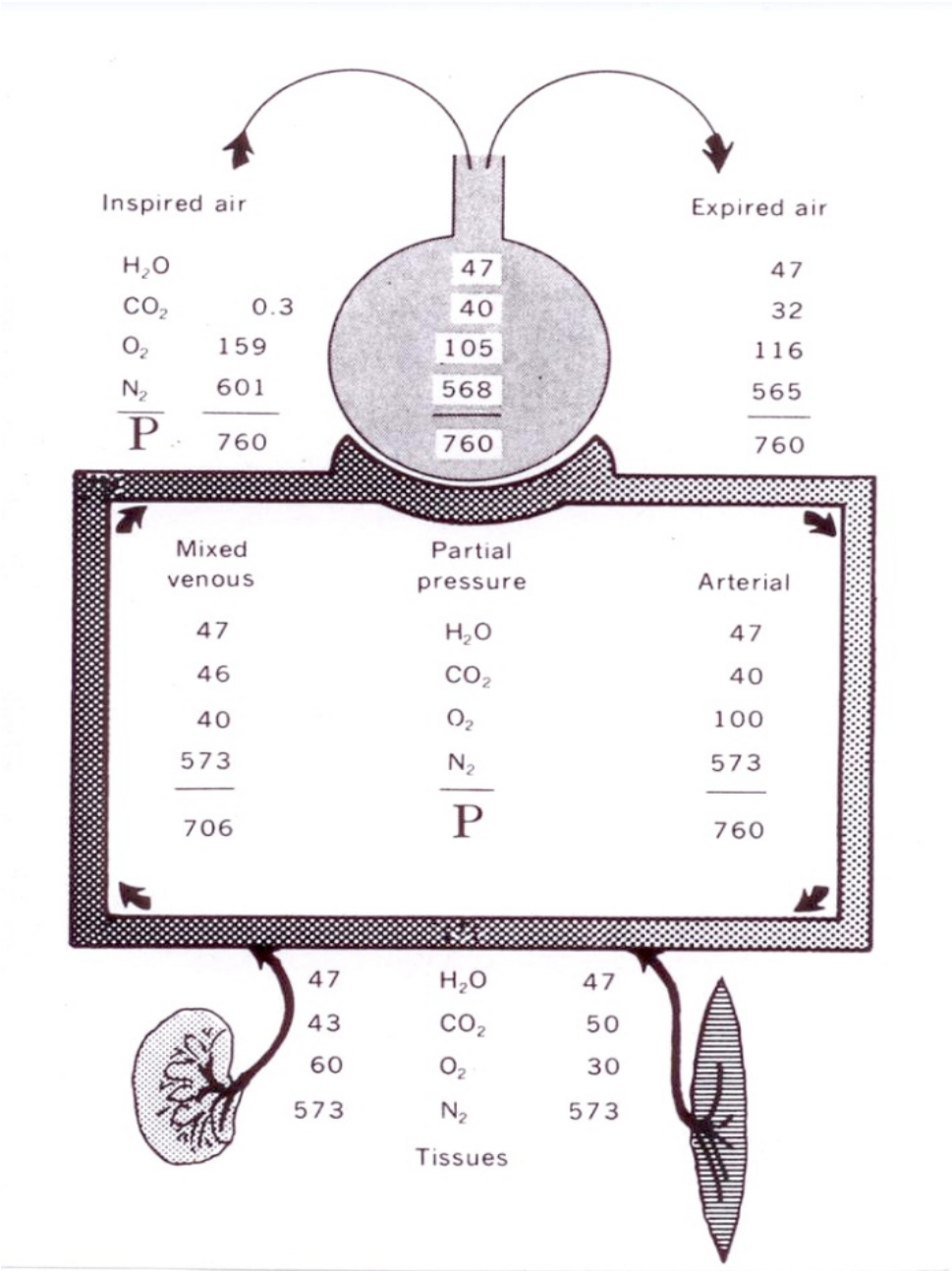
Decompression Sickness (DCS)

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. Most dives N_2**

Mechanisms of N_2 wash in and washout



- Gas exchange: lung
  no diffusion limit
- Cardiac output
- Tissue blood flow
  distribution
- Gas exchange: tissue
  no diffusion limit

Enhanced N_2 Elimination

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

> Posture: increased/decreased cardiac output

> Immersion in water: increased cardiac output and tissue blood flow

> Negative pressure breathing: increased cardiac output

> Oxygen partial pressure: vasoconstriction

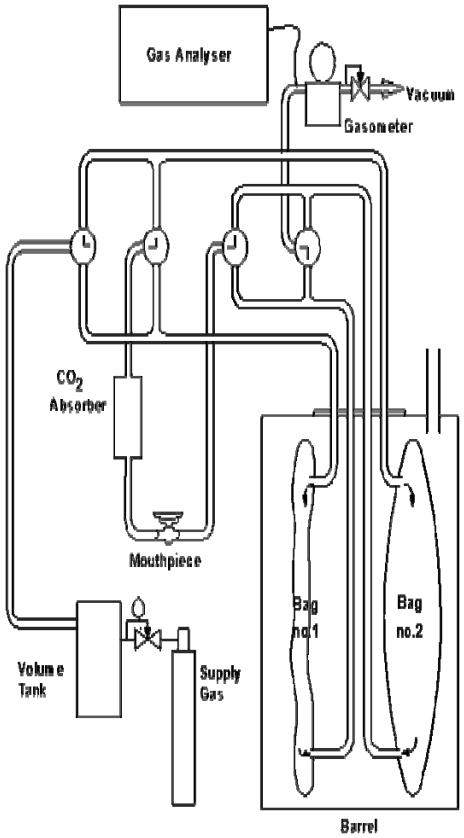
> Exercise: increased cardiac output and muscle blood flow

> Thermal environment: vasoconstrcition (cold)/vasodilitation (warm)

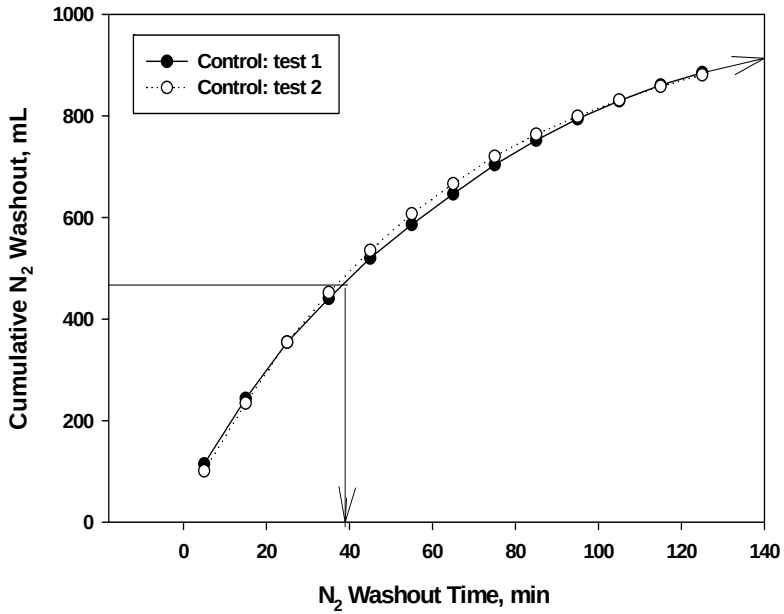
> Aging: reduced cardiac output and peripheral perfusion

N_2 Elimination Method and Reproducibility

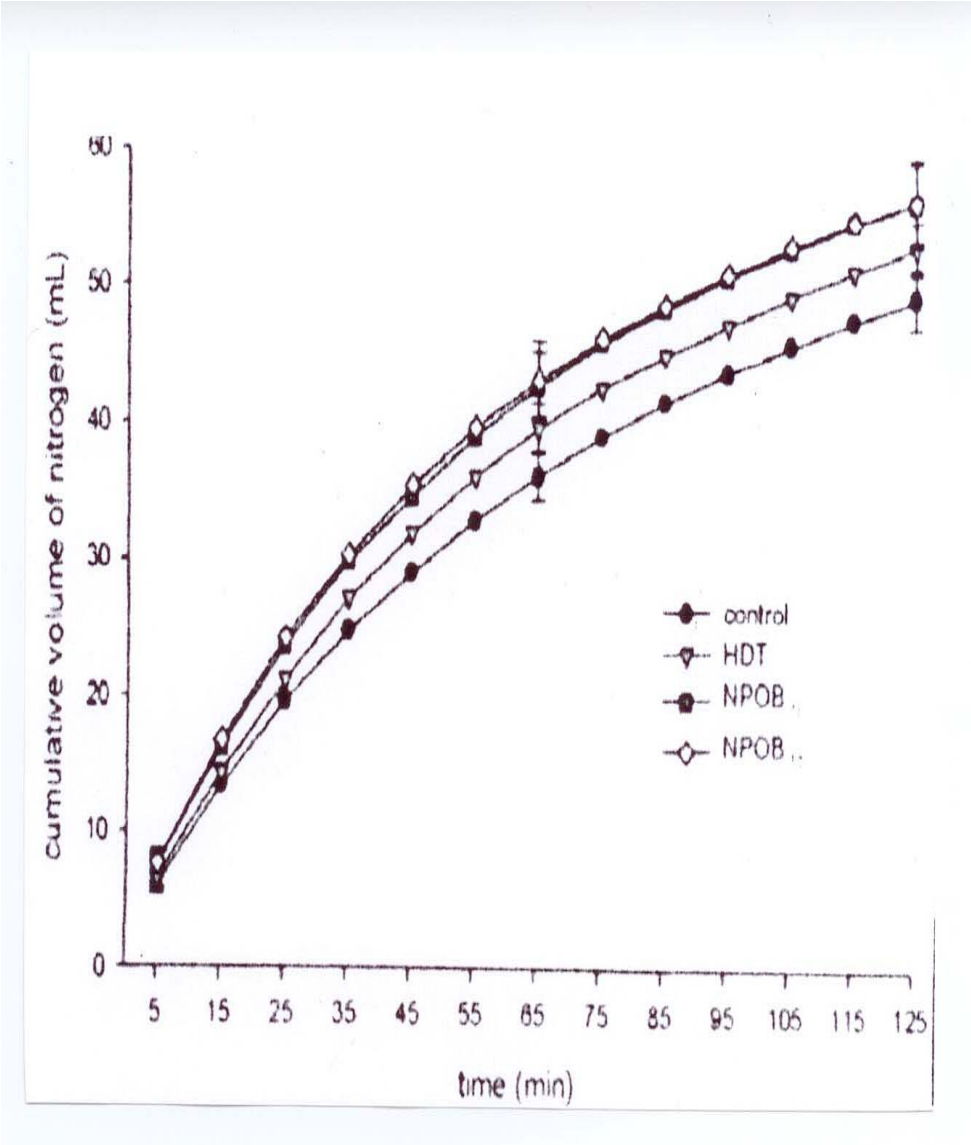
Method: N_2 Washout



- Closed circuit
- Bag-in-Box
- O_2 (21%)/Argon:
  O_2 add system
- CO_2 scrubber
- Subject in tent: Argon to prevent N_2 uptake through skin
- N2 by Gas Chromatograph
- Vol: wet- spirometer
- Collection at 5" and the 10" intervals
- First collection is corrected for lung N_2

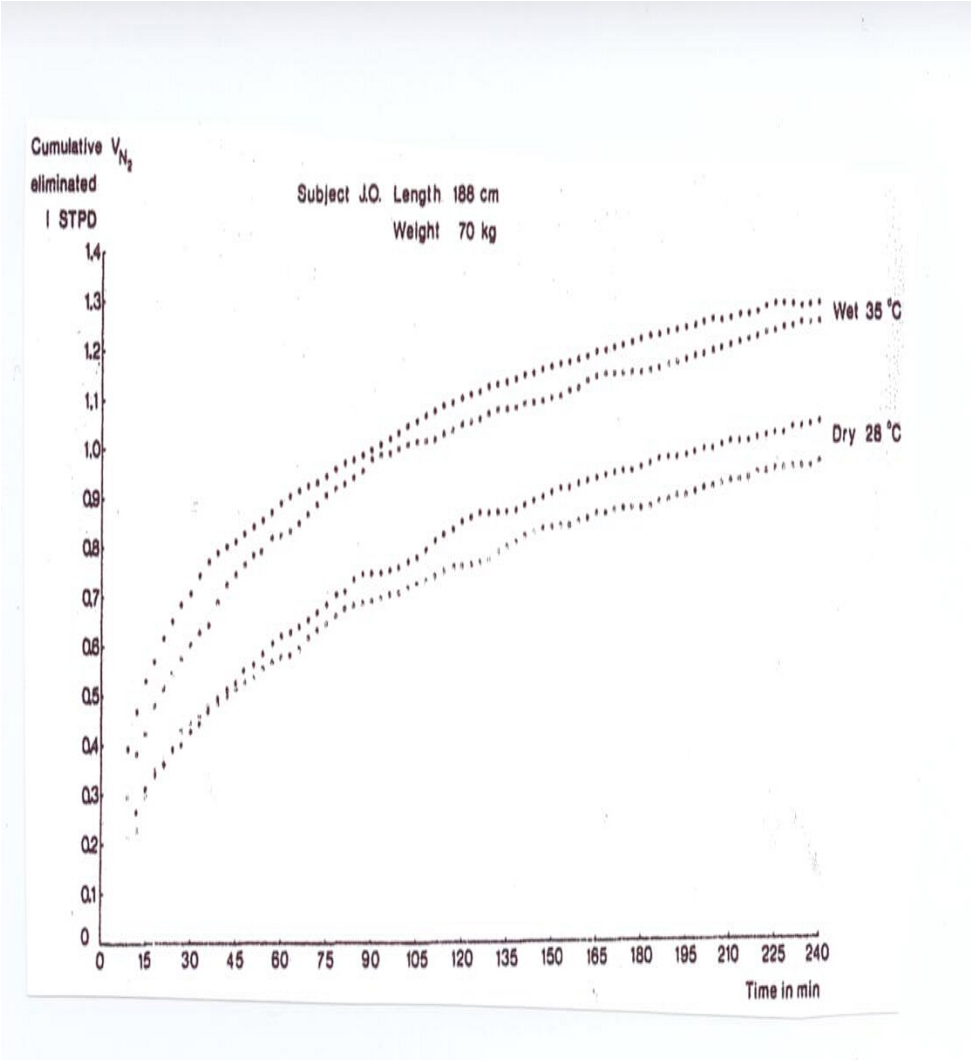


Effect of Changes in Posture



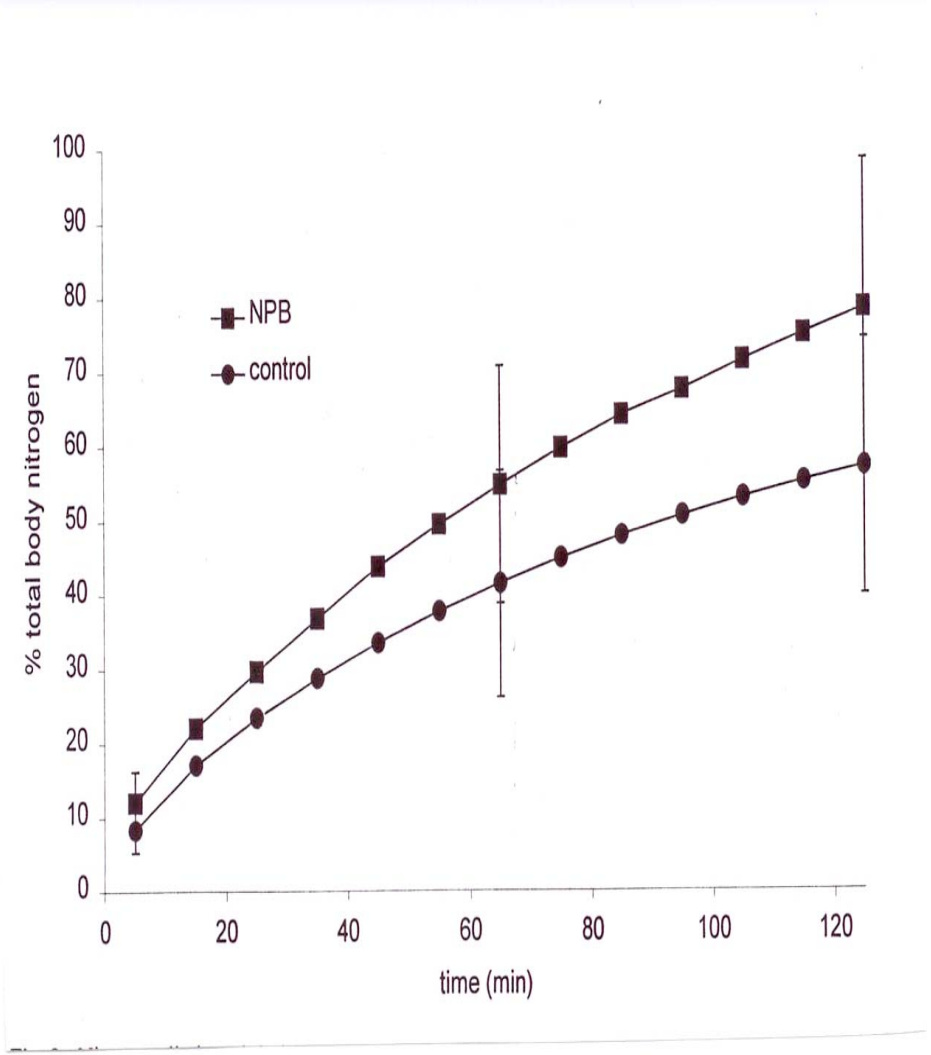
- CO is greater in HDT than supine
- CO is greater in supine than erect
- N_2 is faster in HDT and supine than erect

Effect of Immersion



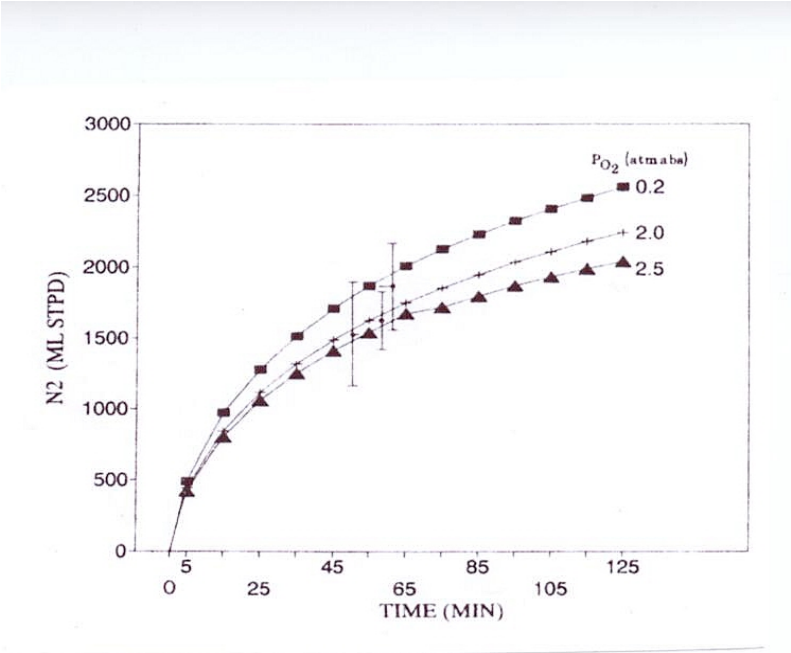
- Increased CO
- > SV and < HR
- Increased peripheral blood flow
- Constant blood pressures

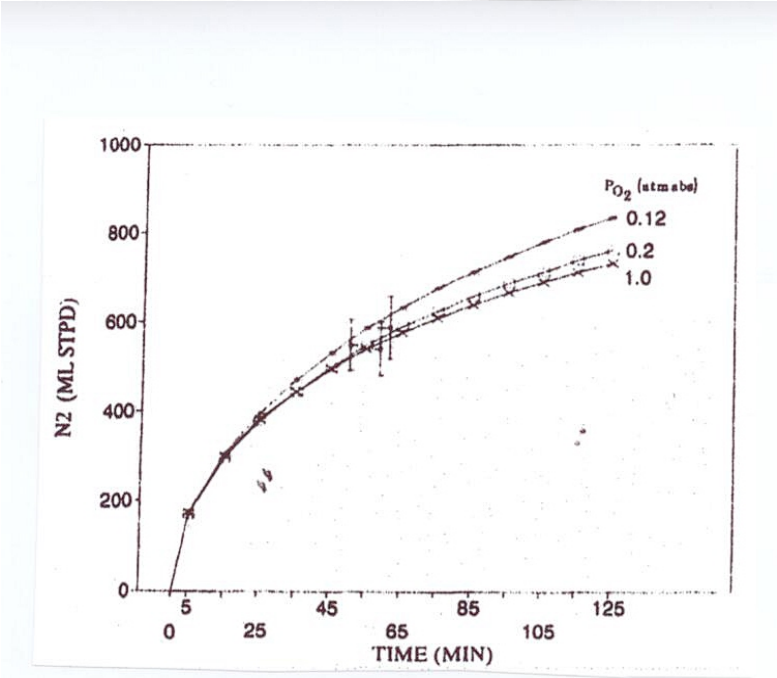
Effect of Negative Pressure Breathing



- NPB Increases CO
- > SV and < HR
- Increased peripheral blood flow
- Constant blood pressures

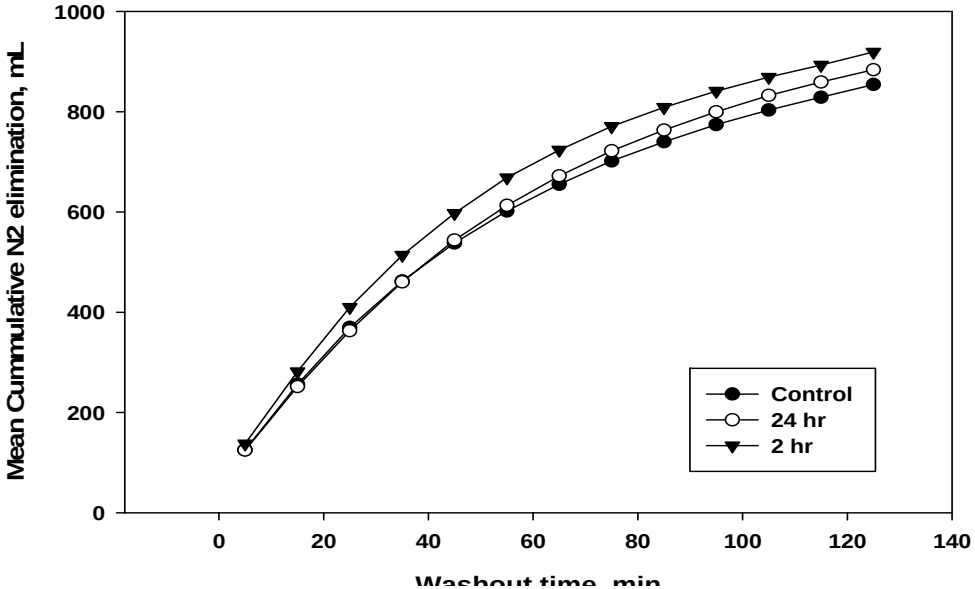
Effect of Oxygen Breathing

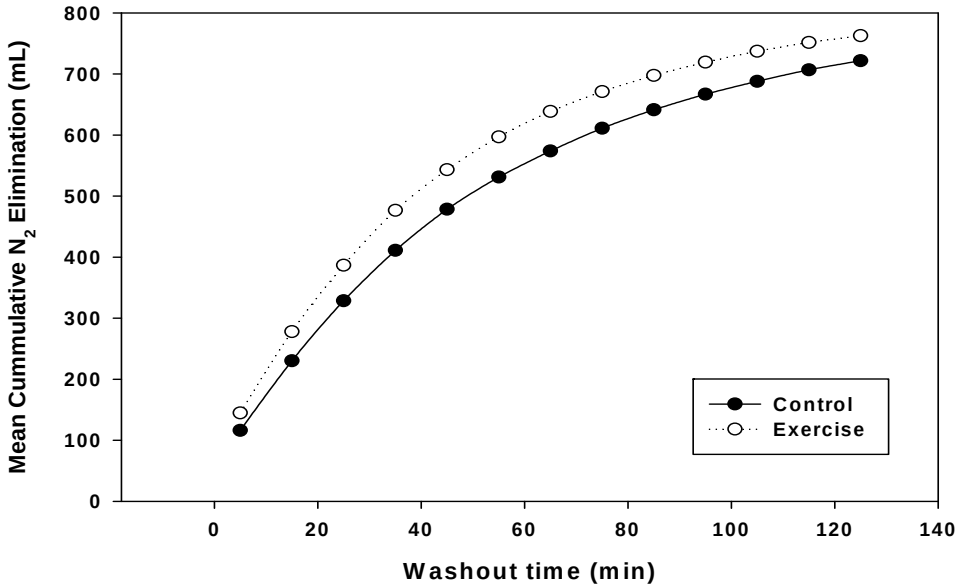




- > PO_2 vasoconstriction slowed elimination
- < PO_2 vasodilitation facilitated eliminaiton

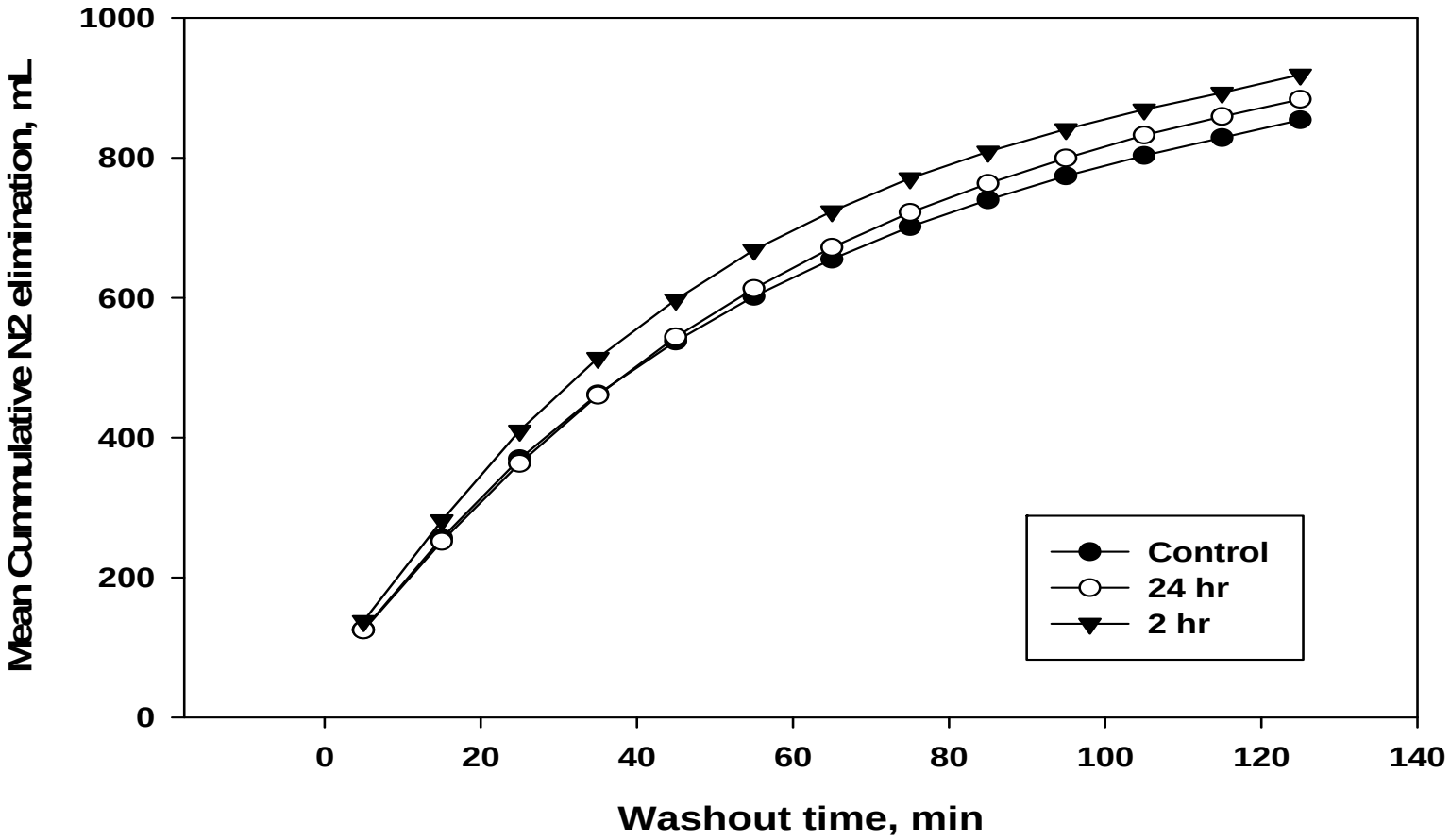
Effect of exercise





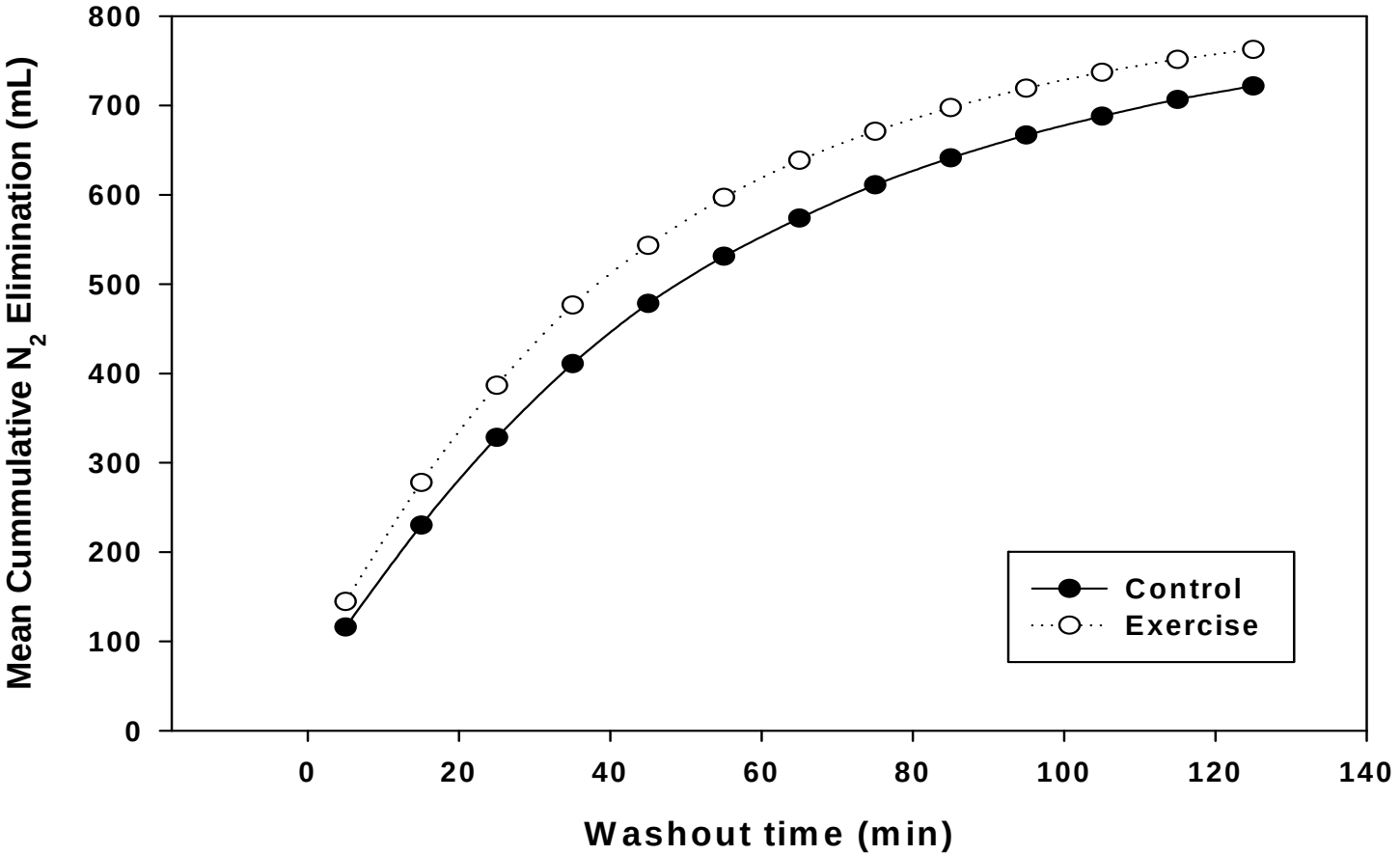
- Ex. Pre-dive shown to:
  reduce bubbles and DCS
- Exercise pre-dive no effect
- Exercise during decompression facilitated elimination
- Exercise may increase bubbler formation from tissue

Effect of exercise carried out pre-dive



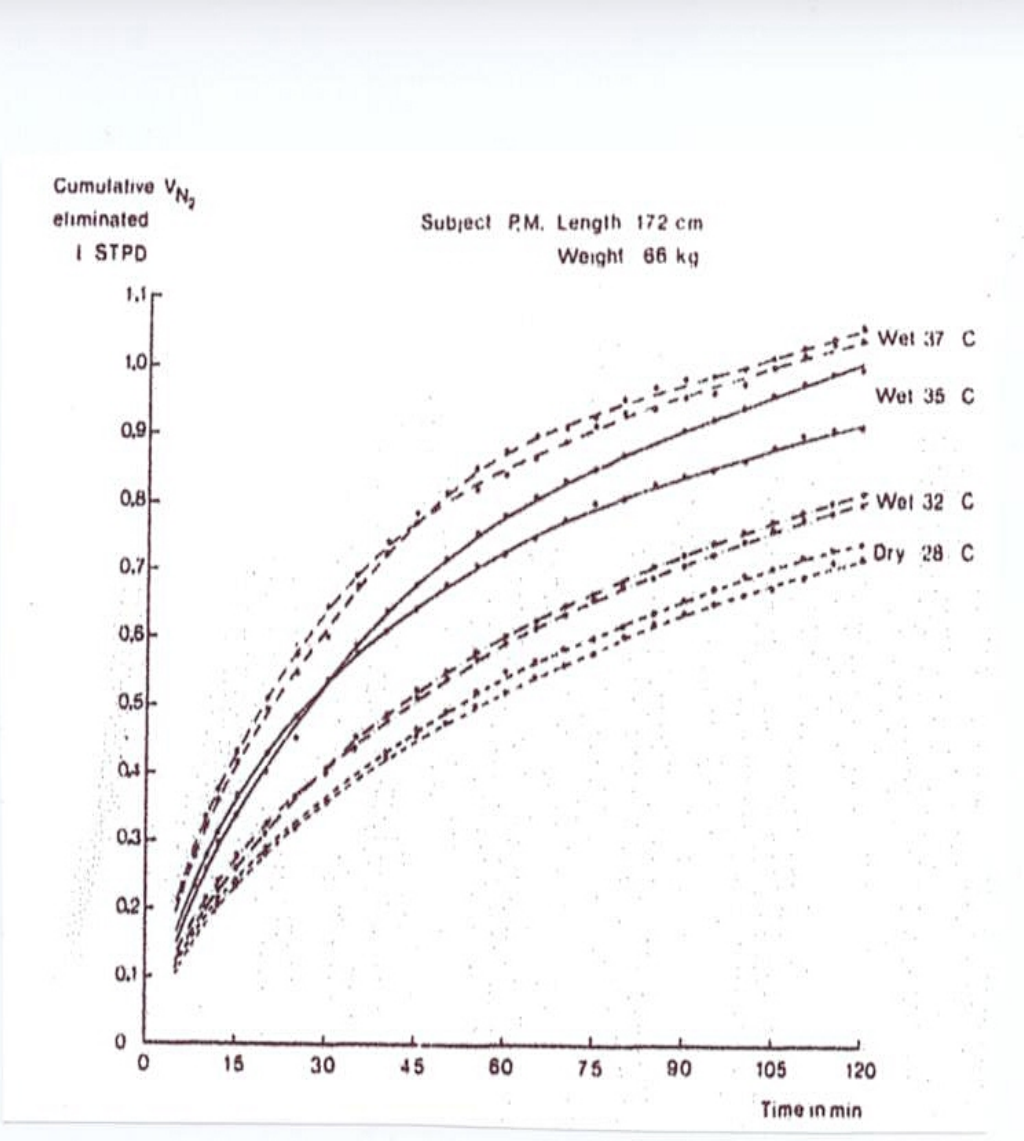
Cumulative N_2 elimination was not effected by exercise 24 or 2hrs prior to the washout

Effect of Exercise During Decompression



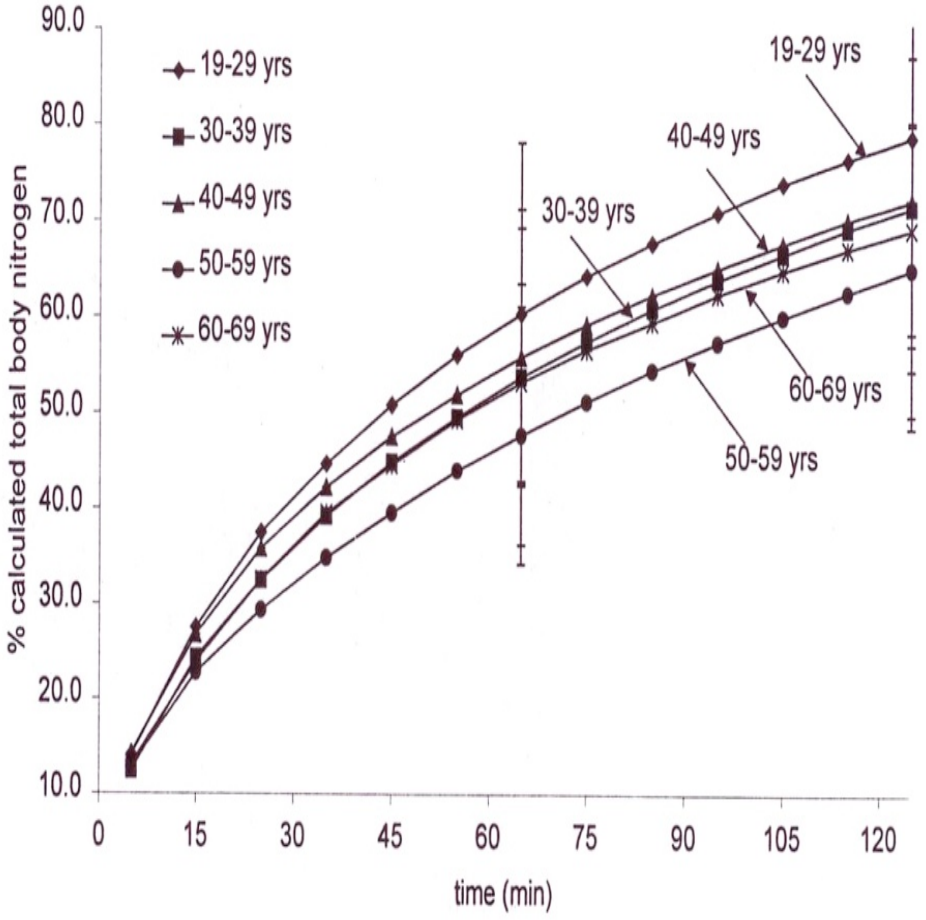
Cumulative N_2 elimination increased at significantly faster rate when exercise was performed during the washout (CO= ~ 14 L/min)

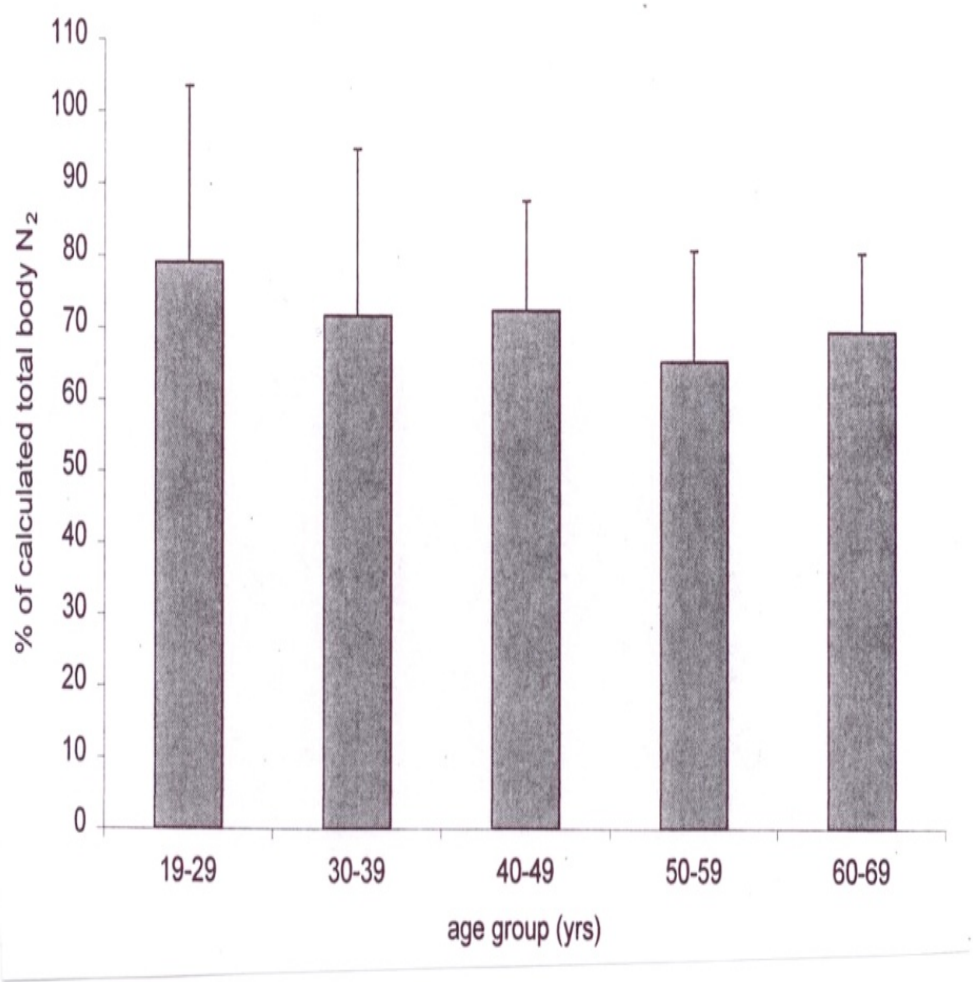
Effect of Thermal Environment



- Immersion > CO and peripheral blood flow
- Cold < blood flow, but not CO
- Warm > blood flow, but not CO
- Cold during uptake reduced N_2 load
- Warm during decompression increases rate of N_2 elimination
- Similar effects on bubbles and DCS

Effect of age





Summary

- Nitrogen elimination is facilitated by:
  supine or head-down tilt postures vs. erect
  immersion in thermal neutral water
  Negative pressure breathing
  Exercise during decompression
  Warm water immersion
- Nitrogen elimination is delayed by:
  Oxygen breathing
  Cold water immersion