

UW SHEEP DISSUB RESCUE PROFILE: ACCELERATED DECOMPRESSION FOLLOWING SATURATION AT 3.7 ATA USING OXYGEN PRE-BREATHING

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Introduction:

Disabled submarine (DISSUB) rescue may require aggressive decompression schedules. Previous work in our laboratory demonstrated that oxygen pre-breathe at depth effectively and significantly reduce decompression time from 60 fsw (2.8 ATA). This portion of an ongoing study series explored a decompression profile using oxygen pre-breathe at 60 fsw following saturation at 90 fsw (3.7ATA). Would 3 hours O₂ pre-breathe before drop-out decompression increase survival and reduce decompression sickness (DCS) risk in emergency decompression?

Materials and Methods:

Ten adult female sheep (88.9 ± 8.3 SD kg) were saturated at 90 fsw in a dry-air chamber for 24 hours to simulate a DISSUB scenario. Following saturation, animals were brought to 60 fsw at 5 feet per minute (fpm). Upon reaching 60 fsw, the animals began a 3-hour oxygen pre-breathe (88-92% oxygen). After the 3-hour oxygen pre-breathe, the animals were surfaced at 30 fpm (0.9 atm/min) while continuing to breathe oxygen. Upon surfacing the animals were switched back to ambient air, and observed for 4 hours for signs of DCS or oxygen toxicity. One month after decompression, bone scans of the radii and tibiae were acquired. Alizarin complexone fluorochrome was injected IV to visualize any dysbaric osteonecrosis (DON). The sheep were then necropsied to further define the severity of DON.

Results:

All sheep (100%) survived the accelerated decompression. Seven sheep (70%) out of ten sheep survived without signs of serious DCS or severe oxygen toxicity. However, all 7 animals showed frank signs of limb bends within 2 hours of surfacing. Two sheep (20%) developed respiratory DCS with labored breathing and frothy sputum after surfacing. Both were treated with lasix and butorphanol. One sheep (10%) exhibited pain and neurological dysfunction (CNS-DCS) with decompression and was treated with butorphanol and dexamethasone. All sheep were ambulatory at 4 hours and none required early euthanasia for intractable symptoms. Six weeks after decompression, gross pathology confirmed DON lesions visualized in bone scans.

Figure 4. Results of decompression from 90 fsw.

| Decompression from a 90 fsw 24-hr Hyperbaric Air Exposure | | | | | | | | | |
|---|---------|-------------|------------------------------------|-----------------------|-------------------|--------------|---------|--------------------|----------|
| Decompr | Sheep # | Weight (kg) | Doppler bubble scores ¹ | Limb DCS ² | RDCS ³ | Rx Treatment | CNS DCS | Outcome | |
| 5 fsw to 60 fsw and pre-breathe | 228 | 78 | 3 | 3 | 3+ | Mild | No | | survival |
| | 229 | 99 | 4 | 4+ | 4 | N/A | Severe | Lasix, butorphanol | No |
| | 230 | 106 | 2 | 4+ | 3 | Mild | No | Lasix, butorphanol | No |
| | 231 | 84 | 3+ | 4 | 3+ | Mild | No | | survival |
| | 234 | 83 | 2+ | 3 | 2 | Moderate | No | | No |
| | 235 | 82 | 2 | 3+ | 3 | Severe | No | | survival |
| | 236 | 88 | 2 | 3+ | 4+ | Severe | No | | survival |
| | 237 | 82 | 2 | 3 | 3 | Moderate | No | | survival |
| | 238 | 99 | 2 | 3+ | 3 | N/A | Mild | Lasix, butorphanol | No |
| | 239 | 94 | 2 | 4 | 4 | N/A | Severe | Lasix, butorphanol | Yes |

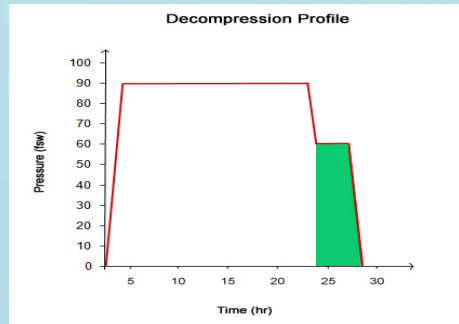


Figure 2. Oxygen pre-breathe trial with 24-h at 90 fsw exposures.

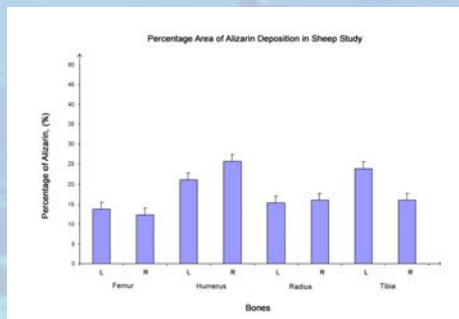


Figure 3. Calculated (using NIH Scion Image Software) Percentage Area of Alizarin Deposition in Sheep Long Bones.

Discussion and Conclusion:

Our data suggests that oxygen pre-breathing may reduce the DCS morbidity/mortality risk during an accelerated decompression profile following a simulated saturation dive. Therefore, oxygen pre-breathing may be a viable option in DISSUB rescue scenarios.

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