Pulmonary Oxygen Toxicity Guidance Beyond PO_2 = 1.3 Atm

(Task # 10-05)

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Pulmonary Oxygen Toxicity Guidance Beyond P_{O_2} = 1.3 Atm

Previously, to measure pulmonary effects relevant to MK16 rebreather or shallow, 100% oxygen exposures, NEDU conducted many dives with P_{O_2} = 1.3 to 1.4 atm.

Questions addressed:

How does injury accumulate?

How long does recovery take?

– Responses vary widely among individuals.

– We characterize injury by fractional incidence of symptoms or of changes in pulmonary function.

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Problem addressed by current effort:

A dive may involve oxygen-accelerated decompression, a deep excursion, or some other period at P_{O_2} > 1.4 atm.

- How do these exposures add to dives with P_{O_2} = 1.3 atm?
- How do they affect recovery times?

We are measuring pulmonary function and recording symptoms after exposures to P_{O_2} = 2 atm.

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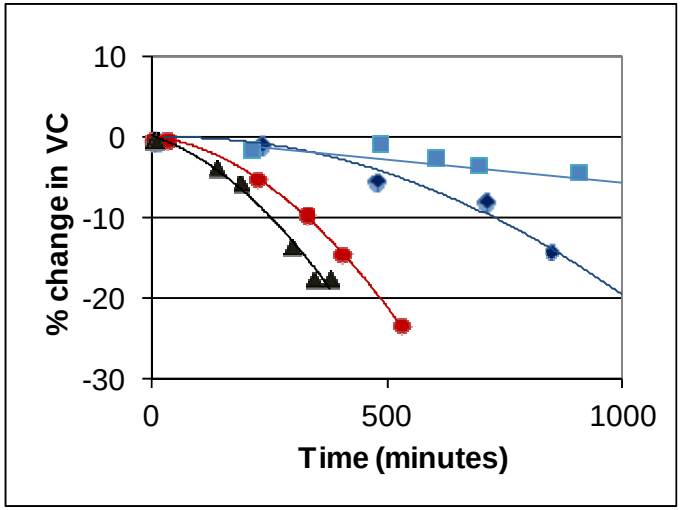
On the average, the onset of pulmonary injury is a function of time and P_{O_2}, and recovery is a function of time and exposure duration.



Data from U Penn (Lambertsen's lab). Light blue squares: P_{O_2} = 1 atm (Eckenhoff et al. 1987). Dark blue diamonds: P_{O_2} = 1.5 atm; Red circles: P_{O_2} = 2 atm; Black triangles: P_{O_2} = 2.5 atm (Clark et al. 1999).

The functional relationships may change with P_{O_2}.

- Lung pathology in rats after lethal exposures differs with P_{O_2} (Demchenko et al. 2007)

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Protocol: Dry exposure to PO_2 = 2 atm using hoods

Dives	Number completed (23 May)
– Single 2-hr dives	n = 12
– Single 3-hr dives	n = 19
– Two 3-hr dives	
• surface interval (SI) = 3 hrs	n = 24
• SI = 6 hrs	n = 11
• SI = 15 to 18 hrs	n = 31 (19)
– Three 30-min dives, SI = 2 hrs	n = 23

Goal: n = 24 to 36 for each set

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Approach #1:

Compare incidences of symptoms and of decreased pulmonary function parameters to those after dives with P_{O_2} = 1.3 atm.

Use SIs to look at recovery in terms of residual oxygen time (ROT) at P_{O_2} = 1.3 atm.

e.g., if ROT = A hrs after a 3-hr dive at 2 atm, and

ROT = A+B after two 3-hr dives with a 6-hr SI,

then that 6-hr SI reduced ROT to B hrs.

Approach #2: More in-depth modeling with the full data set.

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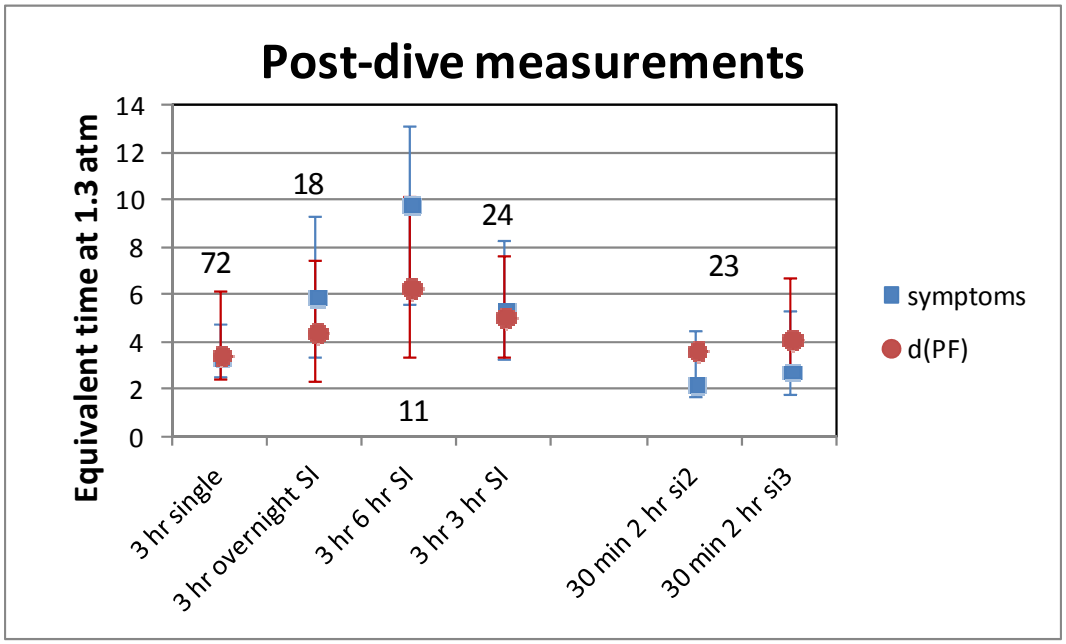
PRELIMINARY RESULTS – MAY CHANGE !!



Numbers above data indicate the number of measurements.
Error bars show binomial 95% confidence limits.

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- Still to do:
  - Increase n for the 6-hour SI and for other selected sets.
  - Add data, currently collected but not reduced, for an additional 12 subjects for the overnight SI.
  - Deal with delayed signs and symptoms, not just those within a few hours of surfacing.
  - Use more sophisticated modeling approaches.