COMPARING AIR AND OXYGEN PRE-BREATHE DECOMPRESSION SCHEDULES FOLLOWING SATURATION AT 5 ATA

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Background:

Submarine disaster survivors can be transferred from a disabled submarine (DISSUB) at a pressure of 5 ATA to a rescue vehicle. However, they face risky surface decompression sickness (DCS) without recompression and an extended decompression. Previously we demonstrated that oxygen pre-breathe at depth can reduce decompression time from 2.8 ATA and 3.7 ATA. We now present data using oxygen pre-breathe from 5 ATA.

Materials and Methods:

Sixteen adult female sheep were exposed to 5 ATA dry-air for 24 hours to simulate a DISSUB scenario. Following saturation, 8 sheep (86.4 ± 16.6 SD kg) underwent a 16-24 hours staged decompression on air (Schedule 1). Another 8 sheep (86.1 ± 7.3 SD kg) were decompressed while breathing oxygen (Schedule 2): 1 hour of 50% O_2 pre-breathe at 5 ATA; 1 hour of 50% O_2 at 3.7ATA; 1 hour of 85% O_2 oxygen at 2.8, 2.5, and 2.2 ATA, and then dropout. Upon surfacing the animals breathed ambient air and were observed for 24-hours followed by necropsy. .

Results:

All sheep from Schedule 1 survived to surfacing. Three sheep showed Type I DCS (limb bends) within 2 hours of surfacing. Four sheep developed Type II DCS with labored breathing and frothy sputum after surfacing. One sheep exhibited pain and neurological dysfunction and was euthanized 2 hours after surfacing. All other sheep were ambulatory at 24-hours. Only two sheep survived decompression on Schedule 2, both had Type II DCS, and required euthanasia. Six sheep showed signs of seizures at pressures of 2.5 and 2.8 ATA, and were euthanized.

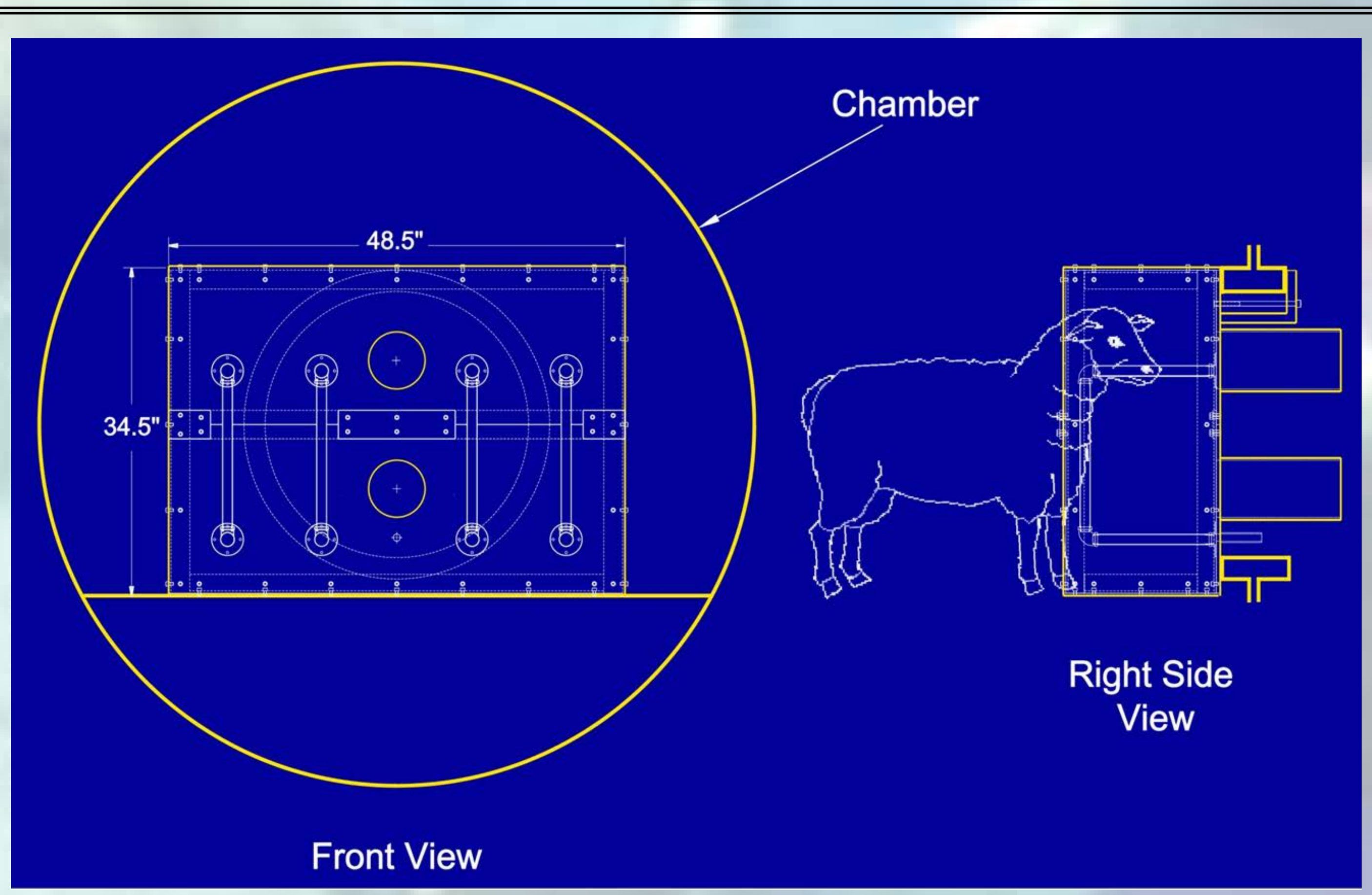

Figure 1. UW O_2 delivery system used to evaluate emergency decompression to surface pressure.

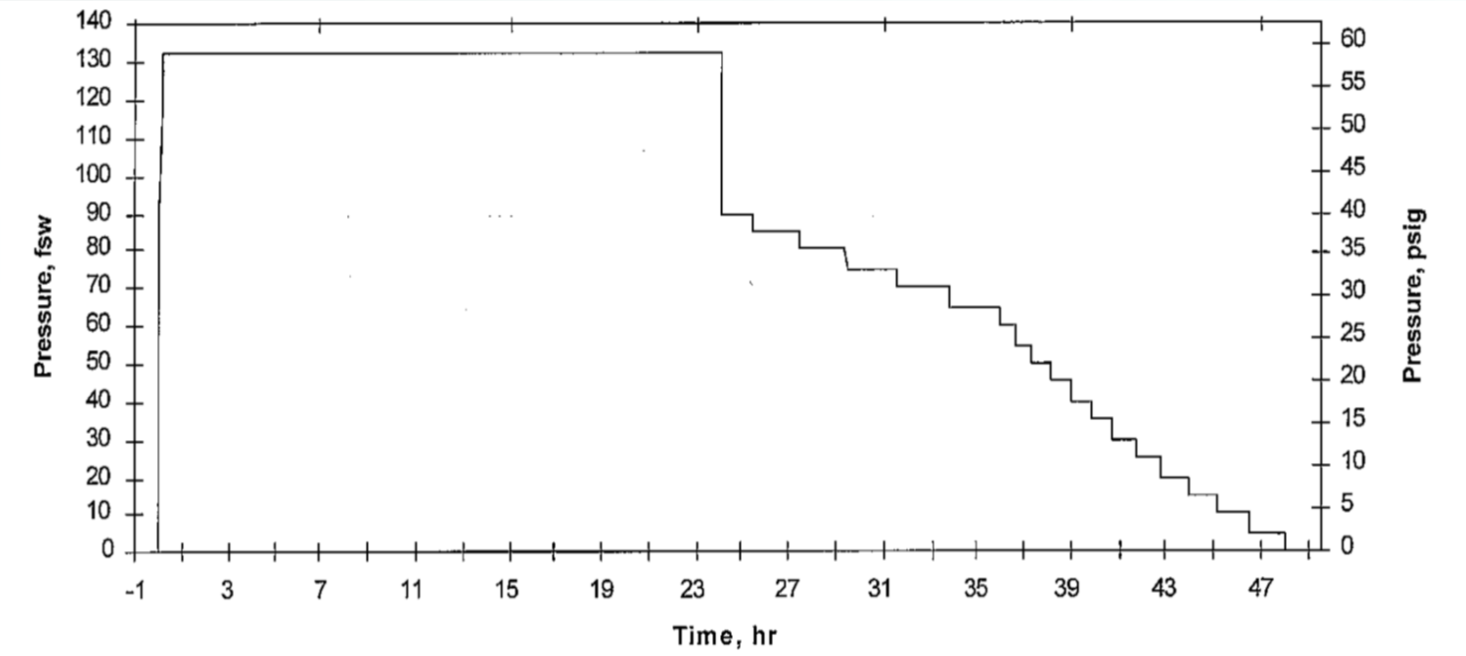

Figure 2. Schedule 1: 16-24 hours staged decompression on air.

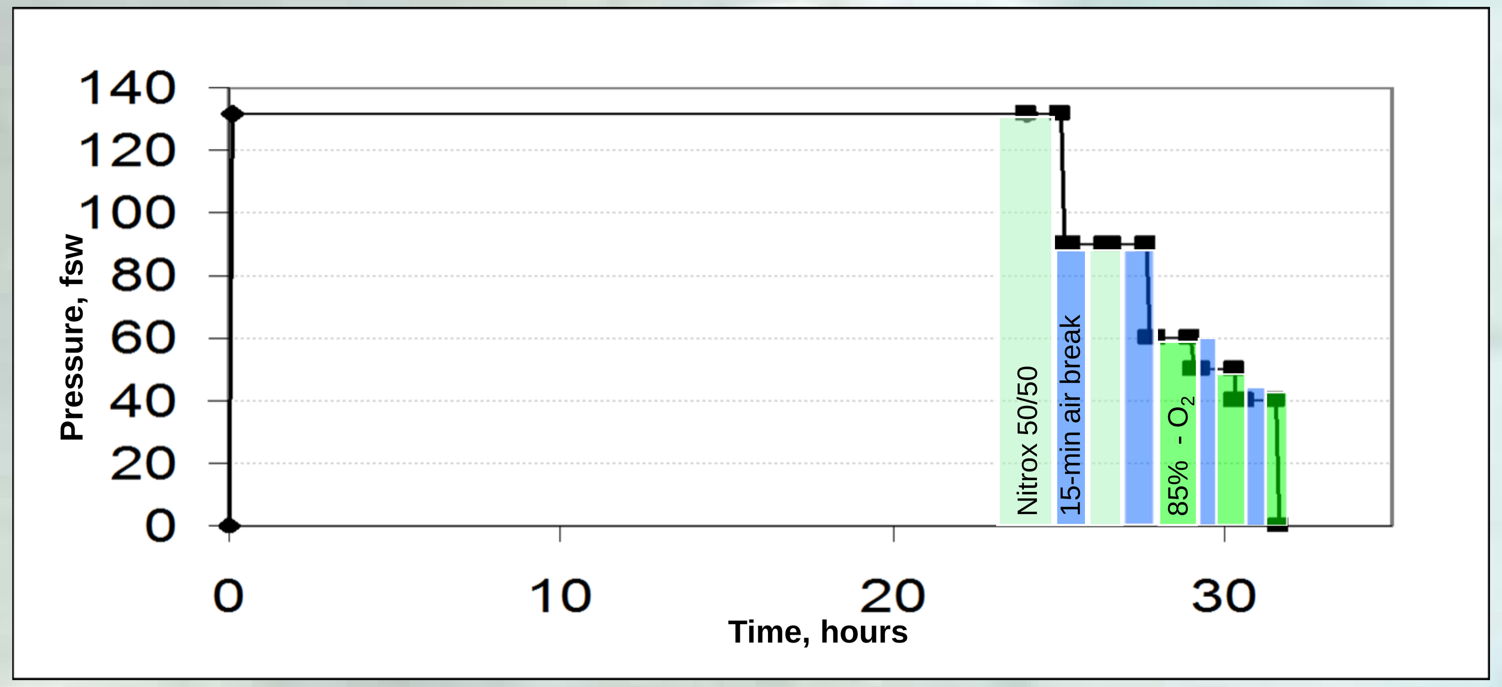

Figure 3. Schedule 2: 5-hours decompression on Nitrox 50/50 and oxygen.

	Schedule 1 On air 16 – 24 h	Schedule 2 Nitrox 50/50 and O_2
Weight (kg), mean ± SD	86.4 ± 16.6	86.1 ± 7.3
During 4-h observation period		
Death, N (%)	1 (12.5)	6 (75)
Type II DCS, N (%)	5 (62.5)	8 (100)
• Cardiopulmonary	4 (50)	8 (100)
• Neurologic	1 (12.5)	2 (25)
Type I DCS, N (%)	3 (37.5)	-
• Limb Lifting	3 (37.5)	-
• Pain	4 (50)	-
During 24-h observation period		
Death, N (%)	0	2 (25)
Type II DCS, N (%)	1 (12.5)	2 (25)
• Cardiopulmonary	1 (12.5)	2 (25)
• Neurologic	0	0
Type I DCS, N (%)	4 (50)	-
• Limb Lifting	4 (50)	-
• Pain	1 (12.5)	-

Figure 4. Outcome of decompression schedule

Discussion and Conclusions:

We have previously shown protective effects of O_2 pre-breathing at 2.8 ATA and 3.7 ATA. However, O_2 pre-breathing at 5 ATA caused increased mortality, likely due to neurologic and respiratory oxygen toxicity. Clearly, more studies are needed to better define safe O_2 pre-breathing decompression schedules following saturation conditions at extreme depths.

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Selected References:

- Dunford RG, Mejia EB, Salbador GW, Gerth WA, Hampson NB: Diving methods and decompression sickness incidence of Miskito Indian underwater harvesters. Undersea & Hyperbaric Medicine 29 (2): 74-85, 2002.
- Ertracht O, Arieli R, Arieli Y, Ron R, Erlichman Z, Adir Y.: Optimal oxygen pressure and time for reduced bubble formation in the N2-saturated decompressed prawn. J Appl Physiol. 98(4):1309-13; 2005
- Sobakin AS, Wilson MA, Lehner CE, Dueland RT, Gendron-Fitzpatrick AP: Oxygen pre-breathing decreases dysbaric diseases in UW sheep undergoing hyperbaric exposure. Undersea & Hyperbaric Medicine 35 (1): 61-67, 2008.
- Peterson K, Soutiere SE, Tucker KE, Dainer HM, Mahon RT "Oxygen prebreathing accelerates decompression from saturation at 40 msw in 70-kg swine." Aviation, Space, and Environmental Medicine, Vol. 81, No.7,639-645, 2010.