

# THE EFFECT OF DIVING ENVIRONMENT ON DECOMPRESSION SICKNESS (DCS)

Based on 137,451 air or nitrox recreational dives

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# Background

- ❖ Predictability of dive outcome based on depth-time profile alone has a wide range of uncertainty.
- ❖ Risk factors affecting dive outcome may be related to environmental conditions and demographics of divers.
- ❖ The purpose of this study was to investigate effects of these factors on DCS incidences in various environments and groups of divers.

# Methods

- ❖ Volunteer divers provided dive computer-recorded depth-time profiles and dive, demographic, and DCS outcome data.
- ❖ DCS was defined operationally as manifestations consistent with the Perceived Severity Index (Ozyigit. ASEM 81:3-7, 2009) within 48 hrs of diving and resolution with recompression.
- ❖ Variables were assessed by t-test or multiple logistic regression.

# Results

## ❖ Data

- Collection period 1995-2008
- 10,722 divers (71.3% male)
- 18,970 dive series
- 137,451 dives (air or nitrox)
- 41 DCS cases

❖ Diving experience, age, gender, and body mass index were not associated with DCS.

# DCS Incidence & Diving Environment

- Caribbean Live-aboards: 0.006%
  - 37.8% of total; mean max depth  $67.0 \pm 25.8$  fsw
  - Live-aboard, multi-day, repetitive diving
  
- North Sea: 0.152%
  - - 13.4% of total; mean max depth  $86.6 \pm 30.2$  fsw
  - - Primarily wreck, decompression dives
  
- Other Conditions: 0.015%
  - included shore & small boat dives in waters of unknown location or conditions. Other Conditions approached but did not achieve significance.

# DCS Incidence & Breathing Gas

## ➤ Air: 0.031%

- 75.7% of total; mean max depth  $65 \pm 30.3$  fsw; mean time  $43.6 \pm 16.5$  min

## ➤ Nitrox: 0.027%

- 24.3% of total; mean max depth  $76 \pm 28.7$  fsw; mean time  $46.3 \pm 17.3$  min
- Nitrox dives were deeper than air dives ( $p < 0.000$ ) and longer ( $p < 0.000$ ), but the difference of 2.7 min may not be of practical importance.
- We did not correct for depth nor equivalent air depth. Assuming a minimal 32%  $O_2$  concentration, an equivalent air depth for the nitrox mean max depth is 4 fsw shallower (at 60.8 fsw) than the mean max air depth and likely to be of less DCS incidence.

# DCS Incidence & Repetitive Diving

➤ 1<sup>st</sup> Dive of Day: 0.031%

- (57.2% of total; mean max depth  $78 \pm 32.8$  fsw).

➤ Repetitive dives: 0.038%

- (42.8% of total; mean max depth  $59 \pm 25.1$  fsw).

Mean max depth of first dive of the day was deeper than the mean max depth of repetitive dives ( $p < 0.000$ ).

# DCS Incidence & Maximum Depth of Dive

Maximum Depth Range (fsw)	% of Total Dives	DCS Incidence (%)
0 - 29	11	0.007
30 - 59	33	0.024
60 - 89	31	0.038
90 - 119	20	0.058
120 - 149	4	0.072



# Logistic regression comparisons

Variable	Odds Ratio	P Value	95% CI
North Sea <sup>1</sup>	28.0	0.000	8.4 – 94.0
Other Conditions <sup>1</sup>	3.14	0.083	0.9 – 11.4
Max depth <sup>2</sup>	1.2	0.006	1.0 – 1.3
Dive of Day (1 <sup>st</sup> vs. Repet)	2.25	0.028	1.1 – 4.7
Nitrox <sup>3</sup>	0.45	0.027	0.2 – 0.9

<sup>1</sup>Compared to Caribbean live-aboards.

<sup>2</sup>Per 10 fsw interval.

<sup>3</sup>Compared to air.

# Discussion

- ❖ Dive conditions associated with North Sea dives, primarily wreck dives, had higher DCS incidences compared to Caribbean Live-aboard dives when controlled for dive depth, number of repetitive dives and breathing gas.
- ❖ Nitrox was associated with lower overall DCS incidence.
- ❖ The DCS incidence increased with depth.
- ❖ Increased DCS risk with increasing depth of dive and number of repetitive dives may indicate that current recreational diving procedures do not provide equal protection across the depth range and number of repetitive exposures.