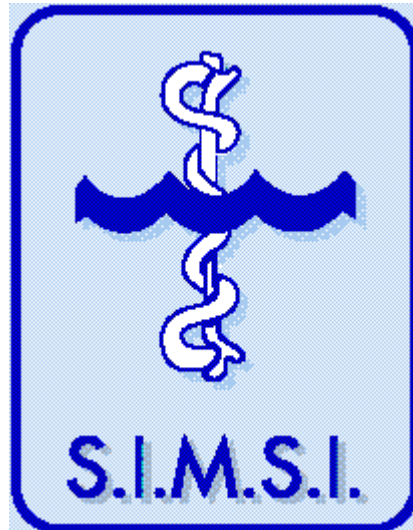
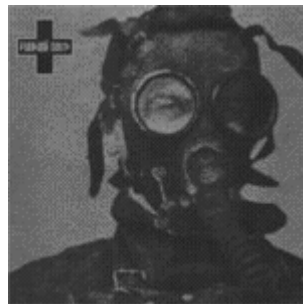


**SOCIETA' ITALIANA  
DI  
MEDICINA SUBACQUEA E IPERBARICA**



**RICERCA IN MEDLINE DEI LAVORI DI  
MEDICINA SUBACQUEA  
INDICIZZATI CON PAROLA CHIAVE**



**2007  
PRIMO SEMESTRE**

a cura del  
**Dott. Francesco Ruocco**  
Servizio di Medicina Iperbarica e Subacquea  
Anestesia e Rianimazione del Dipartimento di Emergenza  
della Azienda Ospedaliera Universitaria di Careggi

Search "Diving"[MAJR] Limits: Publication Date from 2007/01 to 2007/06

**Search "Diving"[MAJR] Limits:  
Publication Date from 2007/01 to  
2007/06**

1: Int Marit Health. 2007;58(1-4):213-5.  
33rd Annual scientific meeting of the EUBS. 8-15 September 2007 Sharm El Sheik, Egypt.  
[No authors listed]  
Publication Types: Congresses  
PMID: 18396575

2: Int Marit Health. 2007;58(1-4):149-56.  
New Polish occupational health and safety regulations for underwater works.  
Kot J, Sićko Z.  
National Centre for Hyperbaric Medicine, Institute of Maritime and Tropical Medicine in Gdynia, Medical University of Gdańsk, Powstania Styczniowego 9 B, 81-519 Gdynia, Poland. jkot@amg.gda.pl  
In Poland, the new regulation of the Ministry of Health on Occupational Health for Underwater Works (dated 2007) pursuant to the Act on Underwater Works (dated 2003) has just been published. It is dedicated for commercial, non-military purposes. It defines health requirements for commercial divers and candidates for divers, medical assessment guide with a list of specific medical tests done on initial and periodical medical examination in order for a diver or a candidate for diver to be recognised fit for work, health surveillance during diving operations, compression and decompression procedures, list of content for medical equipment to be present at any diving place, formal qualifications for physicians conducting medical assessment of divers, requirements for certifications confirming the medical status of divers and candidates for divers. Decompression tables cover divers up to 120 meters of depth using compressed air, oxygen, nitrox and heliox as breathing mixtures. There are also decompression tables for repetitive

diving, altitude diving and diving in the high-density waters (mud diving). In this paper, general description of health requirements for divers, as well as decompression tables that are included in the new Regulation on Occupational Health for Underwater Works are presented.  
PMID: 18350984

3: Int Marit Health. 2007;58(1-4):139-48.  
Divers' deaths in Split-Dalmatian County, Croatia (cases study, 1994-2004).  
Definis-Gojanović M, Bresković T, Sutlović D, Petri N.  
Department of Forensic Medicine, Split University Hospital and School of Medicine, Croatia.  
The circumstances which lead to divers' death in Split-Dalmatian County in eleven-year period (1994-2004) were analyzed. The data were extracted from the files of autopsy reports of the Department of Forensic Medicine, Split University Hospital and School of Medicine, and the police reports of the Ministry of Internal Affairs, Split-Dalmatian County. A total of 31 cases were found during the study period. The number of diving deaths didn't vary significantly through the years 1994-1999 but it increased after year 2000, mostly as a result of domestic and foreign tourists who practiced diving during their summer vacation. The average age of victims was 37.65 years. Of the 31 cases, 13 (41.9%) were apnoea (skin) divers and rest of them (18; 58.1%) were scuba divers. The leading activity of the apnoea divers was underwater fishing, while the majority of scuba divers were in recreational diving. The major cause of death was drowning. The circumstances which had led to the death remained unknown in most cases, mainly due to inexistence of proper criminal investigation.  
PMID: 18350983

4: Neuropsychiatr. 2007;21(3):226-9.  
[Scuba diving -- a therapeutic option for patients with paraplegia] [Article in German]  
Haydn T, Brenneis C, Schmutzhard J, Gerstenbrand F, Saltuan L, Schmutzhard E.

**OBJECTIVE:** Spasticity is often a handicap in paraplegics and interferes with quality of life. Medical therapeutic options (e.g. baclofen, tizanidin) lead to drowsiness, fatigue and loss in activity. On the other hand paraplegics are increasingly active in daily life and leisure (paralympics). Neurorehabilitation is effective in reduction of spasticity, gaining motor function and enhancing quality of life. Hippotherapy (Lechner et al 2003) and aquatic rehabilitation are additive methods. Already 15 years ago Madorsky et al pointed out SCUBA diving as a positive neurorehabilitation procedure. The study group around Stanghelle reported also beneficial aspects on spasticity of patients with spinal cord injuries. These references inspired to introduce a prospective study. **METHODS:** After obtaining an ethic votum and evaluation assessment for diving permission 6 volunteers with paraplegia entered the pilot study. Medication was kept stable throughout the study time. Supervised by diving instructors and a diving trained doctor the volunteers dived to a platform in the depth of 7.2 meters. The daily diving time was exactly 30 minutes. Stabilized on the platform physiotherapeutic assessment took place in different positions to reduce spasticity. Ashworth Scale and spasm frequency scale were noted daily and at beginning and end of the study the WHO Quality of life Test had to be completed. For objective reasons a locomat training happened before, within a week after and 4 weeks after the study week. **RESULTS:** All patients did the daily dives without any difficulties. The statistics included the assessment of day 1 versus day 7 of 5 patients and showed a significant reduction of Modified Ashwoth Scale ( $p=0.04$ ). Quality of life showed an improvement. **CONCLUSION:** The improvement rationale can only be supposed. A correlation to the ambient pressure suggests itself. Therefore deeper depths should increase the good spasticity results or manage to achieve those faster. Many questions remain, so further studies are necessary to ascertain the ideal standard options.

Publication Types: English  
Abstract  
PMID: 17915183

5: Undersea Hyperb Med. 2007 May-Jun;34(3):211-20.

Influence of bottom time on preflight surface intervals before flying after diving.

Vann RD, Pollock NW, Freiburger JJ, Natoli MJ, Denoble PJ, Pieper CF. Center for Hyperbaric Medicine and Environmental Physiology, Duke University Medical Center, Durham, NC 2 7710, USA.

Previous trials of flying at 8,000 ft after a single 60 fsw, 55 min no-stop air dive found low decompression sickness (DCS) risk for a 11:00 preflight surface interval (PFSI). Repetitive 60 fsw no-stop dives with 75 and 95 min total bottom times found 16:00. Trials reported here investigated PFSIs for a 60 fsw, 40 min no-stop dive and a 60 fsw, 120 min decompression dive. The 40 min trials began with a 12:05 PFSI (USN guideline) which was incrementally reduced to 0:05 (three DCS incidents in 281 trials). The 120 min trials began with a 22:46 PFSI (USN guideline) which was reduced to 2:00 (nine incidents in 281 trials); 2:00 was rejected with six incidents. Low-risk PFSIs for the 40 min dive were nearly 12 hours shorter than for the 55 min dive, and low-risk PFSIs for the single 120 min decompression dive were 12 hours shorter than for the 75-95 min repetitive dives. With the dry, resting conditions of these dives, low-risk PFSIs appeared to be sensitive to dive profile characteristics such as bottom time, repetitive diving, and decompression stops. Whether this is so for wet, working dives is unknown.

Publication Types: Case Reports  
Evaluation Studies  
PMID: 17672177

6: Undersea Hyperb Med. 2007 May-Jun;34(3):199-210.

Comment in: Undersea Hyperb Med. 2007 Sep-Oct;34(5):311-2; author reply 313-4. Undersea Hyperb Med. 2007 Sep-Oct;34(5):312-3; author reply 313-4.

The SANDHOG criteria and its validation for the diagnosis of DCS arising from bounce diving.

Grover I, Reed W, Neuman T.  
Hyperbaric Medicine Department, UCSD  
Medical Center, San Diego, CA 92103,  
USA.

**PURPOSE:** A three-point scale, the SANDHOG (SAN Diego Diving and Hyperbaric Organizations) criteria, was developed to diagnose DCS (decompression sickness), and then it was validated against a known database of diving related injuries. **INTRODUCTION:** There are currently no universally accepted diagnostic criteria for the diagnosis of DCS. The SANDHOG criteria were developed to address the need for a case definition of DCS. **METHODS:** A point scale and entrance criteria were developed for the diagnosis of DCS. Once the entrance criterion had been met, points were awarded based upon the diver's symptoms and their time of onset. The point system and time limits (SANDHOG criteria) were determined based upon US Navy and Royal Canadian diving reports. The SANDHOG criteria were then applied on a post hoc basis to the Duke Hyperbaric database of diving injuries. Sensitivity and specificity were then calculated using three points as the cut off. The ROC (receiver operating characteristic) analysis was performed to determine the area under the curve (AUC). **RESULTS:** The three point SANDHOG criteria had a specificity of 90.3% and a sensitivity of 52.7%. ROC analysis of the original SANDHOG criteria gave an AUC of 0.72. Using different point values for the diagnosis of DCS will subsequently affect the sensitivity and specificity of the SANDHOG criteria. **CONCLUSIONS:** The specificity of the SANDHOG criteria is good, and demonstrates that the SANDHOG criteria are a useful tool for the diagnosis of DCS.

**Publication Types:** Practice  
Guideline Validation Studies  
PMID: 17672176

7: Undersea Hyperb Med. 2007 May-Jun;34(3):191-7.

Complement levels before and after dives with a high risk of DCS.  
Nyquist P, Ball R, Sheridan MJ.  
Department of Neurology and  
Anesthesia/Critical Care,  
Cerebrovascular Division, Johns  
Hopkins School of Medicine, Rm 125

Phipps, 600 North Wolfe Street,  
Baltimore, Maryland 21287-6953, USA.

**BACKGROUND:** Previously, complement activation has been associated with decompression sickness (DCS). However data, both in humans and in animals, are controversial. **Hypothesis:** Complement activation and depletion occurs after exposure to the hyperbaric environment and is associated with increasing risk of DCS. **METHODS:** We obtained serological samples from 102 dives (120-300 feet of seawater) with a constant partial pressure of O<sub>2</sub> set at 1.3 ATA in thirty-five U.S. Navy diver volunteers. Blood was obtained within one hour of diving and within one hour of surfacing. Plasma was extracted and analyzed for complement depletion. The risk of DCS was estimated using a validated model of DCS risk. **RESULTS:** Pre-post dive concentrations of C3a were significantly related to estimated risk of DCS (Figure 1), but the variation in predicted DCS explained by C3a was small (correlation coefficient ( $r^2 = 0.19$ ,  $p < 0.0001$ )). **CONCLUSIONS:** There was a reduction in total Ca<sub>3</sub> levels in divers after exposure to dives with a high estimated risk of DCS. This decompensation appeared to increase as the estimated risk of DCS increased.

**Publication Types:** Research  
Support, U.S. Gov't, Non-P.H.S.  
PMID: 17672175

8: Undersea Hyperb Med. 2007 May-Jun;34(3):169-80.

Comment in: Undersea Hyperb Med. 2007 May-Jun;34(3):145-6.  
Resistive respiratory muscle training improves and maintains endurance swimming performance in divers.

Lindholm P, Wylegala J, Pendergast DR, Lundgren CE.

Center for Research and Education in Special Environments, University at Buffalo, Buffalo, NY 14214, USA.

Respiratory work is increased during exercise under water and may lead to respiratory muscle fatigue, which in turn can compromise swimming endurance. Previous studies have shown that respiratory muscle training, conducted five days per week for four weeks, improved both respiratory and fin swimming endurance. This training (RRMT-5)

consisted of intermittent vital capacity breaths (twice/minute) against spring loaded breathing valves imposing static and resistive loads generating average inspiratory pressures of approximately 40 cmH<sub>2</sub>O and expiratory pressures of approximately 47 cmH<sub>2</sub>O. The purpose of the present study (n = 20) was to determine if RRMT 3 days per week (RRMT-3) would give similar improvements, and if continuing RRMT 2 days per week (RRMT-M) would maintain the benefits of RRMT-3 in fit SCUBA divers. Pulmonary function, maximal inspiratory (P(insp)) and expiratory pressures (P(exp)), respiratory endurance (RET), and surface and underwater (4 fsw) fin swimming endurance were determined prior to and after RRMT, and monthly for 3 months. Pulmonary function did not significantly improve after either RRMT-3 or RRMT-5; while P(insp) (20 and 15%) and P(exp) (25 and 11%), RET (73 and 217%), surface (50 and 33%) and underwater (88 and 66%) swim times improved. VO<sub>2</sub>, VE and breathing frequency decreased during the underwater endurance swims after both RRMT-3 and RRMT-5. During RRMT-M P(insp) and P(exp) and RET and swimming times were maintained at post RRMT-3 levels. RRMT 3 or 5 days per week can be recommended to divers to improve both respiratory and fin swimming endurance, effects which can be maintained with RRMT twice weekly.

Publication Types: Randomized Controlled Trial  
PMID: 17672173

9: Undersea Hyperb Med. 2007 May-Jun;34(3):145-6.

Comment on: Undersea Hyperb Med. 2007 May-Jun;34(3):169-80.  
Resistive respiratory muscle training.

Bosco G, Zanon V, Camporesi EM.  
Publication Types: Comment Editorial

PMID: 17672170

10: Undersea Hyperb Med. 2007 May-Jun;34(3):143; author reply 144.

Comment on: Undersea Hyperb Med. 2005 Jan-Feb;32(1):11-20.

Neurological manifestations in Japanese Ama divers.  
James PB.

Publication Types: Comment Letter  
PMID: 17672169

11: Eur J Appl Physiol. 2007 Aug;100(6):637-44. Epub 2007 Feb 16.  
Cardiac and ventilatory responses to apneic exercise.

Wein J, Andersson JP, Erdéus J.  
Department of Ecology, Biocentre Grindel, Hamburg University, Martin-Luther-King Platz 3, Hamburg, Germany. jens.wein@uni-hamburg.de

This study was to elucidate the physiological effects of dynamic apneas, as performed as a discipline in breath-hold diving for recreational or competitive purposes. Therefore, cardiovascular and respiratory effects of apneas with simultaneously initiated exercise were investigated in ten trained breath-hold divers. They performed maximum duration apneas with face immersion (26 degrees C) under rest and exercise (40 W, 80 W and 120 W) on a cycle ergometer in the laboratory. Apneic time, heart rate (HR), mean arterial pressure (MAP), arterial oxygen saturation and O<sub>2</sub> (.VO<sub>2</sub>) and CO<sub>2</sub> exchange were measured. All end-apnea heart rates were lower than corresponding control values. Higher workloads increased the initial rise in HR and delayed the onset of bradycardia. After an initial drop, MAP rose to 150% of control towards the end of apnea. Apneic .VO<sub>2</sub> was reduced by 25% during exercise and by 40% during resting apneas compared to eupneic control values. It was concluded that magnitude and time course of diving bradycardia depend on work intensity. Higher workloads delay the onset and attenuate HR reduction, presumably due to increased sympathetic activity. It was also found that apnea with simultaneously initiated exercise has an O<sub>2</sub> conserving effect compared to eupneic exercise. Although aimed to be a realistic approach to breath-hold diving, the study has certain methodological limitations in terms of body-immersion (hydrostatic pressure effects) and body-cooling effects due to conduction of the experiments in a laboratory set-up.

PMID: 17661074

12: Ambio. 2007 Jun;36(4):316-22.

Erratum in: Ambio. 2007  
Nov;36(7):527.

Managing scuba divers to meet  
ecological goals for coral reef  
conservation.

Sorice MG, Oh CO, Ditton RB.  
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Sciences at Texas A&M University,  
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Marine protected areas increasingly  
are challenged to maintain or  
increase tourism benefits while  
adequately protecting resources.  
Although carrying capacity  
strategies can be used to cope with  
use-related impacts, there is little  
understanding of divers themselves,  
their management preferences, and  
how preferences relate to  
conservation goals. By using a  
stated preference choice modeling  
approach, we investigated the  
choices divers make in selecting  
diving trips to marine protected  
areas as defined by use level,  
access, level of supervision, fees,  
conservation education, and diving  
expectations. Logit models showed  
that divers preferred a more  
restrictive management scenario over  
the status quo. Divers favored  
reductions in the level of site use  
and increased levels of conservation  
education. Divers did not favor fees  
to access protected areas, having  
less access to the resource, or  
extensive supervision. Finally,  
divers were much more willing to  
accept increasingly restrictive  
management scenarios when they could  
expect to see increased marine life.

Publication Types: Research  
Support, Non-U.S. Gov't Research  
Support, U.S. Gov't, Non-P.H.S.  
PMID: 17626469

13: Comp Biochem Physiol A Mol  
Integr Physiol. 2007 Oct;148(2):360-  
7. Epub 2007 May 21.

Allometric scaling of lung volume  
and its consequences for marine  
turtle diving performance.

Hochscheid S, McMahon CR, Bradshaw  
CJ, Maffucci F, Bentivegna F, Hays  
GC.

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Marine turtle lungs have multiple  
functions including respiration,  
oxygen storage and buoyancy  
regulation, so lung size is an

important indicator of dive  
performance. We determined maximum  
lung volumes (V(L)) for 30  
individuals from three species  
(*Caretta caretta* n=13; *Eretmochelys*  
*imbricata* n=12; *Natator depressus*  
n=5) across a range of body masses  
(M(b)): 0.9 to 46 kg. V(L) was 114  
ml kg<sup>-1</sup> and increased with M(b)  
with a scaling factor of 0.92. Based  
on these values for V(L) we  
demonstrated that diving capacities  
(assessed via aerobic dive limits)  
of marine turtles were potentially  
over-estimated when the V(L)-body  
mass effect was not considered (by  
10 to 20% for 5 to 25 kg turtles and  
by >20% for turtles > or =25 kg).  
While aerobic dive limits scale with  
an exponent of 0.6, an analysis of  
average dive durations in free-  
ranging chelonian marine turtles  
revealed that dive duration  
increases with a mass exponent of  
0.51, although there was  
considerable scatter around the  
regression line. While this  
highlights the need to determine  
more parameters that affect the  
duration-body mass relationship, our  
results provide a reference point  
for calculating oxygen storage  
capacities and air volumes available  
for buoyancy control.

Publication Types: Research  
Support, Non-U.S. Gov't  
PMID: 17596981

14: J Comp Physiol B. 2007  
Oct;177(7):779-86. Epub 2007 Jun 23.  
Respiratory properties of blood in  
flatback turtles (*Natator*  
*depressus*).

Sperling JB, Grigg GC, Beard LA,  
Limpus CJ.

School of Integrative Biology, The  
University of Queensland, 4072,  
Brisbane, QLD, Australia.  
jsperling@sib.uq.edu.au

Oxygen equilibrium curves and other  
respiratory-related variables were  
determined on blood from the  
flatback turtle (*Natator depressus*)  
and, for comparison, on some samples  
from the loggerhead turtle (*Caretta*  
*caretta*). The oxygen carrying  
capacity of the flatback turtle,  
4.9-8.7 mmol l<sup>-1</sup> (n = 49), is at  
the high end of the range in diving  
reptiles. Oxygen affinity (P(50))  
was similar in both species at 5%  
CO<sub>2</sub>, ranging from 37 to 55 mmHg  
(43 mmHg +/- 5.3 SD, n = 24, 25

degrees C, pH 7.17) in flatbacks and 43-49 mmHg in loggerheads (46 mmHg +/- 2.0 SD, n = 7, 25 degrees C, pH 7.13), whereas at 2% CO(2), flatbacks had a higher oxygen affinity. The curves differed in sigmoidicity, with Hill n coefficients of 2.8 and 1.9 in flatbacks and loggerheads, respectively. The Bohr effect was small in both the species, consistent with results from other sea turtles. Lactate levels were high, perhaps because the samples were taken from turtles coming ashore to lay eggs. Flatbacks are rarely found in waters deeper than 45 m. It is suggested that they have a respiratory physiology particularly suited to sustain prolonged shallow dives.

Publication Types: Comparative Study  
Research Support, Non-U.S. Gov't  
PMID: 17588165

15: Voen Med Zh. 2007 Mar;328(3):49-52.

[The divers' drinking regimen and organism's individual resistance to decompression disease]

[Article in Russian]

Miasnikov AA, Keleshov VI, Chernov VI, Shitov AIu, Zverev DP.

PMID: 17580480

16: J Comp Physiol B. 2007 Aug;177(6):687-700. Epub 2007 Jun 19.

Size and distribution of oxygen stores in harp and hooded seals from birth to maturity.

Burns JM, Lestyk KC, Folkow LP, Hammill MO, Blix AS.

Department of Biological Sciences, University of Alaska Anchorage, Anchorage, AK 99508, USA. afjmb4@uaa.alaska.edu

Pinnipeds rely primarily on oxygen stores in blood and muscles to support aerobic diving; therefore rapid development of body oxygen stores (TBO(2)) is crucial for pups to transition from nursing to independent foraging. Here, we investigate TBO(2) development in 45 harp (*Pagophilus groenlandicus*) and 46 hooded (*Cystophora cristata*) seals ranging in age from neonates to adult females. We found that hooded seal adults have the largest TBO(2) stores yet reported (89.5 ml kg(-1)), while harp seal adults have

values more similar to other phocids (71.6 ml kg(-1)). In adults, large TBO(2) stores resulted from large blood volume (harp 169, hood 194 ml kg(-1)) and high muscle Mb content (harp 86.0, hood 94.8 mg g(-1)). In contrast, pups of both species had significantly lower mass-specific TBO(2) stores than adults, and stores declined rather than increased during the nursing period. This decline was due to a reduction in mass-specific blood volume and the absence of an increase in the low Mb levels (harp 21.0, hood 31.5 mg g(-1)). Comparisons with other phocid species suggests that the pattern of blood and muscle development in the pre- and post-natal periods varies with terrestrial period, and that muscle maturation rates may influence the length of the postweaning fast. However, final maturation of TBO(2) stores does not take place until after foraging begins.

Publication Types: Comparative Study  
Research Support, Non-U.S. Gov't  
Research Support, U.S. Gov't, Non-P.H.S.

PMID: 17576570

17: J Physiol. 2007 Aug 15;583(Pt 1):405; author reply 407. Epub 2007 Jun 14.

Comment on: J Physiol. 2007 Feb 1;578(Pt 3):859-70.

Cardiac changes after SCUBA diving: the evasive shape of right ventricle.

Marabotti C, L'Abbate A, Bedini R.

Publication Types: Comment Letter

PMID: 17569726

18: J Appl Physiol. 2007 Sep;103(3):823-7. Epub 2007 Jun 7.

Comment in: J Appl Physiol. 2008 May;104(5):1547; author reply 1548.

Effects of glossopharyngeal insufflation on cardiac function: an echocardiographic study in elite breath-hold divers.

Potkin R, Cheng V, Siegel R.

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Glossopharyngeal insufflation (GI), a technique used by breath-hold divers to increase lung volume and augment diving depth and duration,

is associated with untoward hemodynamic consequences. To study the cardiac effects of GI, we performed transthoracic echocardiography, using the subcostal window, in five elite breath-hold divers at rest and during GI. During GI, heart rate increased in all divers (mean of 53 beats/min to a mean of 100 beats/min), and blood pressure fell dramatically (mean systolic, 112 to 52 mmHg; mean diastolic, 75 mmHg to nondetectable). GI induced a 46% decrease in mean left ventricular end-diastolic area, 70% decrease in left ventricular end-diastolic volume, 49% increase in mean right ventricular end-diastolic area, and 160% increase in mean right ventricular end-diastolic volume. GI also induced biventricular systolic dysfunction; left ventricular ejection fraction decreased from 0.60 to a mean of 0.30 ( $P = 0.012$ ); right ventricular ejection fraction, from 0.75 to a mean of 0.39 ( $P < 0.001$ ). Wall motion of both ventricles became significantly abnormal during GI; the most prominent left ventricular abnormalities involved hypokinesis or dyskinesis of the interventricular septum, while right ventricular wall motion abnormalities involved all visible segments. In two divers, the inferior vena cava dilated with the appearance of spontaneous contrast during GI, signaling increased right atrial pressure and central venous stasis. Hypotension during GI is associated with acute biventricular systolic dysfunction. The echocardiographic pattern of right ventricular systolic dysfunction is consistent with acute pressure overload, whereas concurrent left ventricular systolic dysfunction is likely due to ventricular interdependence.

PMID: 17556497

19: *Occup Med (Lond)*. 2007 Aug;57(5):349-54. Epub 2007 Jun 4. Comment in: *Occup Med (Lond)*. 2007 Dec;57(8):611-2; author reply 612. Reduced health-related quality of life in former North Sea divers is associated with decompression sickness.

Irgens A, Grønning M, Troland K, Sundal E, Nyland H, Thorsen E. Department of Occupational Medicine, Haukeland University Hospital, Bergen 5021, Norway. aagot.irgens@helse-bergen.no

BACKGROUND: Diving is associated with long-term effects on several organ systems. AIM: The objective was to investigate the impact of decompression sickness (DCS) and diving exposure on health-related quality of life (HRQL) in former Norwegian North Sea divers. METHODS: HRQL was recorded by a questionnaire in the cohort of 375 Norwegian North Sea divers registered before 1990. Demographic data, relevant health data and data on diving education, history of DCS and SF-36 were recorded in 230 divers. RESULTS: All SF-36 subscores were significantly reduced compared with Norwegian norms. Reduced scores were seen for all scales among divers who reported previous DCS compared to those without DCS. A decreasing trend in scores was seen when comparing no DCS, skin or joint DCS and neurological DCS. There was a decreasing trend in scores related to number of days in saturation and maximal depth. Stratification on DCS showed that the impact of saturation diving was present only in divers with DCS. CONCLUSIONS: HRQL was reduced in this study sample of divers. Having had DCS during the diving career contributed significantly to the reduction in all SF-36 scales, and apparently neurological DCS has the most pronounced impact. Cumulative diving exposure including days in saturation and maximal depth contributed to a reduced HRQL.

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17548867

20: *Eur J Appl Physiol*. 2007 Sep;101(1):125-32. Epub 2007 Jun 1. Hematological response and diving response during apnea and apnea with face immersion. Schagatay E, Andersson JP, Nielsen B. Department of Natural Sciences, Mid Sweden University, 851 70, Sundsvall, Sweden. Erika.Schagatay@miun.se

Increased hematocrit (Hct) attributable to splenic contraction accompanies human apneic diving or apnea with face immersion. Apnea also causes heart rate reduction and peripheral vasoconstriction, i.e., a cardiovascular diving response, which is augmented by face immersion. The aim was to study the role of apnea and facial immersion in the initiation of the hematological response and to relate this to the cardiovascular diving response and its oxygen conservation during repeated apneas. Seven male volunteers performed two series of five apneas of fixed near-maximal duration: one series in air (A) and the other with facial immersion in 10 degrees C water (FIA). Apneas were spaced by 2 min and series by 20 min of rest. Venous blood samples, taken before and after each apnea, were analysed for Hct, hemoglobin concentration (Hb), lactic acid, blood gases and pH. Heart rate, skin capillary blood flow and arterial oxygen saturation were continuously measured non-invasively. A transient increase of Hct and Hb by approximately 4% developed progressively across both series. As no increase of the response resulted with face immersion, we concluded that the apnea, or its consequences, is the major stimulus evoking splenic contraction. An augmented cardiovascular diving response occurred during FIA compared to A. Arterial oxygen saturation remained higher, venous oxygen stores were more depleted and lactic acid accumulation was higher across the FIA series, indicating oxygen conservation with the more powerful diving response. This study shows that the hematological response is not involved in causing the difference in oxygen saturation between apnea and apnea with face immersion.

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17541787

21: Aviat Space Environ Med. 2007 May;78(5):523-5.

Cold injury to a diver's hand after a 90-min dive in 6 degrees C water. Laden GD, Purdy G, O'Rielly G. Department Clinical Hyperbaric Unit, Hull and East Riding Hospital,

Lowfield Rd., Anlaby, Hull HU10 7AZ, UK. gerardladen@aol.com

We present here a case of non-freezing cold injury (NFCI) in a sport scuba diver. There are similarities between the presenting symptoms of NFCI and decompression sickness, e.g., pain and/or altered sensation in an extremity, often reported as numbness. In both conditions patients have been known to describe their lower limbs or feet as feeling woolly. Both conditions are the result of environmental exposure. Additionally, there are no good (high sensitivity and specificity) diagnostic tests for either condition. Diagnosis is made based on patient history, clinical presentation, and examination. NFCI is most frequently seen in military personnel, explorers, and the homeless. When affecting the feet of soldiers it is often referred to as "trench foot." Historically, NFCI has been and continues to be of critical importance in infantry warfare in cold and wet environments. A high priority should be given to prevention of NFCI during military operational planning. With the advent of so-called "technical diving" characterized by going deeper for longer (often in cold water) and adventure tourism, this extremely painful condition is likely to increase in prevalence. NFCI is treated symptomatically.

Publication Types: Case Reports  
PMID: 17539448

22: Aviat Space Environ Med. 2007 May;78(5):500-4.

Echocardiography in military oxygen divers.

Boussuges A, Riera F, Rossi P, Blatteau JE, Castagna O, Galland F. Naval Medical Institute (IMNSSA), Toulon, France.  
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BACKGROUND: Oxygen divers undergo environmental stressors such as immersion, ventilation with scuba, cold exposure, and increased ambient pressure. All of these stressors may be responsible for acute hemodynamic modifications. We hypothesized that repeated hyperbaric hyperoxia exposure induces long-term cardiovascular modifications.  
METHODS: A Doppler echocardiography

was conducted on 20 military oxygen divers (average 12 yr diving experience) and compared with 22 controls. Parameters known to be modified by acute hyperoxic exposure, such as left ventricular (LV) function (systolic and diastolic) and arterial compliance, were analyzed. RESULTS: Controls and divers were matched appropriately for age and height, although the divers had a higher body mass index and aerobic capacity. Left atrial and left ventricular diameters did not differ between the two groups. On the other hand, left ventricular mass was significantly higher in the elite military divers (209 +/- 43 g) in comparison with the control group (172 +/- 48 g), even when LV mass was indexed to body surface area. Left ventricular systolic and diastolic function indices, stroke volume, cardiac index, peripheral vascular resistance, and systemic compliance were comparable between the two groups. CONCLUSION: A greater LV mass was observed in oxygen military divers. The echocardiographic differences between divers and controls could be attributed to the high level physical training undertaken by the military divers. Some stressors, such as cold water immersion, repeated hyperoxic exposures, scuba breathing, and long distance swimming, could have participated to the echocardiographic findings in oxygen divers.

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17539444

23: Aviat Space Environ Med. 2007 May;78(5):493-9.

Risk factors for venous gas emboli after decompression from prolonged hyperbaric exposures.

Cameron BA, Olstad CS, Clark JM, Gelfand R, Ochroch EA, Eckenhoff RG. Department of Anesthesia, University of Pennsylvania School of Medicine, Philadelphia, PA, USA.

INTRODUCTION: The physical forces governing gas phase nucleation and growth in a liquid would predict less variation in the development of decompression sickness (DCS) than is known to occur in people. METHODS: In order to gain insight into the causes of biological susceptibility to DCS, we analyzed a

dataset containing 250 human steady-state hyperbaric exposures using multivariate ordinal and linear regression analysis for relationships between venous gas emboli (VGE) and exposure parameters and subject characteristics. RESULTS: In both previously published data and new chamber exposure data, we found that the strongest predictor of VGE magnitude after decompression was the duration and depth of the hyperbaric exposure, as predicted. Of the subject factors, only age was significantly associated with VGE; body mass index (BMI) and gender were not. The relationship between age and VGE strengthened with decompression magnitude. DISCUSSION: These results suggest that the physiology of aging interacts with the mechanism of VGE generation, altering the risk of DCS after decompression.

PMID: 17539443

24: Thromb Res. 2007;121(2):235-40. Epub 2007 May 22.

Decreased levels of PAI-1 and alpha 2-antiplasmin contribute to enhanced fibrinolytic activity in divers.

Radziwon P, Olszański R, Tomaszewski R, Lipska A, Dabrowiecki Z, Korzeniewski K, Siermontowski P, Boczkowska-Radziwon B.

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BACKGROUND: There are a number of reported cases of decompression sickness (DCS) with haemorrhages. These cases have not been sufficiently investigated and thus bleeding complications could not be directly correlated to the enhanced fibrinolysis. OBJECTIVES: The effect of hyperbaric exposition and decompression on the main components of fibrinolytic system has been measured. METHODS: Two groups of 25 male divers each were subjected to hyperbaric exposures to the pressure of either 400 kPa - group I - or 700 kPa - group II followed by a staged decompression. The divers were monitored for clinical symptoms of DCS and checked for Doppler-detected venous gas bubbles. Venous blood was drawn from divers before exposition and 15 min after decompression. The concentrations and activities of t-PA and PAI-1 as well as

concentrations of PAP and alpha2-antiplasmin and activity of factor XIIIa were measured. RESULTS: In all groups of divers no cases of DCS as well as detectable gas bubbles were noted. We observed elevated concentration of PAP, decreased concentration of alpha2-AP, decreased PAI-1 concentration and activity. There were no significant changes in factor XIIIa activity as well as of t-PA concentration and activity. CONCLUSIONS: Hyperbaric exposition and decompression induce activation of fibrinolysis, even in the absence of detectable gas bubbles. Fibrinolytic activity increases mainly due to decrease of PAI-1 concentration and activity. Further clinical trials are necessary for the estimation of the importance of activation of fibrinolysis with decreased level of PAI-1 and alpha2-AP as a possible risk factor for bleeding in divers. Publication Types: Research Support, Non-U.S. Gov't PMID: 17521709

25: Undersea Hyperb Med. 2007 Mar-Apr;34(2):123-30. Postural control in a simulated saturation dive to 240 msw. Goplen FK, Aasen T, Nordahl SH. Dept. of Otolaryngology, Head & Neck Surgery, Haukeland University Hospital N-5021 Bergen, Norway. INTRODUCTION: There is evidence that increased ambient pressure causes an increase in postural sway. This article documents postural sway at pressures not previously studied and discusses possible mechanisms. METHODS: Eight subjects participated in a dry chamber dive to 240 msw (2.5 MPa) saturation pressure. Two subjects were excluded due to unilateral caloric weakness before the dive. Postural sway was measured on a force platform. The path length described by the center of pressure while standing quietly for 60 seconds was used as test variable. Tests were repeated 38 times in four conditions: with eyes open or closed, while standing on bare platform or on a foam rubber mat. RESULTS: Upon reaching 240 msw, one subject reported vertigo, disequilibrium and nausea, and in all subjects, mean postural sway increased 26% on bare platform with eyes open ( $p < 0.05$ ) compared to

pre-dive values. There was no significant improvement in postural sway during the bottom phase, but a trend was seen toward improvement when the subjects were standing with eyes closed on foam rubber ( $p = 0.1$ ). Postural sway returned to pre-dive values during the decompression phase. DISCUSSION: Postural imbalance during deep diving has been explained previously as HPNS possibly including a specific effect on the vestibulo-ocular reflex. Although vertigo and imbalance are known to be related to compression rate, this study shows that there remains a measurable increase in postural sway throughout the bottom phase at 240 msw, which seems to be related to absolute pressure.

Publication Types: Research Support, Non-U.S. Gov't PMID: 17520863

26: Undersea Hyperb Med. 2007 Mar-Apr;34(2):99-105.

The relationship between venous gas bubbles and adverse effects of decompression after air dives. Eftedal OS, Lydersen S, Brubakk AO. Department of Circulation and Medical Imaging, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway.

The presence of gas bubbles in the vascular system is often considered a sign of decompression stress and several studies in the existing literature have addressed the relationship between the amount of bubbles detected by ultrasound Doppler systems and the incidence of decompression sickness. The use of ultrasound imaging has some important advantages to Doppler systems, and here we have looked at the relationship between the amount of intravascular gas bubbles detected by ultrasound echocardiography and the incidence of signs and symptoms of decompression stress after 203 air dives. The results show that venous gas bubbles detected by ultrasound imaging is a highly sensitive, although not specific, predictor of such adverse effects of decompression. Our results agree with the published concordance between Doppler detected bubbles and decompression sickness. We conclude

that bubble detection by ultrasonic scanning of the heart can be used as a tool to assess the safety of decompression procedures for air dives.

PMID: 17520861

27: *Epilepsia*. 2007 May;48(5):851-8. Epilepsy and recreational scuba diving: an absolute contraindication or can there be exceptions? A call for discussion.

Almeida Mdo R, Bell GS, Sander JW. Department of Clinical and Experimental Epilepsy, UCL Institute of Neurology, and the National Hospital for Neurology and Neurosurgery, Queen Square, London, United Kingdom.

Recreational scuba diving is a popular sport, and people with epilepsy often ask physicians whether they may engage in diving. Scuba diving is not, however, without risk for anyone; apart from the risk of drowning, the main physiological problems, caused by exposure to gases at depth, are decompression illness, oxygen toxicity, and nitrogen narcosis. In the United Kingdom, the Sport Diving Medical Committee advises that, to dive, someone with epilepsy must be seizure free and off medication for at least 5 years. The reasons for this are largely theoretical. We review the available evidence in the medical literature and diving websites. The risk of seizures recurring decreases with increasing time in remission, but the risk is never completely abolished. We suggest that people with epilepsy who wish to engage in diving, and the physicians who certify fitness to dive, should be provided with all the available evidence. Those who have been entirely seizure-free on stable antiepileptic drug therapy for at least 4 years, who are not taking sedative antiepileptic drugs and who are able to understand the risks, should then be able to consider diving to shallow depths, provided both they and their diving buddy have fully understood the risks.

Publication Types: Research Support, Non-U.S. Gov't Review  
PMID: 17508997

28: *Intern Med J*. 2007 May;37(5):345-7.

Scuba diving, swimming and pulmonary oedema.

Dwyer N, Smart D, Reid DW.

Publication Types: Case Reports Letter

PMID: 17504290

29: *Int J Sports Med*. 2007 Oct;28(10):848-52. Epub 2007 May 11. Neuroendocrine and psychological assessment in a guinness 10 days scuba dive.

Revelli L, Addolorato G, D'Amore A, Carrozza C, Giubileo G, Puiu A, Lombardi CP, Bellantone R, Gasbarrini G; Progetto Abissi 2005 Dive Medical Group. Department of Endocrine Surgery, Catholic University of Rome, Rome, Italy.

This study was designed to evaluate physiological and psychological stress parameters in 2 professional trained scuba divers, using a unique physiopathologic model, offered by the guinness 240 hours scuba dive. Two scuba dive masters have spent 240 hours at 6 - 8 meters depth (26.4 ft) in Ponza Island water (Italy). Blood samples were collected daily in the underwater bell; samples were carried out of water in waterproof bags. Breath samples were collected, measuring ethylene release. Psychological assessment was performed using the State and Trait Anxiety Inventory and the Zung self-rating depression scale. In the studied subjects, cortisol and prolactin showed physiological pulsatile secretion. Breath ethylene didn't exceed normal values. At the start of the study, no subjects showed high levels of state anxiety, trait anxiety and current depression. Psychometric scales scores remained steady during the diving period and no subjects showed anxiety and/or depression and/or panic symptoms during the time of observation. The present study shows that, although the long-time diving, well trained professional divers did not develop anxiety and/or depression. No subject discontinued the diving due to occurred psychological disorders or systemic events. The present report shows that the long-term diving permanence is possible, at least in well trained scuba divers.

PMID: 17497574

30: Eur J Emerg Med. 2007 Apr;14(2):118-9.

Spontaneous pneumomediastinum as a result of SCUBA diving.

Kosaka T, Haraguchi M, Tsuneoka N, Furui J.

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Publication Types: Case Reports  
PMID: 17496692

31: Aviat Space Environ Med. 2007 Apr;78(4):430-4.

Prophylactic statins as a possible method to decrease bubble formation in diving.

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INTRODUCTION: Nitric oxide (NO) may decrease bubble formation in diving. Statin medications are attractive potential options to increase NO. Statins exhibit a proven safety profile, and possess a myriad of pleiotropic properties improving vascular endothelial function. Additionally, statin-mediated lipid reduction may reduce bubble generation via alterations in plasma surface tension. We investigated the efficacy of atorvastatin as a pharmacological intervention to reduce the risk of bubble formation after diving, a surrogate for decompression sickness (DCS).

METHODS: There were 16 trained military divers who completed a provocative hyperbaric chamber dive protocol after taking either 80-mg of atorvastatin or placebo for 4 d. Subjects completed the alternate medication regimen no sooner than 2 wk. After each dive, subjects were subjected to precordial trans-thoracic echocardiographic exams via standardized protocols. Bubbles were graded via a non-parametric, ordinal grading system and statistically analyzed via Wilcoxon signed-rank tests. RESULTS: We found no within subject differences for the maximum bubble grade scores ( $z = 0.00$ ,  $p = 1.00$ ,  $n=16$ ). Low-density lipoprotein (LDL), and total cholesterol (TC) levels decreased significantly ( $107.6 \pm 26.2$  to  $79.3 \pm 21.9$  mg x dl(-1) and  $175 \pm 20.9$  to  $147 \pm 22.4$  mg x dl(-1), respectively)

1-2 wk post statin administration. Age, bioelectrical impedance (BEI), TC, LDL, potassium, and calcium demonstrated positive correlations to placebo bubble grades.

DISCUSSION: Prophylactic 80-mg atorvastatin administration for 4 d failed to reduce the number of intravascular bubbles observed following a 60-ft, 80-min dry chamber dive despite significant acute reductions in lipid levels. Several hypotheses may explain why statins failed to decrease bubble volume: (1) differential influence of statins on the venous vs. arterial vasculature; (2) failure to elicit an improvement in endothelial function and, therefore, the hypothesized endothelial conditioning in younger patients possessing normal baseline; and (3) the ordinal grading system encompassing a substantial variation in bubble volume (bubbles Scm(-2)).

Publication Types: Clinical Trial  
Randomized Controlled Trial  
Research Support, U.S. Gov't, Non-P.H.S.  
PMID: 17484348

32: Aviat Space Environ Med. 2007 Apr;78(4):414-9.

Comment in: Aviat Space Environ Med. 2008 Jan;79(1):67; author reply 67.

Vestibular symptoms and otoneurological findings in retired offshore divers.

Goplen FK, Grønning M, Irgens A, Sundal E, Nordahl SH.

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INTRODUCTION: Inner ear barotraumas and decompression sickness (DCS) may cause acute vestibular symptoms in divers. The result may be irreversible damage to the vestibular end organs or their central connections. We examined a group of offshore divers in order to find out how many divers experience vestibular symptoms later in life and how this was related to occupational history and objective findings. METHODS: A questionnaire was sent to 230 offshore divers (mean age 52 yr) and 166 age-matched non-diving controls. Most of the divers had retired from diving. A subgroup (n=96) of the divers was

referred for examination, including a clinical otoneurological examination, electronystagmography, bithermal caloric tests, and platform posturography. In addition, 42 of the controls were examined. RESULTS: The prevalence of dizziness (28%), spinning vertigo (14%), and unsteady gait (25%) was significantly higher in divers than controls ( $p < 0.0005$ ). These symptoms were strongly associated with a previous history of DCS, particularly type I, which was reported by 61% of the divers. Symptoms were less strongly associated with the number of dives. In referred divers with dizziness, the prevalence of abnormal postural sway, nystagmus, canal paresis, or pathological smooth pursuit was 32%, 9%, 7%, and 11%, respectively. DISCUSSION: Reasons for the high prevalence of vestibular symptoms among the divers are discussed. The high exposure to DCS is probably an important factor.  
PMID: 17484345

33: Harefuah. 2007 Apr;146(4):286-90, 317.  
[Asthma and scuba diving: can asthmatic patients dive?]  
[Article in Hebrew]  
Sade K, Wiesel O, Kivity S, Levo Y. Department of Medicine 'T', Sourasky Medical Center, Tel Aviv University, Tel Aviv, Israel. kobi-sa@inter.net.il  
Self-contained underwater breathing apparatus (scuba) diving has grown in popularity, with millions of divers enjoying the sport worldwide. This activity presents unique physical and physiological challenges to the respiratory system, raising numerous concerns about individuals with asthma who choose to dive. Asthma had traditionally been a contraindication to recreational diving, although this caveat has been ignored by large numbers of such patients. Herein we review the currently available literature to provide evidence-based evaluation of the risks associated with diving that are posed to asthmatics. Although there is some indication that asthmatics may be at an increased risk of pulmonary barotrauma, the risk seems to be small. Thus, under the right

circumstances, patients with asthma can safely participate in recreational diving without any apparent increased risk of an asthma-related event. Decisions on whether or not diving is hazardous must be made on an individual basis and be founded upon an informed decision shared by both patient and physician.  
Publication Types: English  
Abstract Review  
PMID: 17476937

34: Auris Nasus Larynx. 2007 Sep;34(3):361-4. Epub 2007 May 1.  
Pediatric sudden sensorineural hearing loss after diving.  
Marchese-Ragona R, Marioni G, Ottaviano G, Gaio E, Staffieri C, de Filippis C.  
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OBJECTIVE: Sensorineural hearing loss after diving from a low height has been rarely reported especially in children. METHODS: We present and discuss a new case of pediatric sudden sensorineural hearing loss after diving. RESULTS AND CONCLUSION: Medical and surgical approaches (indications and timing of explorative tympanotomy) to this occurrence are still controversial.  
Publication Types: Case Reports  
PMID: 17475428

35: J Acoust Soc Am. 2007 Apr;121(4):EL156-60.  
Breathing noise elimination in through-water speech communication between divers.  
Woodward B, Sari H.  
Department of Electronic and Electrical Engineering, Loughborough University, United Kingdom. b.woodward1@lboro.ac.uk  
Breathing noise and bubble noise are the main factors affecting the subjective quality of through-water speech signals in communications between divers wearing full-face masks or aural-nasal masks. Only breathing noise is considered here, which can be gated out by applying a combination of zero-crossing detection and energy measurements to noisy speech signals above predetermined threshold values. The signals are picked up by a microphone placed close to the

diver's mouth in the air cavity of the mask. Results were obtained during diving trials with four different types of masks.

PMID: 17471761

36: Wilderness Environ Med. 2007 Spring;18(1):48-53.

Hematocrit change in tropical scuba divers.

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OBJECTIVE: Direct evidence that dehydration results from scuba diving is scanty. Increased hematocrit (Ht) is a commonly used proxy measure for dehydration. This study sought evidence that an increase in Ht occurs over the course of a scuba dive in tropical conditions. As a secondary outcome, evidence was sought that the degree of Ht increase is correlated to pressure exposure. METHODS: Twenty male and 21 female scuba divers were recruited at a remote tropical dive site. Water temperature was 30 degrees C (+/- 1 degrees C). Each diver gave venous blood relating to 1 dive only. Mean maximum dive depth was 13.6 m (+/- 3.7 m [SD]) and mean duration 39.5 minutes (+/- 4.5 minutes [SD]) using air as the breathing gas. Blood was taken at a mean of 12.4 minutes (+/- 3.5 minutes [SD]) before diving and a mean of 16.2 minutes (+/- 3.7 minutes [SD]) after diving. After centrifugation of microcapillaries, Ht was estimated on a visual plate reader. RESULTS: A paired Wilcoxon test showed evidence ( $P < .001$ ) for a change in Ht. The mean difference between pre-dive and post-dive measurements was 0.0073 (95% confidence interval: 0.0104-0.0042), equating to a mean relative Ht increase of 1.78%. Similar results were found for the sexes individually. A correlation between maximum depth of dive and Ht increase was statistically significant, although the correlation itself was weak ( $P = .049$ , Spearman's  $r = .326$ ). CONCLUSIONS: There is evidence of a statistically significant increase in Ht over the course of a single warm-water scuba dive. This increase is small and is within the range of

error associated with the techniques of Ht estimation employed in this study. Depth exposure was found to correlate with Ht increase. In view of the small magnitude of change in the Ht, there is no reason to amend protocols for fluid resuscitation of recreational scuba divers suspected to have experienced decompression injury in tropical locations.

PMID: 17447715

37: Hum Factors. 2007 Apr;49(2):214-26.

A methodology for identifying human error in U.S. Navy diving accidents. O'Connor P, O'Dea A, Melton J. School of Aviation Safety, 181 Chambers Ave., Pensacola, FL 32508, USA. paul.e.oconnor@navy.mil

OBJECTIVE: To better understand how human error contributes to U.S. Navy diving accidents. BACKGROUND: An analysis of 263 U.S. Navy diving accident and mishap reports revealed that the human factors classifications were not informative for further analysis, and 70% of mishaps were attributed to unknown causes; only 23% were attributed to human factors. METHOD: Five diving fatality reports were examined using the consensual qualitative research (CQR) method to develop a taxonomy of six categories and 21 subcategories for classifying human errors in diving. In addition, 15 critical incident technique (CIT) interviews were conducted with U.S. Navy divers who had been involved in a diving accident or near miss and analyzed using the dive team error taxonomy. RESULTS: Overall, failures in situation awareness and leadership were the most common human errors made by the dive team. CONCLUSION: The dive team human error taxonomy could aid in accident investigation and in the training and evaluation of U.S. Navy divers. APPLICATION: The development of the dive team human error taxonomy has generated a number of considerations that researchers should take into account when developing, or adapting, an error taxonomy from one industry to another.

PMID: 17447664

38: J Appl Physiol. 2007 Aug;103(2):484-93. Epub 2007 Apr 19.

A new class of biophysical models for predicting the probability of decompression sickness in scuba diving.

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Interconnected compartmental models have been used for decades in physiology and medicine to account for the observed multi-exponential washout kinetics of a variety of solutes (including inert gases) both from single tissues and from the body as a whole. They are used here as the basis for a new class of biophysical probabilistic decompression models. These models are characterized by a relatively well-perfused, risk-bearing, central compartment and one or two non-risk-bearing, relatively poorly perfused, peripheral compartment(s). The peripheral compartments affect risk indirectly by diffusive exchange of dissolved inert gas with the central compartment. On the basis of the accuracy of their respective predictions beyond the calibration regime, the three-compartment interconnected models were found to be significantly better than the two-compartment interconnected models. The former, on the basis of a number of criteria, was also better than a two-compartment parallel model used for comparative purposes. In these latter comparisons, the models all had the same number of fitted parameters (four), were based on linear kinetics, had the same risk function, and were calibrated against the same dataset. The interconnected models predict that inert gas washout during decompression is relatively fast, initially, but slows rapidly with time compared with the more uniform washout rate predicted by an independent parallel compartment model. If empirically verified, this may have important implications for diving practice.

Publication Types: Comparative Study

PMID: 17446410

39: Biol Lett. 2007 Feb 22;3(1):94-8.

Eat now, pay later? Evidence of deferred food-processing costs in diving seals.

Sparling CE, Fedak MA, Thompson D.

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Seals may delay costly physiological processes (e.g. digestion) that are incompatible with the physiological adjustments to diving until after periods of active foraging. We present unusual profiles of metabolic rate (MR) in grey seals measured during long-term simulation of foraging trips (4-5 days) that provide evidence for this. We measured extremely high MRs (up to almost seven times the baseline levels) and high heart rates during extended surface intervals, where the seals were motionless at the surface. These occurred most often during the night and occurred frequently many hours after the end of feeding bouts. The duration and amount of oxygen consumed above baseline levels during these events was correlated with the amount of food eaten, confirming that these metabolic peaks were related to the processing of food eaten during foraging periods earlier in the day. We suggest that these periods of high MR represent a payback of costs deferred during foraging.

Publication Types: Research Support, Non-U.S. Gov't

PMID: 17443975

40: Vnitr Lek. 2007 Feb;53(2):143-6.

[Paradoxical embolization and patent foramen ovale in scuba divers: screening possibilities]

[Article in Czech]

Honek T, Veselka J, Tomek A, Srámek M, Janugka J, Sefc L, Kerekes R, Novotný S.

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INTRODUCTION: The cause of decompression sickness (DCS) in scuba-divers is bubble formation in tissues and in venous blood during ascent. Divers with patent foramen ovale (PFO) have an increased risk of paradoxical embolization to the brain or other vital organs. The aim of our study was to assess the incidence of PFO in scuba-divers with DCS, to compare the group with asymptomatic controls, and to

evaluate ultrasound contrast methods suitable for screening. **METHODOLOGY:** We examined 28 scuba-divers (more than 100 dives). The right-to-left shunt detection was performed by bubble contrast transthoracic echocardiographic examination (TTE) and transcranial Doppler sonography over arteria cerebri media (TCD) in all divers. In divers with shunting, transoesophageal echocardiography (TEE) was performed to prove PFO. **RESULTS:** 15 divers had DCS associated with the ascent. In this group, PFO was diagnosed in 53% (8/15). The symptoms of all of them retrospectively were of paradoxical embolization (neurological form of DCS). In the group of asymptomatic divers, PFO was proven on the basis of right-to-left shunt screening in 1 diver (8% 1/13). TCD proved right-to-left shunt in all divers with PFO. **CONCLUSION:** DCS can unmask a so far asymptomatic intracardiac right-to-left shunting. PFO is a risk factor for paradoxical embolization in divers. TCD is suitable for screening; TEE is a gold standard in PFO detection. Our results showed that PFO detection is a useful clinical tool after repeated DCS and in all frequent divers and instructors.

Publication Types: English  
Abstract  
PMID: 17419175

41: J Physiol. 2007 Jul 15;582(Pt 2):723-30. Epub 2007 Apr 5.

Cerebrovascular reactivity to hypercapnia is unimpaired in breath-hold divers.

Ivancev V, Palada I, Valic Z, Obad A, Bakovic D, Dietz NM, Joyner MJ, Dujic Z.

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Hypercapnic cerebrovascular reactivity is decreased in obstructive sleep apnoea and congestive heart disease perhaps as a result of repeated apnoeas. To test the hypothesis that repeated apnoeas blunt cerebrovascular reactivity to hypercapnia, we studied breath hold divers and determined cerebrovascular reactivity by measuring changes in middle cerebral artery velocity (MCAV, cm s<sup>-1</sup>) per mmHg change in end-tidal partial pressure of

CO<sub>2</sub> (PET, CO<sub>2</sub>) in response to two hyperoxic hypercapnia rebreathing manoeuvres (modified Read protocol) in elite breath-hold divers (BHD, n=7) and non-divers (ND, n=7). In addition, ventilation and central (beat-to-beat stroke volume measurement with Modelflow technique) haemodynamics were determined. Ventilatory responses to hypercapnia were blunted in BHD versus ND largely due to lower breathing frequency. Cerebrovascular reactivity did not differ between groups (3.7 +/- 1.4 versus 3.4 +/- 1.3% mmHg<sup>-1</sup>) in BHD and ND, respectively; P=0.90) and the same was found for cerebral vascular resistance and MCAV recovery to baseline after termination of the CO<sub>2</sub> challenge. Cardiovascular parameters were not changed significantly during rebreathing in either group, except for a small increase in mean arterial pressure for both groups. Our findings indicate that the regulation of the cerebral circulation in response to hypercapnia is intact in elite breath-hold divers, potentially as a protective mechanism against the chronic intermittent cerebral hypoxia and/or hypercapnia that occurs during breath-hold diving. These data also suggest that factors other than repeated apnoeas contribute to the blunting of cerebrovascular reactivity in conditions like sleep apnoea.

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17412771

42: J Appl Physiol. 2007 Apr;102(4):1722.

Comment on: J Appl Physiol. 2007 Apr;102(4):1323.

Commentary on viewpoint "Heliox, nitrox, and trimix diving; hyperbaric oxygen treatment; and a flaw in Henry's law.

Wienke BR.

Publication Types: Comment Letter  
PMID: 17409299

43: J Appl Physiol. 2007 Apr;102(4):1721.

Comment on: J Appl Physiol. 2007 Apr;102(4):1323.

Commentary on viewpoint "Heliox, nitrox, and trimix diving;

hyperbaric oxygen treatment; and a flaw in Henry's law".  
Van Liew HD, Flynn ET.  
Publication Types: Comment  
Letter  
PMID: 17409298

44: J Appl Physiol. 2007  
Apr;102(4):1720.  
Comment on: J Appl Physiol. 2007  
Apr;102(4):1323.  
Commentary on viewpoint "Heliox,  
nitrox, and trimix diving;  
hyperbaric oxygen treatment; and a  
flaw in Henry's law".  
Balestra C, Germonpré P.  
Publication Types: Comment  
Letter  
PMID: 17409297

45: J Appl Physiol. 2007  
Apr;102(4):1719.  
Comment on: J Appl Physiol. 2007  
Apr;102(4):1323.  
Commentary on viewpoint "Heliox,  
nitrox, and trimix diving;  
hyperbaric oxygen treatment; and a  
flaw in Henry's law".  
Boussuges A, Blatteau JE.  
Publication Types: Comment  
Letter  
PMID: 17409296

46: J Appl Physiol. 2007  
Apr;102(4):1718.  
Comment on: J Appl Physiol. 2007  
Apr;102(4):1323.  
Commentary on viewpoint "Heliox,  
nitrox, and trimix diving;  
hyperbaric oxygen treatment; and a  
flaw in Henry's law".  
Hamilton RW.  
Publication Types: Comment  
Letter  
PMID: 17409295

47: J Appl Physiol. 2007  
Apr;102(4):1323.  
Comment in: J Appl Physiol. 2007  
Apr;102(4):1718. J Appl Physiol.  
2007 Apr;102(4):1719. J Appl  
Physiol. 2007 Apr;102(4):1720. J  
Appl Physiol. 2007 Apr;102(4):1721.  
J Appl Physiol. 2007  
Apr;102(4):1722.  
Heliox, nitrox, and trimix diving;  
hyperbaric oxygen treatment; and a  
flaw in Henry's law.  
Arieli R.  
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PMID: 17409289

48: Undersea Hyperb Med. 2007 Jan-  
Feb;34(1):51-9.

The nontechnical causes of diving  
accidents: can U.S. Navy divers  
learn from other industries?  
O'Connor PE.

Although U.S. Navy diving is  
remarkably safe, because of the  
high-risk environment in which  
military divers work, accidents and  
mishaps do occur. Failures in  
leadership and situation awareness  
(particularly in risk and time  
assessment) were found to be the two  
most common causes of fatal and  
nonfatal U.S. Navy diving accidents  
and near misses. Responses to an  
attitude survey showed that junior  
divers want to ask questions, but  
senior divers do not desire to be  
questioned. In other high  
reliability industries (e.g.  
aviation, medicine) methods have  
been developed to identify, analyze  
and mitigate human error. The  
relevance of these techniques for  
U.S. Navy diving are discussed.

Publication Types: Evaluation  
Studies

PMID: 17393939

49: Undersea Hyperb Med. 2007 Jan-  
Feb;34(1):43-9.

First aid normobaric oxygen for the  
treatment of recreational diving  
injuries.

Longphre JM, Denoble PJ, Moon RE,  
Vann RD, Freiburger JJ.

Center for Hyperbaric Medicine and  
Environmental Physiology, Department  
of Anesthesiology, Duke University  
Medical Center Durham, NC, USA.

INTRODUCTION: First aid oxygen  
(FAO2) has been widely used as an  
emergency treatment for diving  
injuries, but there are few studies  
supporting its efficacy. METHODS:  
2,231 sequential diving injury  
reports collected by the Divers  
Alert Network (DAN) Injury database  
from 1998 to 2003 were examined.  
RESULTS: 47% (1,045) of cases  
received FAO2. The median time to  
FAO2 treatment after surfacing was  
four hours and after symptom onset  
was 2.2 hours. Persistent complete  
relief (14%) or improvement (51%)  
was seen with FAO2 alone (65%  
overall response; n = 330). After  
one recompression treatment 67%  
of FAO2 patients reported complete  
relief compared to 58% of the no

FAO2 group (OR = 1.5, 95% CI = 1.2 - 1.8). FAO2 given at any time after surfacing significantly reduced the odds of multiple recompression treatments (OR = 0.83, 0.70-0.98). When FAO2 was given within 4 hours of surfacing, the OR decreased to 0.50 (0.36-0.69) yielding a number needed to treat of 6. Case severity affected urgency of FAO2 treatment. Individuals with more prominent symptoms received prompt treatment. Cardiopulmonary, skin, and serious neurological symptoms had shorter delays to FAO2 ( $p < 0.001$ ).  
CONCLUSIONS: FAO2 increased recompression efficacy and decreased the number of recompression treatments required if given within four hours after surfacing.  
Publication Types: Evaluation Studies  
PMID: 17393938

50: Free Radic Res. 2007 Mar;41(3):274-81.  
Scuba diving enhances endogenous antioxidant defenses in lymphocytes and neutrophils.  
Ferrer MD, Sureda A, Batle JM, Tauler P, Tur JA, Pons A.  
Laboratori de Ciències de l'Activitat Física, Universitat de les Illes Balears, Spain.  
The aim was to study the effects of a scuba diving session on the lymphocyte antioxidant system, NO synthesis, the capability to produce reactive oxygen species and the antioxidant response in neutrophils. For that purpose seven male divers performed an immersion at a depth of 40 m for 25 min. The same parameters were measured after an hyperbaric oxygen (HBO) treatment at resting conditions in a hyperbaric chamber. Lymphocyte H<sub>2</sub>O<sub>2</sub> production rose after diving and after HBO treatment. Glutathione peroxidase (GPx) and catalase activities increased after diving in lymphocytes, while after HBO exposure only increased GPx activity. Lymphocyte HO-1 mRNA expression increased after diving and after HBO exposure, while iNOS levels and nitrite levels significantly increased after diving. The hyperoxia associated to scuba diving leads to a condition of oxidative stress with increased lymphocyte H<sub>2</sub>O<sub>2</sub> production, HO-1 expression, NO synthesis and

antioxidant enzyme adaptations in order to avoid oxidative damage.  
PMID: 17364955

51: Eur J Appl Physiol. 2007 May;100(2):207-24. Epub 2007 Feb 24.  
Computer simulation of human breath-hold diving: cardiovascular adjustments.  
Fitz-Clarke JR.  
Department of Physiology and Biophysics, Dalhousie University, 5849 University Avenue, Halifax, NS, Canada, B3H 4H7.  
jffitzclarke@eastlink.ca  
The world record for a sled-assisted human breath-hold dive has surpassed 200 m. Lung compression during descent draws blood from the peripheral circulation into the thorax causing engorgement of pulmonary vessels that might impose a physiological limitation due to capillary stress failure. A computer model was developed to investigate cardiopulmonary interactions during immersion, apnea, and compression to elucidate hemodynamic responses and estimate vascular stresses in deep human breath-hold diving. The model simulates active and passive cardiovascular adjustments involving blood volumes, flows, and pressures during apnea at diving depths up to 200 m. Redistribution of blood volume from peripheral to central compartments increases with depth. Pulmonary capillary transmural pressures in the model exceed 50 mm Hg at record depth, producing stresses in the range known to cause alveolar capillary damage in animals. Capillary pressures are partially attenuated by blood redistribution to compliant extra-pulmonary vascular compartments. The capillary pressure differential is due mainly to a large drop in alveolar air pressure from outward elastic chest wall recoil. Autonomic diving reflexes are shown to influence systemic blood pressures, but have relatively little effect on pulmonary vascular pressures. Increases in pulmonary capillary stresses are gradual beyond record depth.  
PMID: 17323072

52: Comp Biochem Physiol A Mol Integr Physiol. 2007 Jun;147(2):438-44. Epub 2007 Jan 27.

Brünnich's guillemots (*Uria lomvia*) maintain high temperature in the body core during dives.

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A major challenge for diving birds, reptiles, and mammals is regulating body temperature while conserving oxygen through a reduction in metabolic processes. To gain insight into how these needs are met, we measured dive depth and body temperatures at the core or periphery between the skin and abdominal muscles simultaneously in freely diving Brünnich's guillemots (*Uria lomvia*), an arctic seabird, using an implantable data logger (16-mm diameter, 50-mm length, 14-g mass, Little Leonardo Ltd., Tokyo). Guillemots exhibited increased body core temperatures, but decreased peripheral temperatures, during diving. Heat conservation within the body core appeared to result from the combined effect of peripheral vasoconstriction and a high wing beat frequency that generates heat. Conversely, the observed tissue hypothermia in the periphery should reduce metabolic processes as well as heat loss to the water. These physiological effects are likely one of the key physiological adaptations that makes guillemots to perform as an efficient predator in arctic waters.

PMID: 17321772

53: Surg Neurol. 2007 Mar;67(3):283-7. Epub 2006 Nov 3.

Spinal cord decompression sickness associated with scuba diving: correlation of immediate and delayed magnetic resonance imaging findings with severity of neurologic impairment--a report on 3 cases.

Yoshiyama M, Asamoto S, Kobayashi N, Sugiyama H, Doi H, Sakagawa H, Ida M.

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BACKGROUND: There are few reports detailing an association between immediate and delayed changes in MR imaging findings and severity of neurologic impairment in patients

with spinal cord DCS. We report on the cases of 3 patients diagnosed with spinal cord DCS presenting with severe neurologic symptoms after scuba diving. CASE DESCRIPTION: Of 175 patients with DCS referred to the Tokyo Metropolitan Ebara Hospital Department of Neurosurgery, 3 were determined by MR imaging and neurologic examination to have a spinal cord injury. Hyperbaric oxygen, methylprednisolone, and rehabilitation therapies were applied to these patients. We examined whether the severity of the patients' neurologic dysfunction, classified according to Fränkel's grade, was associated with the extent of abnormal signals depicted by spinal MR imaging in these patients at the acute phase and monthly follow-up points. T2-weighted MR imaging performed within 24 hours of the onset of the patients' neurologic symptoms revealed signals of increased intensity located predominantly in the dorsolateral regions, involving spinal segments 1 through 4, and a neurologic examination upon admission revealed severe sensory and motor dysfunction (Fränkel's grade A) in all 3 patients. The abnormal signals on MR images at 1 month postinjury were markedly decreased in size as compared with those at the acute phase. However, neurologic function showed minimal or no improvement (Fränkel's grade A or B). CONCLUSION: In patients with spinal cord DCS, the improvement in MR imaging findings was not associated with improved clinical status. This discrepancy suggests that intricate pathophysiologic changes, reversible and persistent damage subsequent to initial cord injuries (ie, edematous and neurotoxic lesions), underlie the disease and affect the clinical course.

Publication Types: Case Reports  
PMID: 17320639

54: Can J Occup Ther. 2007 Feb;74(1):6-14.

Psychosocial aspects of scuba diving for people with physical disabilities: an occupational science perspective.

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**PURPOSE:** This project investigated the psychosocial benefits of scuba diving for individuals with acquired physical impairments. **METHOD:** In-depth, semi-structured interviews were conducted with 3 volunteers recruited from a diving club specializing in training people with disabilities to dive. Qualitative methods were used to analyze the data in order to identify the themes recurring in the interviews. **RESULTS:** The respondents indicated that diving is a challenging, enjoyable activity that enhances their quality of life through enriched social experiences and improved self-concept. Furthermore, subjects stressed that carrying out the activity in a buoyant environment allowed them to feel weightless, thus free from their impairments and equal to non-disabled divers. **IMPLICATIONS:** The study highlighted the need to carry out further research in this field in order to gain better insight into the impact of scuba diving on the quality of life of people with physical impairments.  
PMID: 17319318

55: *Occup Med (Lond)*. 2007 Jun;57(4):254-61. Epub 2007 Feb 22. Health status of professional divers and offshore oil industry workers. Ross JA, Macdiarmid JI, Osman LM, Watt SJ, Godden DJ, Lawson A. Department of Environmental and Occupational Medicine, University of Aberdeen, Aberdeen, UK. j.a.ross@abdn.ac.uk  
**AIMS:** To compare the health status of UK professional divers and age-matched non-divers and to contrast offshore divers (OSDs) with non-offshore divers (NOSDs). **METHODS:** A postal survey sent to 2958 male professional divers, registered with the UK Health & Safety Executive (HSE) before 1991, and 2708 men who had worked in the offshore oil industry in 1990-92 (non-divers). The questionnaire addressed lifestyle, occupation and health status. **RESULTS:** In all, 56% of divers and 51% of non-divers responded. Three per cent of participants reported ill-health retirement or being off-work on

sickness benefit with no difference between groups. Divers were less likely to report asthma or hypertension. Health-related quality of life (SF-12) was within normal limits for both groups but the mental component summary was higher in divers who were also less likely to be receiving medical treatment. Divers were more likely than non-divers to report 'forgetfulness or loss of concentration' (18% versus 6%, OR 3.8, 95% CI 2.7-5.3), musculoskeletal symptoms (41% versus 34%, OR 3.8, 95% CI 2.7-5.3) and 'impaired hearing' (16% versus 11%, OR 1.6, 95% CI 1.2-2.0). These differences were attributable to increased symptom reporting in OSDs and were not present for NOSDs, with the exception of cognitive symptomatology which was commoner in both OSDs (22%, OR 4.8, 95% CI 3.4-6.8) and NOSDs (9%, OR 1.9, 95% CI 1.1-3.3) than in non-divers (6%). **CONCLUSIONS:** There was increased symptom reporting in OSDs. However, there was no evidence to suggest any major impact on long-term health of UK divers who had started their career before 1991.

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17317702

56: *Aviat Space Environ Med*. 2007 Feb;78(2):94-9. Validation of decompression procedures based on detection of venous gas bubbles: A Bayesian approach. Eftedal OS, Tjelmeland H, Brubakk AO. Department of Circulation and Medical Imaging, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway. olav.s.eftedal@ntnu.no  
**INTRODUCTION:** Verification of new decompression procedures has traditionally been based on observing the occurrence of decompression sickness (DCS) in test dives. Several hundred exposures are required to determine the safety of a procedure with any degree of certainty. The number of venous gas emboli (VGE) corresponds with the risk of getting DCS and detection of VGE has been used as an alternative method for validation of decompression procedures. We propose a new and improved method for

validation based on detection of VGE. METHODS: Our Bayesian statistics method combines results from ultrasound detection of VGE in test dives with knowledge about the correspondence between VGE and DCS risk obtained from a large number of previous experimental studies. Our algorithm is implemented in a computer program; it estimates DCS risk and 95% credible intervals for the tested procedure. RESULTS: We have applied the method to available VGE data from tested air diving procedures with between 7 and 14 test dives for each procedure. The estimated credible intervals correspond to confidence intervals from 130-250 dives using the binomial distribution of the traditional "DCS observation validation." DISCUSSION: We conclude that, compared with previous methods, the proposed method can greatly reduce the number of dives required to validate or reject new decompression procedures. Publication Types: Validation Studies PMID: 17310879

57: Aviat Space Environ Med. 2007 Feb;78(2):87-93. Stress biomarkers in a rat model of decompression sickness. Montcalm-Smith E, Caviness J, Chen Y, McCarron RM. Naval Medical Research Center, Silver Spring, MD 20910-7500, USA. INTRODUCTION: Immune reactivity, stress responses, and inflammatory reactions may all contribute to pathogenic mechanisms associated with decompression sickness (DCS). Currently, there are no biomarkers for DCS. This research examined if DCS is associated with increased levels of biomarkers associated with vascular function, early/non-specific stress responses, and hypothalamic-pituitary-adrenal (HPA) axis stress responses. METHODS: Rats undergoing a test dive to 175 ft of seawater (fsw) (6.2 ATA) for 60 min with a rapid decompression were observed for DCS (ambulatory deficit). Animals exercised on a rotating cage (approximately 3 m x min(-1)) throughout the dive and subsequent 30-min observation period. All animals were euthanized and blood and tissue samples (brain, liver, lung) were collected for

analysis of CRP and ET-1 by ELISA and stress markers by PCR. RESULTS: HO-1 and HSP-70 increased in the brain, and HO-1, Egr-1, and iNOS increased in the lungs of animals with DCS. There was no difference in any stress marker in the liver, or in serum levels of CRP or ET-1. CONCLUSIONS: The results demonstrate that < 30 min after surfacing, there are genomic changes in animals with DCS compared with animals not showing signs of DCS. Identification of specific markers of DCS may permit use of such biomarkers as predictors of DCS susceptibility and/or occurrence. Publication Types: Research Support, U.S. Gov't, Non-P.H.S. PMID: 17310878

58: Aviat Space Environ Med. 2007 Feb;78(2):81-6. Fatal respiratory failure during a "technical" rebreather dive at extreme pressure. Mitchell SJ, Cronjé FJ, Meintjes WA, Britz HC. Department of Anaesthesia, Auckland City Hospital, Auckland, New Zealand. dr.m@extra.co.nz A diving fatality at the extreme depth of 264 m fresh water is described. The diver was equipped with an underwater video camera which recorded events leading to his death. These events corroborated predictions about respiratory complications at extreme pressure made by early researchers. Review of the video and relevant literature resulted in the following physiological interpretation: an increase in respired gas density during descent caused a progressive increase in resistance to flow in both the airways and the breathing circuit. Initially, this was associated with a shift to ventilation at higher lung volumes, a relative degree of hypoventilation, and mild permissive hypercapnia. The promotion of turbulent airway flow by increasing gas density resulted in effort-independent expiratory flow at lower flow rates than usual. The consequent inability to match ventilation to the demands of physical work at the bottom precipitated a spiraling crisis of dyspnea, increasing PaCO<sub>2</sub>, and wasted respiratory effort, thus

producing more CO<sub>2</sub>. Extreme hypercapnia eventually led to unconsciousness. This tragic case provides a timely and salient lesson to a growing population of deep "technical" divers that there are physiological limitations that must be understood and considered when planning extreme dives.

Publication Types: Case Reports  
PMID: 17310877

59: J Comp Physiol B. 2007 May;177(4):483-94. Epub 2007 Feb 9. The physiological and behavioural development of diving in Australian fur seal (*Arctocephalus pusillus doriferus*) pups. Spence-Bailey LM, Verrier D, Arnould JP.

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The physiological and behavioural development of diving was examined in Australian fur seal (*Arctocephalus pusillus doriferus*) pups to assess whether animals at weaning are capable of exploiting the same resources as adult females. Haematocrit, haemoglobin and myoglobin contents all increased throughout pup development though total body oxygen stores reached only 71% of adult female levels just prior to weaning. Oxygen storage components, however, did not develop at the same pace. Whereas blood oxygen stores had reached adult female levels by 9 months of age, muscle oxygen stores were slower to develop, reaching only 23% of adult levels by this age. Increases in diving behaviour corresponded to the physiological changes observed. Pups spent little time (<8%) in the water prior to moulting (age 1-2 months) whereas following the moult, they spent >27% of time in the water and made mid-water dives (maximum depth 35.7 +/- 2.9 m) with durations of 0.35 +/- 0.03 min. By 9 months (just prior to weaning), 30.5 +/- 9.3% of all dives performed were U-shaped benthic dives (maximum depth 65.0 +/- 6.0 m) with mean durations of 0.87 +/- 0.25 min, significantly shorter than those of adult females. These results suggest that while Australian fur seal pups approaching

the age of weaning are able to reach similar depths as adult females, they do not have the physiological capacity to remain at these depths for sufficient durations to exploit them to the same efficiency.

PMID: 17294194

60: Physiol Biochem Zool. 2007 Mar-Apr;80(2):209-19. Epub 2007 Jan 16. Behavioral inference of diving metabolic rate in free-ranging leatherback turtles.

Bradshaw CJ, McMahon CR, Hays GC. School for Environmental Research, Institute of Advanced Studies, Charles Darwin University, Darwin, Northern Territory 0909, Australia. corey.bradshaw@cdu.edu.au

Good estimates of metabolic rate in free-ranging animals are essential for understanding behavior, distribution, and abundance. For the critically endangered leatherback turtle (*Dermochelys coriacea*), one of the world's largest reptiles, there has been a long-standing debate over whether this species demonstrates any metabolic endothermy. In short, do leatherbacks have a purely ectothermic reptilian metabolic rate or one that is elevated as a result of regional endothermy? Recent measurements have provided the first estimates of field metabolic rate (FMR) in leatherback turtles using doubly labeled water; however, the technique is prohibitively expensive and logistically difficult and produces estimates that are highly variable across individuals in this species. We therefore examined dive duration and depth data collected for nine free-swimming leatherback turtles over long periods (up to 431 d) to infer aerobic dive limits (ADLs) based on the asymptotic increase in maximum dive duration with depth. From this index of ADL and the known mass-specific oxygen storage capacity ( $To(2)$ ) of leatherbacks, we inferred diving metabolic rate (DMR) as  $To2/ADL$ . We predicted that if leatherbacks conform to the purely ectothermic reptilian model of oxygen consumption, these inferred estimates of DMR should fall between predicted and measured values of reptilian resting and field metabolic rates, as well as being substantially lower than the FMR

predicted for an endotherm of equivalent mass. Indeed, our behaviorally derived DMR estimates (mean=0.73+/-0.11 mL O<sub>2</sub> min<sup>-1</sup> kg<sup>-1</sup>) were 3.00+/-0.54 times the resting metabolic rate measured in unrestrained leatherbacks and 0.50+/-0.08 times the average FMR for a reptile of equivalent mass. These DMRs were also nearly one order of magnitude lower than the FMR predicted for an endotherm of equivalent mass. Thus, our findings lend support to the notion that diving leatherback turtles are indeed ectothermic and do not demonstrate elevated metabolic rates that might be expected due to regional endothermy. Their capacity to have a warm body core even in cold water therefore seems to derive from their large size, heat exchangers, thermal inertia, and insulating fat layers and not from an elevated metabolic rate.

Publication Types: Comparative Study  
Research Support, Non-U.S. Gov't  
PMID: 17252517

61: Adv Otorhinolaryngol. 2007;65:146-9.  
Clinical significance of stapedioplasty biomechanics: swimming, diving, flying after stapes surgery.

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A piston prosthesis in stapedioplasty significantly modifies the function of the normal ossicular chain. Due to the fact that the ear works as a pressure receptor, a piston prosthesis will be displaced at ambient air pressure changes in a different way than the normal stapes. Our ear is constantly exposed to these pressure changes in daily life, for example during swallowing, with tubal opening, with wind gusts at the external ear, during flying, or diving. Temporal bone experiments showed that elevated static pressures, like in tympanometry, can displace a piston up to 0.5mm in the vestibule. These large movements, which are caused by the missing attachment of the piston to the annular ligament, may explain why a short piston can be

lifted out of the footplate perforation (e.g. after sneezing) or a piston with excessive length might come into contact with the membranous labyrinth, causing vertigo with an inward movement. Flying or diving can be performed by the patients after stapedioplasty, provided that a test with tympanometry is tolerated without evoking vertigo.

PMID: 17245036

62: Ann Readapt Med Phys. 2007 Apr;50(3):174-8. Epub 2007 Jan 17.

[Neurogenic bladder dysfunction a main disability of decompression sickness: a case report]

[Article in French]

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INTRODUCTION: Bladder dysfunction is common in the acute phase of decompression sickness and often precedes motor disorders. Few studies have reported the persistence of urinary problems, and no prior reports describe a neurogenic bladder in the primary presentation of decompression sickness. CASE REPORT: We report the case of a 21-year-old female scuba diver with no medical history. After two successive deep dives, dysbaric myelitis developed. The risk factors were foramen ovale and history of diving. The patient initially showed tetraparesia, which was quickly followed by paraparesia with urinary retention. Treatment consisted of recompression with high concentrations of inspired oxygen, aspirin administration and continuous drainage by an indwelling catheter. No lesion was found on 2 sessions of magnetic resonance imaging (MRI) (cerebral and spinal), and somatosensory-evoked potentials were normal. Motor-evoked potential onset latencies were delayed.

Neuro-urodynamic investigations revealed detrusor sphincter dysynergia and detrusor overactivity. On quick, complete motor recovery, the patient returned to work and continued with sports (except scuba diving). A year later, she still had urinary and faecal urgencies which were not completely

resolved with medication and altered her quality of life. CONCLUSION: Half of the cases of neurological decompression involve dysbaric myelitis. Venous ischemia is the most likely cause. Foramen ovale is an important risk factor, but the pathophysiology is obscure. Bladder problems, common in the acute phase of decompression sickness, may be the primary presentation, and may be prolonged.

Publication Types: Case Reports  
English Abstract  
PMID: 17239473

63: Am J Physiol Regul Integr Comp Physiol. 2007 May;292(5):R2028-38. Epub 2007 Jan 11.

Estimating the rate of oxygen consumption during submersion from the heart rate of diving animals.

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How animals manage their oxygen stores during diving and other breath-hold activities has been a topic of debate among physiologists for decades. Specifically, while the behavior of free-ranging diving animals suggests that metabolism during submersion must be primarily aerobic in nature, no studies have been able to determine their rate of oxygen consumption during submersion ( $\dot{V}_{O_2}$ ) and hence prove that this is the case. In the present study, we combine two previously used techniques and develop a new model to estimate  $\dot{V}_{O_2}$  accurately and plausibly in a free-ranging animal and apply it to data for macaroni penguins (*Eudyptes chrysolophus*) as an example. For macaroni penguins at least,  $\dot{V}_{O_2}$  can be predicted by measuring heart rate during the dive cycle and the subsequent surface interval duration. Including maximum depth of the dive improves the accuracy of these predictions. This suggests that energetically demanding locomotion events within the dive combine with the differing buoyancy and locomotion costs associated with traveling to depth to influence its cost in terms of oxygen use. This will in turn effect the duration of the dive and the duration of the subsequent recovery period. In the present study,  $\dot{V}_{O_2}$

ranged from 4 to 28 ml.min<sup>-1</sup>.kg<sup>-1</sup>), indicating that, at least as far as aerobic metabolism was concerned, macaroni penguins were often hypometabolic, with rates of oxygen consumption usually below that for this species resting in water (25.6 ml.min<sup>-1</sup>.kg<sup>-1</sup>) and occasionally lower than that while resting in air (10.3 ml.min<sup>-1</sup>.kg<sup>-1</sup>).

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17218442

64: J Appl Physiol. 2007 Apr;102(4):1301-2. Epub 2007 Jan 11. Comment on: J Appl Physiol. 2007 Apr;102(4):1324-8.

A rat model to study decompression sickness after a trimix dive.

Boussuges A.

Publication Types: Comment Editorial  
PMID: 17218434

65: J Exp Biol. 2007 Jan;210(Pt 2):278-89.

Total body oxygen stores and physiological diving capacity of California sea lions as a function of sex and age.

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A defining physiological capability for air-breathing marine vertebrates is the amount of oxygen that can be stored in tissues and made available during dives. To evaluate the influence of oxygen storage capacity on aerobic diving capacity, we examined the extent to which blood and muscle oxygen stores varied as a function of age, body size and sex in the sexually dimorphic California sea lion, *Zalophus californianus*. We measured total body oxygen stores, including hematocrit, hemoglobin, MCHC, plasma volume, blood volume and muscle myoglobin in pups through adults of both sexes. Blood and muscle oxygen storage capacity was not fully developed by the end of the dependency period, with blood stores not fully developed until animals were larger juveniles (70 kg; 1.5-2.5 years) and muscle stores not until animals were sub-adult size (125 kg; 4-6 years).

Differences in aerobic diving capacity among size classes were reflective of these major milestones in the development of oxygen stores. Male sea lions had greater absolute blood volume than females and reflected the larger mass of males, which became apparent when animals were large juveniles. Adult female sea lions had greater muscle myoglobin concentrations compared to males, resulting in greater mass-specific muscle and total oxygen stores. Delayed development of oxygen stores is consistent with the shallow epi-mesopelagic foraging behavior in this species. We hypothesize that the greater mass-specific oxygen stores of female sea lions compared to males is related to differences in foraging behavior between the sexes.

Publication Types: Comparative Study  
Research Support, Non-U.S. Gov't  
Research Support, U.S. Gov't, Non-P.H.S.  
PMID: 17210964

66: J Appl Physiol. 2007 Apr;102(4):1324-8. Epub 2006 Dec 28.  
Comment in: J Appl Physiol. 2007 Apr;102(4):1301-2.

Decompression sickness in the rat following a dive on trimix: recompression therapy with oxygen vs. heliox and oxygen.

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Trimix (a mixture of helium, nitrogen, and oxygen) has been used in deep diving to reduce the risk of high-pressure nervous syndrome during compression and the time required for decompression at the end of the dive. There is no specific recompression treatment for decompression sickness (DCS) resulting from trimix diving. Our purpose was to validate a rat model of DCS on decompression from a trimix dive and to compare recompression treatment with oxygen and heliox (helium-oxygen). Rats were exposed to trimix in a hyperbaric chamber and tested for DCS while walking in a rotating wheel. We first established the experimental model, and then studied the effect of hyperbaric treatment on DCS: either hyperbaric oxygen (HBO) (1 h, 280 kPa oxygen)

or heliox-HBO (0.5 h, 405 kPa heliox 50%-50% followed by 0.5 h, 280 kPa oxygen). Exposure to trimix was conducted at 1,110 kPa for 30 min, with a decompression rate of 100 kPa/min. Death and most DCS symptoms occurred during the 30-min period of walking. In contrast to humans, no permanent disability was found in the rats. Rats with a body mass of 100-150 g suffered no DCS. The risk of DCS in rats weighing 200-350 g increased linearly with body mass. Twenty-four hours after decompression, death rate was 40% in the control animals and zero in those treated immediately with HBO. When treatment was delayed by 5 min, death rate was 25 and 20% with HBO and heliox, respectively.

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17194730

67: J Anim Ecol. 2007 Jan;76(1):183-90.

Recording the free-living behaviour of small-bodied, shallow-diving animals with data loggers.

Hays GC, Forman DW, Harrington LA, Harrington AL, MacDonald DW, Righton D.

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1. Time-depth data recorders (TDRs) have been widely used to explore the behaviour of relatively large, deep divers. However, little is known about the dive behaviour of small, shallow divers such as semi-aquatic mammals. 2. We used high-resolution TDRs to record the diving behaviour of American mink *Mustela vison* (weight of individuals 580-1275 g) in rivers in Oxfordshire (UK) between December 2005 and March 2006. 3. Dives to > 0.2 m were measured in all individuals (n = 6). Modal dive depth and duration were 0.3 m and 10 s, respectively, although dives up to 3 m and 60 s in duration were recorded. Dive duration increased with dive depth. 4. Temperature data recorded by TDRs covaried with diving behaviour: they were relatively cold (modal temperature 4-6 degrees C across individuals) when mink were diving and relatively warm (modal temperature 24-36 degrees C across

individuals) when mink were not diving. 5. Individuals differed hugely in their use of rivers, reflecting foraging plasticity across both terrestrial and aquatic environments. For some individuals there was < 1 dive per day while for others there was > 100 dives per day. 6. We have shown it is now possible to record the diving behaviour of small free-living animals that only dive a few tens of centimetres, opening up the way for a new range of TDR studies on shallow diving species.

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17184367

68: Eur J Appl Physiol. 2007 Mar;99(4):393-404. Epub 2006 Dec 13. Respiratory muscle training improves swimming endurance in divers. Wylegala JA, Pendergast DR, Gosselin LE, Warkander DE, Lundgren CE. Center for Research and Education in Special Environments, State University of New York at Buffalo, Buffalo, NY, USA.

Respiratory muscles can fatigue during prolonged and maximal exercise, thus reducing performance. The respiratory system is challenged during underwater exercise due to increased hydrostatic pressure and breathing resistance. The purpose of this study was to determine if two different respiratory muscle training protocols enhance respiratory function and swimming performance in divers. Thirty male subjects (23.4 +/- 4.3 years) participated. They were randomized to a placebo (PRMT), endurance (ERMT), or resistance respiratory muscle training (RRMT) protocol. Training sessions were 30 min/day, 5 days/week, for 4 weeks. PRMT consisted of 10-s breath-holds once/minute, ERMT consisted of isocapnic hyperpnea, and RRMT consisted of a vital capacity maneuver against 50 cm H<sub>2</sub>O resistance every 30 s. The PRMT group had no significant changes in any measured variable. Underwater and surface endurance swim time to exhaustion significantly increased after RRMT (66%, P < 0.001; 33%, P = 0.003) and ERMT (26%, P = 0.038; 38%, P < 0.001). Breathing frequency (f (b)) during the underwater endurance swim decreased in RRMT

(23%, P = 0.034) and tidal volume (V (T)) increased in both the RRMT (12%, P = 0.004) and ERMT (7%, P = 0.027) groups. Respiratory endurance increased in ERMT (216.7%) and RRMT (30.7%). Maximal inspiratory and expiratory pressures increased following RRMT (12%, P = 0.015, and 15%, P = 0.011, respectively). Results from this study indicate that respiratory muscle fatigue is a limiting factor for underwater swimming performance, and that targeted respiratory muscle training (RRMT > ERMT) improves respiratory muscle and underwater swimming performance.

Publication Types: Randomized Controlled Trial  
Support, Non-U.S. Gov't  
PMID: 17165052

69: J Appl Physiol. 2007 Mar;102(3):831-3. Epub 2006 Nov 30. Comment on: J Appl Physiol. 2007 Mar;102(3):841-6.

Going to extremes of lung volume. Whittaker LA, Irvin CG.

Publication Types: Comment Editorial  
Research Support, N.I.H., Extramural  
Support, Non-U.S. Gov't  
PMID: 17138830

70: Br J Sports Med. 2007 Jun;41(6):375-9. Epub 2006 Nov 30. Haemodynamic changes induced by submaximal exercise before a dive and its consequences on bubble formation.

Blatteau JE, Boussuges A, Gempp E, Pontier JM, Castagna O, Robinet C, Galland FM, Bourdon L. Département de Médecine Hyperbare, Hôpital d'Instruction des Armées Sainte-Anne, 83800 Toulon Armées, France. je.blatteau@infonie.fr  
OBJECTIVES: To evaluate the effects of a submaximal exercise performed 2 h before a simulated dive on bubble formation and to observe the haemodynamic changes and their influence on bubble formation. PARTICIPANTS AND METHODS: 16 trained divers were compressed in a hyperbaric chamber to 400 kPa for 30 min and decompressed at a rate of 100 kPa/min with a 9 min stop at 130 kPa (French Navy MN90 procedure). Each diver performed two dives 3 days apart, one without exercise and one with exercise before the dive. All participants performed a 40 min

constant-load submaximal and calibrated exercise, which consisted of outdoor running 2 h before the dive. Circulating bubbles were detected with a precordial Doppler at 30, 60 and 90 min after surfacing. Haemodynamic changes were evaluated with Doppler echocardiography. RESULTS: A single bout of strenuous exercise 2 h before a simulated dive significantly reduced circulating bubbles. Post-exercise hypotension (PEH) was observed after exercise with reductions in diastolic and mean blood pressure (DBP and MBP), but total peripheral resistance was unchanged. Stroke volume was reduced, whereas cardiac output was unchanged. Simulated diving caused a similar reduction in cardiac output independent of pre-dive exercise, suggesting that pre-dive exercise only changed DBP and MBP caused by reduced stroke volume. CONCLUSION: A single bout of strenuous exercise 2 h before a dive significantly reduced the number of bubbles in the right heart of divers and protected them from decompression sickness. Declining stroke volume and moderate dehydration induced by a pre-dive exercise might influence inert gas load and bubble formation.

Publication Types: Comparative Study

PMID: 17138641

71: J Appl Physiol. 2007 Mar;102(3):841-6. Epub 2006 Nov 16. Comment in: J Appl Physiol. 2007 Mar;102(3):831-3.

Transpulmonary pressures and lung mechanics with glossopharyngeal insufflation and exsufflation beyond normal lung volumes in competitive breath-hold divers.

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Throughout life, most mammals breathe between maximal and minimal lung volumes determined by respiratory mechanics and muscle strength. In contrast, competitive breath-hold divers exceed these limits when they employ glossopharyngeal insufflation (GI) before a dive to increase lung gas

volume (providing additional oxygen and intrapulmonary gas to prevent dangerous chest compression at depths recently greater than 100 m) and glossopharyngeal exsufflation (GE) during descent to draw air from compressed lungs into the pharynx for middle ear pressure equalization. To explore the mechanical effects of these maneuvers on the respiratory system, we measured lung volumes by helium dilution with spirometry and computed tomography and estimated transpulmonary pressures using an esophageal balloon after GI and GE in four competitive breath-hold divers. Maximal lung volume was increased after GI by 0.13-2.84 liters, resulting in volumes 1.5-7.9 SD above predicted values. The amount of gas in the lungs after GI increased by 0.59-4.16 liters, largely due to elevated intrapulmonary pressures of 52-109 cmH<sub>2</sub>O. The transpulmonary pressures increased after GI to values ranging from 43 to 80 cmH<sub>2</sub>O, 1.6-2.9 times the expected values at total lung capacity. After GE, lung volumes were reduced by 0.09-0.44 liters, and the corresponding transpulmonary pressures decreased to -15 to -31 cmH<sub>2</sub>O, suggesting closure of intrapulmonary airways. We conclude that the lungs of some healthy individuals are able to withstand repeated inflation to transpulmonary pressures far greater than those to which they would normally be exposed.

Publication Types: Research Support, Non-U.S. Gov't  
PMID: 17110514

72: J Physiol. 2007 Feb 1;578(Pt 3):859-70. Epub 2006 Nov 16.

Comment in: J Physiol. 2007 Aug 15;583(Pt 1):405; author reply 407. The effects of acute oral antioxidants on diving-induced alterations in human cardiovascular function.

Obad A, Palada I, Valic Z, Ivancev V, Baković D, Wisløff U, Brubakk AO, Đujić Z.

Department of Physiology, University of Split School of Medicine, Soltanska 2, 21000 Split, Croatia. Diving-induced acute alterations in cardiovascular function such as arterial endothelial dysfunction,

increased pulmonary artery pressure (PAP) and reduced heart function have been recently reported. We tested the effects of acute antioxidants on arterial endothelial function, PAP and heart function before and after a field dive. Vitamins C (2 g) and E (400 IU) were given to subjects 2 h before a second dive (protocol 1) and in a placebo-controlled crossover study design (protocol 2). Seven experienced divers performed open sea dives to 30 msw with standard decompression in a non-randomized protocol, and six of them participated in a randomized trial. Before and after the dives ventricular volumes and function and pulmonary and brachial artery function were assessed by ultrasound. The control dive resulted in a significant reduction in flow-mediated dilatation (FMD) and heart function with increased mean PAP. Twenty-four hours after the control dive FMD was still reduced 37% below baseline (8.1 versus 5.1%,  $P = 0.005$ ), while right ventricle ejection fraction (RV-EF), left ventricle EF and endocardial fractional shortening were reduced much less (approximately 2-3%). At the same time RV end-systolic volume was increased by 9% and mean PAP by 5%. Acute antioxidants significantly attenuated only the reduction in FMD post-dive ( $P < 0.001$ ), while changes in pulmonary artery and heart function were unaffected by antioxidant ingestion. These findings were confirmed by repeating the experiments in a randomized study design. FMD returned to baseline values 72 h after the dive with pre-dive placebo, whereas for most cardiovascular parameters this occurred earlier (24-48 h). Right ventricular dysfunction and increased PAP lasted longer. Acute antioxidants attenuated arterial endothelial dysfunction after diving, while reduction in heart and pulmonary artery function were unchanged. Cardiovascular changes after diving are not fully reversed up to 3 days after a dive, suggesting longer lasting negative effects.

Publication Types: Randomized Controlled Trial  
Research Support, Non-U.S. Gov't  
PMID: 17110413

73: J Laryngol Otol. 2007 Apr;121(4):306-11. Epub 2006 Jul 3. Otolaryngological requirements for recreational self-contained underwater breathing apparatus (SCUBA) diving. Sim RJ, Youngs RP. Department of Otolaryngology, Gloucester Royal Hospital, Gloucester, UK. Recreational self-contained underwater breathing apparatus (SCUBA) diving continues to grow in popularity. Medical requirements to be 'fit to dive' vary throughout the world, from self-certification to a full medical examination prior to training. This review discusses the relative merits of the most commonly used guidelines for recreational SCUBA diving, with reference to common diving-related otorhinolaryngological conditions. Areas of controversy, such as fitness to dive after rhinological and otological surgery, are discussed. The authors suggest that a unified approach from the various recreational SCUBA diving organizations involved would aid in clarification for divers and physicians alike. The difficulties in achieving such a unified approach, however, should not be underestimated.

Publication Types: Review  
PMID: 17040582

74: Int J Sports Med. 2007 Apr;28(4):295-9. Epub 2006 Oct 6. Loss of motor control and/or loss of consciousness during breath-hold competitions. Lindholm P.

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Since the first official world championships in breath-hold diving (1996), a sport has developed where the athletes compete in various disciplines of breath-hold diving. One of the rules is that the diver should surface from a dive without showing any signs of hypoxia. Depending on the severity of hypoxia, a diver may suffer disqualifying signs such as loss of consciousness (LOC) or loss of motor control (LMC), the latter

including signs such as confusion, affected postural control, spasms or speech problems. Data was collected from the results of the major international competitions following AIDA guidelines (Association International pour le Développement de l'Apnée) in 1998, 2001-2004. The data was analyzed for frequency of LOC and LMC during constant weight diving and during static apnea. In constant weight diving, the diver swims down (and up) as deeply as possible along a vertically suspended rope (current record 105 m). In static apnea, the diver strives for maximum duration, floating motionless face down in a pool (current record 8.58 min). A total of 601 static apnea (SA) performances and 596 constant weight dives were judged in the six competitions. On average, 10 % of SA, and 11 % of CW performances were disqualified due to signs of hypoxia. For the competitions in 2002-2004, a distinction was made in the rules between LOC and LMC; of a total number of 355 SA performances, 1.1 % resulted in LOC, while 9.6 % resulted in LMC. For CW, the number was 344 with 6.1 % LOC and 6.1 % LMC. Despite the relatively high incidence of dramatic signs, it is noteworthy that there have been no reports of fatal accidents or permanent injuries from any of the above-mentioned competitions. This descriptive paper shows a relatively high incidence of disqualifications due to signs of hypoxia in breath-hold competitions 1998-2004.

PMID: 17024640

75: Anaesthesist. 2007 Jan;56(1):44-52.

[Oxygen therapy in diving accidents]  
[Article in German]

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Diving accidents represent a departure from the routine practice of emergency physicians. The incidence of non-fatal diving accidents is reported as 1-2 per 10,000 dives. Apart from adequate intravenous hydration, oxygen is the only medication with a proven effect in the treatment of diving

accidents. After a typical diving accident, administration of oxygen at an inspired concentration (F(I)O<sub>2</sub>) 1.0 as high as possible is recommended. Many divers bring along their own oxygen administration systems to the diving sites and these are often better suited for the treatment of diving accidents than the oxygen systems of many emergency responders. Pressure regulators supplying low constant flow oxygen, nasal prongs and inhalation masks are inappropriate. When using artificial ventilation bags with face masks, an oxygen flow of at least 15 l/min should be used. Demand regulators are simple to use and able to deliver a F(I)O<sub>2</sub> of 1.0. Their ease of use has earned them high marks in the emergency management of diving accidents and their similarity to standard diving equipment has also aided relatively widespread acceptance. Circulation breathing systems are more technologically complex oxygen delivery systems which permit CO<sub>2</sub> absorption and re-breathing at low oxygen flow. In contrast to the demand modules, the likelihood of mistakes during their usage is higher. In diving accidents, the administration of normobaric oxygen, already begun in the field, is the most important therapy and should not be interrupted. Presented with an inadequate supplemental oxygen supply, the inspired oxygen concentration should not be decreased, rather the duration of the oxygen administration should be reduced. Hyperbaric oxygen therapy should be the mainstay of further treatment.

Publication Types: English  
Abstract Review

PMID: 17021886 [PubMed - indexed for MEDLINE]