



UW SHEEP DISSUB TRIALS: OXYGEN PRE-BREATHE BEFORE DROP-OUT DECOMPRESSION OFFERS A POTENTIAL SURVIVAL BENEFIT



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Introduction:

In submarine rescue, disabled submarine (DISSUB) personnel may experience prolonged increased ambient pressure and abrupt emergency decompression when exiting to the surface. Scientific, recreational and operational scuba divers experiencing a saturation hyperbaric exposure and emergency decompression face similar decompression risks. We used the UW sheep model to test human "drop-out" risk of a 24-h exposure at 60 fsw (2.79 atm abs) and abrupt decompression. Would even a brief O₂ pre-breathe before drop-out decompression increase survival and reduce decompression sickness (DCS) risk in emergency decompression?

Materials and Methods:

We investigated the efficacy of O₂ pre-breathes (15-min to 180-min) for minimizing decompression risk in adult sheep. Decompression findings were analyzed by logistic regression. All 27 ewes (85-127 kg \pm 10.85 SD) underwent air exposure at 60 fsw for 24-h and 23 inspired an O₂ (88-92%) pre-breathe (15 min, 1-h, 2-h, or 3-h) before drop-out decompression (30 fsw/min) to surface pressure. The longer 3-h O₂ pre-breathes also included a 1-h air break before drop-out decompression. Approximately 5-6 weeks after drop-out decompression, bone scans of the radii and tibiae were performed. Sheep underwent necropsy to observe gross pathology.

Results:

Twenty-one out of 27 sheep survived drop-out decompression; all 4 sheep breathing only air died of fulminant chokes, a respiratory DCS (RDCS), with pulmonary edema. Surviving sheep with O₂ pre-breathes all showed frank limb bends and most developed dysbaric osteonecrosis (DON); two showed CNS-DCS. Gross pathology confirmed bone scan DON lesions. Logistic regression showed a significant relationship between survival and O₂ pre-breathe duration ($p = 0.045$) concomitant with decreasing RDCS severity. The odds of survival were 25 times higher for each hour increase in O₂ pre-breathes.

Discussion and Conclusion:

This study suggests that O₂ pre-breathes can greatly reduce DCS morbidity/mortality risk in provocatively decompressed submariners and divers. These findings also suggest that a 15-min pre-breathe may offer survival benefits for submariners faced with DISSUB evacuation.

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Figure 1. Oxygen delivery system for the UW sheep model in the high pressure Biotron chamber used in DISSUB trials.

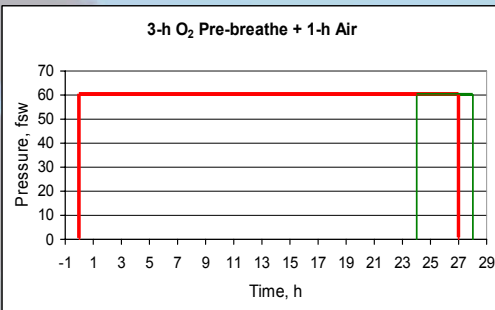


Figure 2. Oxygen pre-breathe trial with 24-h at 60 fsw exposures.

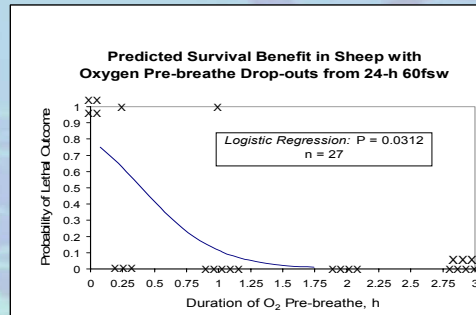


Figure 3. Survival benefit in UW sheep with O₂ pre-breathe before drop-out decompression (2-min) from a 24-h 60 fsw hyperbaric exposure. Data were fit by logistic regression.