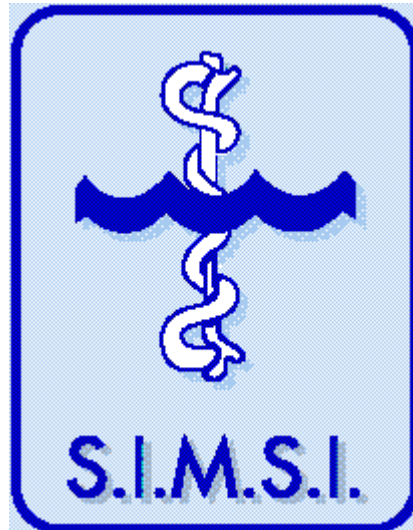
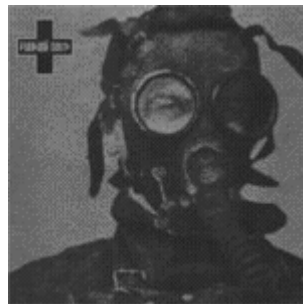


**SOCIETA' ITALIANA
DI
MEDICINA SUBACQUEA E IPERBARICA**



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



**2008
SECONDO 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 2008/07 to 2008/12

**Search "Diving"[MAJR] Limits:
Publication Date from 2008/07 to
2008/12**

1: G Ital Cardiol (Rome). 2008 Oct;9(10 Suppl 1):94S-98S.

[The heart in extreme sports: hyperbaric activity and microgravity]

[Article in Italian]

Berrettini U, Landolfi A, Patteri G. U.O. di Cardiologia, Presidio di Alta Specializzazione "G.M. Lancisi", Ospedali Riuniti, Ancona. uberrettini@hotmail.it

The study of the cardiovascular and respiratory modifications in extreme environments could be useful for the understanding of the adaptive mechanisms of the body in particular conditions. The knowledge of how different environmental conditions in terms of extreme pressure, temperature and gravity modify the neurovegetative and cardiovascular system could be useful in daily practice for hypobaric and hyperbaric sports.

Publication Types: English Abstract

PMID: 19195315

2: Undersea Hyperb Med. 2008 Nov-Dec;35(6):417-26.

Pulmonary effects of submerged exercise while breathing 140 kPa oxygen.

Shykoff BE.

Navy Experimental Diving Unit, Panama City, FL, USA.

Pulmonary effects of prolonged mild intermittent underwater cycle ergometer exercise were assessed after single and repeated four-hour dives to 12 feet. With air, five daily dives (surface interval [SI], 20 hours), and with 100% oxygen, single dives, five daily dives, and afternoon-morning dives (SI, 15 hours) were conducted. Air divers had no symptoms or abnormal pulmonary function values but showed slight decreases within the normal range in forced expired volume in one second (FEV1; -0.45%/day) and forced expired flow between 25% and 75% of volume expired (FEF25-75; -

0.8%/day). After one oxygen dive, incidences of mild symptoms or reduced pulmonary function were not different with exercise from those resting, but during five dives, decreases were significant in FEF25-75 (-1.8%/day) and diffusing capacity of the lung for carbon monoxide (D(L)CO; -1.2%/day), estimated to cause abnormal values in 25% of divers in nine to ten days. Following afternoon-morning dive pairs, changes in FEV1 and FEF25-75 were similar to those after nine or four daily dives, respectively. Exercise increases the injurious pulmonary effects of 140 kPa oxygen, and oxygen, those of exercise. A one-day break should follow two 4-hour exercise oxygen dives with surface intervals of 15 to 20 hours.

Publication Types: Research Support, U.S. Gov't, Non-P.H.S.
PMID: 19175197

3: Undersea Hyperb Med. 2008 Nov-Dec;35(6):407-16.

Doppler ultrasound surveillance in deep tunneling compressed-air work with Trimix breathing: bounce dive technique compared to saturation-excursion technique.

Vellinga TP, Sterk W, de Boer AG, van der Beek AJ, Verhoeven AC, van Dijk FJ.

Coronel Institute of Occupational Health, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands.

The Western Scheldt Tunneling Project in The Netherlands provided a unique opportunity to evaluate two deep-diving techniques with Doppler ultrasound surveillance. Divers used the bounce diving techniques for repair and maintenance of the TBM. The tunnel boring machine jammed at its deepest depth. As a result the work time was not sufficient. The saturation diving technique was developed and permitted longer work time at great depth. Thirty-one divers were involved in this project. Twenty-three divers were examined using Doppler ultrasound. Data analysis addressed 52 exposures to Trimix at 4.6-4.8 bar gauge using the bounce technique and 354 exposures to Trimix at 4.0-6.9 bar gauge on saturation excursions. No

decompression incidents occurred with either technique during the described phase of the project. Doppler ultrasound revealed that the bubble loads assessed in both techniques were generally low. We find out, that despite longer working hours, shorter decompression times and larger physical workloads, the saturation-excursion technique was associated with significant lower bubble grades than in the bounce technique using Doppler Ultrasound. We conclude that the saturation-excursion technique with Trimix is a good option for deep and long exposures in caisson work. The Doppler technique proved valuable, and it should be incorporated in future compressed-air work.

Publication Types: Comparative Study Evaluation Studies
PMID: 19175196

4: Undersea Hyperb Med. 2008 Nov-Dec;35(6):393-406.

Common causes of open-circuit recreational diving fatalities.

Denoble PJ, Caruso JL, Dear Gde L, Pieper CF, Vann RD.

Divers Alert Network, Duke University Medical Center, Durham, NC 27710, USA.

Diving fatalities causes were investigated in 947 recreational open-circuit scuba diving deaths from 1992-2003. Where possible, cases were classified at each step of a four step sequence: trigger, disabling agent, disabling injury, cause of death (COD). The most frequent adverse events within each step were: (a) triggers 41% insufficient gas, 20% entrapment, 15% equipment problems; (b) disabling agents--55% emergency ascent, 27% insufficient gas, 13% buoyancy trouble; (c) disabling injuries--33% asphyxia, 29% arterial gas embolism (AGE), 26% cardiac incidents; and (d) COD--70% drowning, 14% AGE, 13% cardiac incidents. We concluded that disabling injuries were more relevant than COD as drowning was often secondary to a disabling injury. Frequencies and/or associations with risk factors were investigated for each disabling injury by logistic regression. (The reference group for each injury was all other injuries.) Frequencies and/or associations included: (a)

asphyxia--40% entrapment (Odds Ratio, OR > or = 30), 32% insufficient gas (OR = 15.9), 17% buoyancy trouble, 15% equipment trouble (OR = 4.5), 11% rough water, drysuit (OR = 4.1), female gender (OR = 2.1); (b) AGE--96% emergency ascent (OR > or = 30), 63% insufficient gas, 17% equipment trouble, 9% entrapment; (c) cardiac incidents--cardiovascular disease (OR = 10.5), age > 40 (OR = 5.9). Minimizing the frequent adverse events would have the greatest impact on reducing diving deaths.

PMID: 19175195

5: An Pediatr (Barc). 2009 Jan;70(1):95-7. Epub 2008 Nov 14.

[Immersion-induced spontaneous pneumomediastinum]

[Article in Spanish]

Donoso Fuentes A, Cruces P, Bertrán Salinas K.

Publication Types: Case Reports Letter

PMID: 19174131

6: Mil Med. 2008 Dec;173(12):1225-32.

A pilot study evaluating surfactant on eustachian tube function in divers.

Duplessis C, Fothergill D, Gertner J, Hughes L, Schwaller D.

Naval Submarine Medical Research Laboratory, Naval Submarine Base New London, Box 900, Groton, CT 06349-5900, USA.

BACKGROUND: Middle ear barotrauma (MEBT) is the most common medical complication in diving, aviation, and hyperbaric medicine. Eustachian tube dysfunction (ETD) quantifies the inability to open the eustachian tube (ET), risking MEBT. Surfactant administration improved ET function and efficaciously treated otitis media in a host of animal models. We performed a pilot study evaluating the efficacy of intranasal surfactant administration in reducing MEBT in repetitive diving. METHODS: Eight divers participated in a subject-blinded, placebo-controlled, random order, multiarm (air and O₂)-repeated measures trial investigating the relative efficacy of intranasally administered surfactant, acetylcysteine and oxymetazoline, and orally administered pseudoephedrine versus saline-placebo in middle ear

equilibration during repetitive, multiday diving. Subjects were tested with the Nine-Step Inflation/Deflation Tympanometry Test (NSI/DT) and sonotubometry (testing eustachian tube opening pressure [ETOP]) before and immediately after each dive. RESULTS: Significant interaction effects were found for drug-by-test ($F_{8,668} = 4.05$; $p < 0.001$) and the three-way interaction of drug-by-dive-by-test ($F_{16,668} = 2.47$; $p = 0.001$) in sonotubometry testing. The ETOP revealed trends toward lowered (improved) values post-versus pre-dive in all treatment arms, which was significant for oxymetazoline ($p = 0.04$). Only four of the eight subjects experienced any holds during diving. Statistical analysis of the NSI/DT data showed that none of the drug interventions resulted in improvements in ET function over that expected by chance. CONCLUSIONS: There is large intra- and intersubject variability in daily functioning of the ET as measured using the NSI/DT and sonotubometry (ETOP). Sonotubometry engendered trends toward lowered (improved) values post-versus pre-dive in all treatment arms. The repetitive dives did not result in a significant decrease in ET function as evidenced in the saline-placebo trials, circumventing an ability to detect superiority among the various treatment arms in our subject population. Additionally, since our study was underpowered to detect significant effects, we can only assert that various inhalational agents may improve middle ear ventilation in repetitive diving warranting further study. A larger subject population including subjects diagnosed with ET dysfunction may provide more statistical power to discern the benefit of inhaled agents as a useful prophylactic for preventing or reducing ET dysfunction during diving and/or hyperbaric/hypobaric pressure changes.

Publication Types: Clinical Trial
Randomized Controlled Trial
Research Support, Non-U.S. Gov't
PMID: 19149344

7: *Respir Physiol Neurobiol.* 2009 Feb 28;165(2-3):221-8. Epub 2008 Dec 24.

Lung compression effects on gas exchange in human breath-hold diving.

Fitz-Clarke JR.

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jfitzclarke@eastlink.ca

Lung compression during breath-hold diving reduces gas exchanging surface area. Beyond a critical depth, collapse of all alveoli should result in total pulmonary shunt and a drop in arterial oxygen partial pressure toward the mixed-venous level. The effect of lung collapse on human breath-hold diving capability is analysed using a computational model of the lungs and circulation that simulates oxygen, carbon dioxide, and nitrogen exchange between alveoli, blood, and tissues. Gas uptake during descent becomes limited by lung compression when the ratio of diffusing capacity to the product of perfusion and gas solubility in blood drops below one. An equation is derived for estimating collapse depth due to direct alveolar compression and time-dependent absorption atelectasis. Oxygen dissolved in blood during descent builds a limited capacitive store for supporting metabolism during the period of lung collapse. Hypoxemia with loss of consciousness prior to alveolar re-opening on ascent is predicted to occur on dives beyond 300 m, depending on initial lung volume.

PMID: 19136079

8: *Pol Merkur Lekarski.* 2008 Sep;25(147):294-7.

[Land and marine fauna constituting a threat for recreational divers in the tropics]

[Article in Polish]

Korzeniewski K.

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Due to intensively growing international tourism, increasing numbers of people leave for countries with hot climates, where various threats for human health and life exist. Besides climatic and

sanitary conditions, a rich fauna, represented by predators and venomous animals, can be included. Based on available world literature and their own observations, the authors present the threats that a tourist can possibly encounter whilst relaxing on the beach or during recreational diving in tropical waters. When staying in water, a large threat is posed by marine fish of prey (sharks, barracuda, muraena), Cnidaria (jellyfish, corals, anemones) and venomous animals (fish, sea snakes). On land, on the other hand, a threat can be posed by venomous arthropods (scorpions, spiders) and Hymenoptera insects. The study presents the most important representatives of fauna present in coastal areas frequently visited by diving enthusiasts. Also, clinical image and conduct in the case of body injuries are discussed.

Publication Types: English
Abstract Review
PMID: 19112854

9: Postgrad Med J. 2008 Nov;84(997):571-8.
Bubble trouble: a review of diving physiology and disease.
Levett DZ, Millar IL.
Centre for Altitude, Space and Extreme Environment Medicine, UCL, Highgate Hill, London, UK.
denny.levett@ucl.ac.uk
Exposure to the underwater environment for recreational or occupational purposes is increasing. Approximately 7 million divers are active worldwide and 500,000 more are training every year. Diving related illnesses are consequently an increasingly common clinical problem with over 1000 cases of decompression illness reported annually in the USA alone. Divers are exposed to a number of physiological risks as a result of the hyperbaric underwater environment including: the toxic effects of hyperbaric gases, the respiratory effects of increased gas density, drowning, hypothermia and bubble related pathophysiology. Understanding the nature of this pathophysiology provides insight into physiological systems under stress and as such may inform translational research relevant to clinical medicine. We will review

current diving practice, the physics and physiology of the hyperbaric environment, and the pathophysiology and treatment of diving related diseases. We will discuss current developments in diving research and some potential translational research areas.

Publication Types: Review
PMID: 19103814

10: Clin Physiol Funct Imaging. 2009 Apr;29(2):100-7. Epub 2008 Dec 4.
Effects of tetrahydrobiopterin on venous bubble grade and acute diving-induced changes in cardiovascular function.
Glavas D, Bakovic D, Obad A, Palada I, Breskovic T, Valic Z, Brubakk AO, Dujic Z.
Department of Internal Medicine, University Hospital Split, Split, Croatia.
INTRODUCTION: Self-contained underwater breathing apparatus diving reduces cardiovascular function and increases pulmonary artery pressure (PAP) up to 3 days after a single dive. Acute antioxidants partially attenuated arterial endothelial dysfunction, whereas cardiac and PA functions were unaffected. We tested the hypothesis that acute tetrahydrobiopterin (BH(4)), as a cofactor of endothelial nitric oxide (NO) synthase, reduces bubble grade (BG) and attenuates alteration in cardiovascular function after diving because of increased NO bioavailability. MATERIALS AND METHODS: Mean PAP (mPAP), PA acceleration time and right ventricle ejection time, left ventricle ejection fraction (LV-EF) and BG were measured after oral placebo (P), vitamin C (C) or a combination of vitamin C and BH(4) (BH(4)) in a randomized, placebo controlled trial before and after field dive to 30 m of sea water for 30 min bottom time. RESULTS: Eight recreational divers performed three dives with a 3-days period between them. Regarding the primary hypothesis, no difference was observed between post-dive changes in BG (2.1 +/- 2.2 bubbles cm(-2) for P, 3.4 +/- 3.9 for C and 3.6 +/- 2.1 for BH(4)), mPAP (25.6 +/- 6.5 mmHg for P, 25.9 +/- 8.6 for C and 22.6 +/- 3.5 for BH(4)) and LV-EF (62.6 +/- 4.6% for P, 61.4 +/- 3.9

for C and 61.6 +/- 3.7 for BH(4) with all three conditions. CONCLUSION: This suggests that co-administration of BH(4) and vitamin C does not improve heart and pulmonary artery function after diving.

Publication Types: Randomized Controlled Trial
Research Support, Non-U.S. Gov't
PMID: 19076728

11: J Appl Biomech. 2008 Nov;24(4):307-15.

Biomechanical comparison of the track start and the modified one-handed track start in competitive swimming: an intervention study.

Galbraith H, Scurr J, Hencken C, Wood L, Graham-Smith P.

Department of Sport and Exercise Science, University of Portsmouth, UK.

This study compared the conventional track and a new one-handed track start in elite age group swimmers to determine if the new technique had biomechanical implications on dive performance. Five male and seven female GB national qualifiers participated (mean +/- SD: age 16.7 +/- 1.9 years, stretched stature 1.76 +/- 0.8 m, body mass 67.4 +/- 7.9 kg) and were assigned to a control group (n = 6) or an intervention group (n = 6) that learned the new one handed dive technique. All swimmers underwent a 4-week intervention comprising 12 +/- 3 thirty-minute training sessions. Video cameras synchronized with an audible signal and timing suite captured temporal and kinematic data. A portable force plate and load cell handrail mounted to a swim starting block collected force data over 3 trials of each technique. A MANCOVA identified Block Time (BT), Flight Time (FT), Peak Horizontal Force of the lower limbs (PHF) and Horizontal Velocity at Take-off (Vx) as covariates. During the 10-m swim trial, significant differences were found in Time to 10 m (TT10m), Total Time (TT), Peak Vertical Force (PVF), Flight Distance (FD), and Horizontal Velocity at Take-off (Vx) (p < .05). Results indicated that the conventional track start method was faster over 10 m, and therefore may be seen as a superior start after a short intervention. During training,

swimmers and coaches should focus on the most statistically significant dive performance variables: peak horizontal force and velocity at take-off, block and flight time.

Publication Types: Comparative Study

PMID: 19075299

12: Aviat Space Environ Med. 2008 Dec;79(12):1112-6.

MRI findings and clinical outcome in 45 divers with spinal cord decompression sickness.

Gempp E, Blatteau JE, Stephant E, Pontier JM, Constantin P, Pény C.

Department of Hyperbaric Medicine, Military Teaching Hospital, Sainte-Anne, Toulon, France. gempp@voila.fr

BACKGROUND: Decompression sickness (DCS) affecting the spinal cord is the most dangerous form of diving-related injury with potential sequelae. This study was conducted to evaluate the relationship between spinal cord lesions on MRI and clinical findings in divers with spinal DCS. METHODS: We studied 45 cases of DCS that were referred to our hyperbaric facility with clinical evidence of spinal involvement during the period 2002-2007. The study included only patients who underwent MRI within 10 d of injury. The severity of spinal DCS for each patient was rated numerically for both the acute event and 1 mo later. The presence or absence of back pain was also noted. RESULTS: Spinal cord lesions were significantly more frequent in divers with severe DCS, and did not occur in any diver who experienced a favorable outcome (sensitivity = 67%, specificity = 100%, negative predictive value = 77%, positive predictive value = 100%). The presence of vertebral degenerative changes that impinged on the spinal cord was strongly associated with MRI abnormalities, but not with a negative outcome. Acute back pain was associated with hyperintense lesions and persistence of neurological sequelae [OR = 14 (95% CI, 3.1 to 63.5)]. CONCLUSION: The results show that MRI could be helpful in predicting clinical outcome in divers with spinal cord DCS. The presence of medullary compressive factors and vertebral back pain after surfacing indicate

increased likelihood of severe myelopathy with incomplete recovery.
PMID: 19070307

13: Aviat Space Environ Med. 2008 Dec;79(12):1100-5.

Predive sauna and venous gas bubbles upon decompression from 400 kPa.

Blatteau JE, Gempp E, Balestra C, Mets T, Germonpre P.

Hyperbaric Department, Sainte-Anne Military Hospital, 544 Avenue Ernest Roller, Toulon 83200, France. je.blatteau@infonie.fr

INTRODUCTION: This study investigated the influence of a far infrared-ray dry sauna-induced heat exposure before a simulated dive on bubble formation, and examined the concomitant adjustments in hemodynamic parameters. **METHODS:** There were 16 divers who were compressed in a hyperbaric chamber to 400 kPa (30 msw) for 25 min and decompressed at 100 kPa x min(-1) with a 4-min stop at 130 kPa. Each diver performed two dives 5 d apart, one with and one without a predive sauna session for 30 min at 65 degrees C ending 1 h prior to the dive. Circulating venous bubbles were detected with a precordial Doppler 20, 40, and 60 min after surfacing, at rest, and after flexions. Brachial artery flow mediated dilation (FMD), blood pressure, and bodyweight measurements were taken before and after the sauna session along with blood samples for analysis of plasma volume (PV), protein concentrations, plasma osmolality, and plasma HSP70. **RESULTS:** A single session of sauna ending 1 h prior to a simulated dive significantly reduced bubble formation [-27.2% (at rest) to 35.4% (after flexions)]. The sauna session led to an extracellular dehydration, resulting in hypovolemia (-2.7% PV) and -0.6% bodyweight loss. A significant rise of FMD and a reduction in systolic blood pressure and pulse pressure were observed. Plasma HSP70 significantly increased 2 h after sauna completion. **CONCLUSION:** A single predive sauna session significantly decreases circulating bubbles after a chamber dive. This may reduce the risk of decompression sickness. Sweat dehydration, HSP, and the NO pathway could be involved in this protective effect.

PMID: 19070305

14: Aviat Space Environ Med. 2008 Dec;79(12):1096-9.

Blood platelet count and bubble formation after a dive to 30 msw for 30 min.

Pontier JM, Jimenez C, Blatteau JE. Département des facteurs humains, Centre de Recherches du Service de Santé des Armées, La Tronche, France. jm.pontier@free.fr

INTRODUCTION: Previous human studies reported that platelet count (PC) is decreased following decompression. Platelet aggregation and adherence to the bubble surface has been demonstrated in severe decompression sickness (DCS). The present study was designed to clarify the relationship between post-dive changes in blood PC and the level of bubble formation in divers. **METHODS:** There were 40 healthy experienced divers who were assigned to 1 experimental group (N = 30) with an open-sea air dive to 30 msw for 30 min in field conditions and 1 control group (N = 10) without hyperbaric exposure. Bubble grades were monitored with a pulsed Doppler according to the Spencer scale and Kissman integrated severity score (KISS). Blood samples for red blood cell counts (RBC), hematocrit (Hct), and PC were taken 1 h before and after exposure in two groups. **RESULTS:** None of the divers developed any signs of DCS. In two groups, the results showed significant increase in RBC count and Hct related with hemoconcentration and no change in PC. Divers with a high KISS score (39 +/- 5.8; mean +/- SD) presented a significantly more pronounced percent fall in PC than divers with a lower KISS score. We found a significant correlation between the percent fall in PC after a dive and the bubble KISS score. **DISCUSSION:** The present study highlighted a relationship between the post-dive decrease in PC and the magnitude of bubble level after decompression. Our primary result is that the post-dive decrease in PC could be a predictor of decompression severity after diving.

PMID: 19070304

15: J Med Entomol. 2008 Nov;45(6):1050-6.

Diving behavior in *Anopheles gambiae* (Diptera: Culicidae): avoidance of a predacious wolf spider (Araneae: Lycosidae) in relation to life stage and water depth.

Futami K, Sonye G, Akweywa P, Kaneko S, Minakawa N.

Institute of Tropical Medicine, Nagasaki University, Nagasaki, Japan.

It has been suggested that mosquito larvae and pupae dive to avoid predators. We tested this predator-avoidance hypothesis by using immature *Anopheles gambiae* Giles (Diptera: Culicidae) and the wolf spider *Pardosa messingerae* (Stand) (Araneae: Lycosidae). Because previous studies have suggested that wolf spiders are poor predators of immature mosquitoes, we first examined the predatory ability of the wolf spider and found that the spider was effective at capturing all stages of larvae and pupae. The mortality from experimental cups containing deep water increased with the age of mosquitoes, with the exception of pupae. In contrast, this trend was not observed in shallow water. In particular, mortality was significantly lower in deep water during the second instar. During the third instar, the opposite trend was observed. When the effect of cannibalism was excluded by subtracting the number of missing mosquitoes for the treatment without spiders from those with spiders, the cannibalism corrected mortality was significantly lower in deep water during the second instar. The duration of diving by larvae and pupae decreased with age. With the exception of first instar, diving frequency also decreased with age. We postulate that this diving behavior allows *An. gambiae* to escape predation by wolf spiders, which supports the predator-avoidance hypothesis. This study indicates some important implications for vector control.

Publication Types: Research Support, Non-U.S. Gov't
PMID: 19058628

16: J Invasive Cardiol. 2008 Dec;20(12):E331-3.

Coronary artery air embolism causing pulmonary edema secondary to acute coronary syndrome in a diver.

Sammut MA, Cassar A, Felice H. Cardiology Department, Mater Dei Hospital, Tal-Qroqq, Malta.

Air embolism in the coronary arteries is a known complication of coronary angiography. Diving is a non-iatrogenic cause of arterial air embolism, commonly presenting with neurological and musculoskeletal symptoms. This is the first known case of coronary air embolism confirmed on coronary angiography in a diver presenting with pulmonary edema secondary to acute coronary syndrome. The possible mechanisms of coronary air embolism during a dive are reviewed in this article.

Publication Types: Case Reports
PMID: 19057040

17: J Nutr. 2009 Jan;139(1):90-5. Epub 2008 Dec 3.

Body iron stores and oxidative damage in humans increased during and after a 10- to 12-day undersea dive.

Zwart SR, Kala G, Smith SM.

Universities Space Research Association, Houston, TX 77058, USA. sara.zwart-1@nasa.gov

The National Aeronautics and Space Administration Extreme Environment Mission Operations (NEEMO) underwater habitat is a useful analogue for spaceflight. However, the increased air pressure in the habitat exposes crewmembers to higher oxygen pressures, which increases their risk for oxidative damage to DNA, proteins, and lipids. Studies from a previous NEEMO mission suggested that DNA oxidation occurs at an increased level, similar to that in smokers and astronauts returning from space. Astronauts in space and NEEMO crewmembers also have similar changes in iron metabolism. Newly formed RBC are destroyed and body iron stores are elevated. Because excess iron can act as an oxidant and cause tissue damage, we investigated aspects of oxidative damage and tested whether toxic forms of iron were present when iron stores increased during NEEMO missions. Subjects ($n = 12$) participated in 10- to 12-d saturation dives, and blood and 24-h urine samples were collected twice before, twice during, and twice after the dive. During the dive, ferritin was higher ($P < 0.001$),

transferrin was lower ($P < 0.001$), and transferrin receptors were lower ($P < 0.01$). Serum iron was higher during and immediately after the dive ($P < 0.001$). Total homocysteine ($P < 0.001$) and superoxide dismutase (SOD) ($P < 0.05$) activity were affected by time; homocysteine increased during the dive and SOD decreased during and after the dive. Labile plasma iron was measurable only during the dive. These data indicate that the NEEMO environment increases body iron stores and labile forms of iron, which may contribute to oxidative damage.
Publication Types: Research Support, U.S. Gov't, Non-P.H.S.
PMID: 19056648

18: Undersea Hyperb Med. 2008 Jul-Aug;35(4):241-323.
Abstracts from the Annual Scientific Meeting of the Undersea and Hyperbaric Medical Society (UHMS), June 18-27, 2008, Salt Lake City, Utah, USA.

[No authors listed]
Publication Types: Congresses
Overall
PMID: 19054884

19: Toxicol Ind Health. 2008 Sep;24(8):525-30.
Determining standards for professional divers diving in benzene polluted waters.

Froom P.
Department of Occupational and Environmental Health, School of Public Health, Sackler Medical School, University of Tel Aviv, Tel Aviv, Israel. froomp@gmail.com
The main objective of this study is to calculate the hours of diving in benzene-polluted waters acceptable for professional divers. We considered recommended absorption limit as that from pulmonary workplace absorption during an 8-h workday at recommended exposure limits set by the National Institute of Occupational Safety and Health, and developed a formula to determine recommended limits for diving time based on actual water and sediment concentrations and exposure conditions. The recommended absorption limit is 1.6 mg of benzene per workday. This is equivalent to total body dermal absorption over a 1-h dive at water concentration of 7.6 mg/L, or

absorption from drinking 0.1 L of water with a concentration of 16.5 mg/L, or dermal absorption with 50% of the body covered in sediment with a concentration of 18,851 mg/kg. A formula that calculates allowable diving time considering benzene water and sediment concentrations, and gastrointestinal and dermal exposures is presented. Water concentrations and not exposure to sediment limit recommended diving time, and unlimited diving in areas with sediment and water concentrations thought to pose a serious human health hazard would not surpass the recommended amount of benzene absorbed in the workplace. We conclude that allowable diving time in polluted waters can be calculated resulting in absorption equivalent to recommended limits for pulmonary absorption in the workplace. Our results suggest that agencies determining significant health risk levels of chemical concentrations in sediment and water should consider our findings.
PMID: 19039080

20: J Appl Physiol. 2009 Jan;106(1):276-83. Epub 2008 Nov 26.
The underwater environment: cardiopulmonary, thermal, and energetic demands.

Pendergast DR, Lundgren CE.
Center for Research and Education in Special Environments, University at Buffalo, Buffalo, NY 14214, USA. dpenderg@buffalo.edu
Water covers over 75% of the earth, has a wide variety of depths and temperatures, and holds a great deal of the earth's resources. The challenges of the underwater environment are underappreciated and more short term compared with those of space travel. Immersion in water alters the cardio-endocrine-renal axis as there is an immediate translocation of blood to the heart and a slower autotransfusion of fluid from the cells to the vascular compartment. Both of these changes result in an increase in stroke volume and cardiac output. The stretch of the atrium and transient increase in blood pressure cause both endocrine and autonomic changes, which in the short term return plasma volume to control levels and decrease total peripheral

resistance and thus regulate blood pressure. The reduced sympathetic nerve activity has effects on arteriolar resistance, resulting in hyperperfusion of some tissues, which for specific tissues is time dependent. The increased central blood volume results in increased pulmonary artery pressure and a decline in vital capacity. The effect of increased hydrostatic pressure due to the depth of submersion does not affect stroke volume; however, a bradycardia results in decreased cardiac output, which is further reduced during breath holding. Hydrostatic compression, however, leads to elastic loading of the chest wall and negative pressure breathing. The depth-dependent increased work of breathing leads to augmented respiratory muscle blood flow. The blood flow is increased to all lung zones with some improvement in the ventilation-perfusion relationship. The cardiac-renal responses are time dependent; however, the increased stroke volume and cardiac output are, during head-out immersion, sustained for at least hours. Changes in water temperature do not affect resting cardiac output; however, maximal cardiac output is reduced, as is peripheral blood flow, which results in reduced maximal exercise performance. In the cold, maximal cardiac output is reduced and skin and muscle are vasoconstricted, resulting in a further reduction in exercise capacity.

Publication Types: Review
PMID: 19036887

21: Eur J Appl Physiol. 2009 Mar;105(5):673-8. Epub 2008 Nov 26. Hypoxia and cardiac arrhythmias in breath-hold divers during voluntary immersed breath-holds.

Hansel J, Solleder I, Gfroerer W, Muth CM, Paulat K, Simon P, Heitkamp HC, Niess A, Tetzlaff K.

Department of Sports Medicine, Medical Clinic and Policlinic, University of Tuebingen, 72076, Tuebingen, Germany.

The incidence and nature of cardiac arrhythmias during static apnea were studied by monitoring the electrocardiogram (ECG) and oxygen saturation (SaO₂) of 16 recreational breath-hold divers. All

subjects completed a maximal apnea with a mean (+/-SD) breath-hold duration of 281 (+/-73) s without clinical complications. Both heart rate (HR) and SaO₂ decreased significantly with breath-hold duration. The decline in SaO₂ was inversely related to the decline in HR ($r = -0.55$, $P < 0.05$). Cardiac arrhythmias (supraventricular and ventricular premature complexes, right bundle branch block) occurred in 12/16 (77%) subjects and were related to breath-hold duration. Subjects with atrial premature complexes ($n = 9$) had a reduced BMI ($P = 0.016$) and a higher decline of the terminal SaO₂ ($P = 0.01$). In conclusion, ectopic arrhythmias were common during maximal static apneas for training purposes. The results indicate that the occurrence of ectopic beats is associated with individual factors such as the tolerable SaO₂ decrease.

PMID: 19034490

22: J Appl Physiol. 2009 Jan;106(1):311-5. Epub 2008 Nov 20. DNA damage after long-term repetitive hyperbaric oxygen exposure.

Gröger M, Oter S, Simkova V, Bolten M, Koch A, Warninghoff V, Georgieff M, Muth CM, Speit G, Radermacher P. Sektion Anästhesiologische Pathophysiologie und Verfahrensentwicklung Universitätsklinikum, Parkstrasse 11, D-89073 Ulm, Germany.

A single exposure to hyperbaric oxygen (HBO), i.e., pure oxygen breathing at supra-atmospheric pressures, causes oxidative DNA damage in humans in vivo as well as in isolated lymphocytes of human volunteers. These DNA lesions, however, are rapidly repaired, and an adaptive protection is triggered against further oxidative stress caused by HBO exposure. Therefore, we tested the hypothesis that long-term repetitive exposure to HBO would modify the degree of DNA damage. Combat swimmers and underwater demolition team divers were investigated because their diving practice comprises repetitive long-term exposure to HBO over years. Nondiving volunteers with and without endurance training served as controls. In addition to the measurement of DNA damage in

peripheral blood (comet assay), blood antioxidant enzyme activities, and the ratio of oxidized and reduced glutathione content, we assessed the DNA damage and superoxide anion radical (O(2)(*⁻)) production induced by a single ex vivo HBO exposure of isolated lymphocytes. All parameters of oxidative stress and antioxidative capacity in vivo were comparable in the four different groups. Exposure to HBO increased both the level of DNA damage and O(2)(*⁻) production in lymphocytes, and this response was significantly more pronounced in the cells obtained from the combat swimmers than in all the other groups. However, in all groups, DNA damage was completely removed within 1 h. We conclude that, at least in healthy volunteers with endurance training, long-term repetitive exposure to HBO does not modify the basal blood antioxidant capacity or the basal level of DNA strand breaks. The increased ex vivo HBO-related DNA damage in isolated lymphocytes from these subjects, however, may reflect enhanced susceptibility to oxidative DNA damage.

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

PMID: 19023023

23: J Appl Physiol. 2009 Feb;106(2):691-700. Epub 2008 Nov 20.

Effects of head and body cooling on hemodynamics during immersed prone exercise at 1 ATA.

Wester TE, Cherry AD, Pollock NW, Freiburger JJ, Natoli MJ, Schinazi EA, Doar PO, Boso AE, Alford EL, Walker AJ, Uguccioni DM, Kernagis D, Moon RE.

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Immersion pulmonary edema (IPE) is a condition with sudden onset in divers and swimmers suspected to be due to pulmonary arterial or venous hypertension induced by exercise in cold water, although it does occur even with adequate thermal protection. We tested the hypothesis that cold head immersion could facilitate IPE via a reflex rise in pulmonary vascular pressure due solely to cooling of the head. Ten

volunteers were instrumented with ECG and radial and pulmonary artery catheters and studied at 1 atm absolute (ATA) during dry and immersed rest and exercise in thermoneutral (29-31 degrees C) and cold (18-20 degrees C) water. A head tent varied the temperature of the water surrounding the head independently of the trunk and limbs. Heart rate, Fick cardiac output (CO), mean arterial pressure (MAP), mean pulmonary artery pressure (MPAP), pulmonary artery wedge pressure (PAWP), and central venous pressure (CVP) were measured. MPAP, PAWP, and CO were significantly higher in cold pool water ($P < \text{or} = 0.004$). Resting MPAP and PAWP values (means \pm SD) were 20 \pm 2.9/13 \pm 3.9 (cold body/cold head), 21 \pm 3.1/14 \pm 5.2 (cold/warm), 14 \pm 1.5/10 \pm 2.2 (warm/warm), and 15 \pm 1.6/10 \pm 2.6 mmHg (warm/cold). Exercise values were higher; cold body immersion augmented the rise in MPAP during exercise. MAP increased during immersion, especially in cold water ($P < 0.0001$). Except for a transient additive effect on MAP and MPAP during rapid head cooling, cold water on the head had no effect on vascular pressures. The results support a hemodynamic cause for IPE mediated in part by cooling of the trunk and extremities. This does not support the use of increased head insulation to prevent IPE.

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

PMID: 19023017

24: J Appl Physiol. 2009 Jan;106(1):274-5. Epub 2008 Nov 20.

The physiology and pathophysiology of the hyperbaric and diving environments.

Pendergast DR, Lundgren CE.

Publication Types: Editorial
Introductory Journal Article

PMID: 19023014

25: J Exp Biol. 2008 Dec;211(Pt 23):3712-9.

Foraging behavior of humpback whales: kinematic and respiratory patterns suggest a high cost for a lunge.

Goldbogen JA, Calambokidis J, Croll DA, Harvey JT, Newton KM, Oleson EM, Schorr G, Shadwick RE.

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Lunge feeding in rorqual whales is a drag-based feeding mechanism that is thought to entail a high energetic cost and consequently limit the maximum dive time of these extraordinarily large predators. Although the kinematics of lunge feeding in fin whales supports this hypothesis, it is unclear whether respiratory compensation occurs as a consequence of lunge-feeding activity. We used high-resolution digital tags on foraging humpback whales (*Megaptera novaengliae*) to determine the number of lunges executed per dive as well as respiratory frequency between dives. Data from two whales are reported, which together performed 58 foraging dives and 451 lunges. During one study, we tracked one tagged whale for approximately 2 h and examined the spatial distribution of prey using a digital echosounder. These data were integrated with the dive profile to reveal that lunges are directed toward the upper boundary of dense krill aggregations. Foraging dives were characterized by a gliding descent, up to 15 lunges at depth, and an ascent powered by steady swimming. Longer dives were required to perform more lunges at depth and these extended apneas were followed by an increase in the number of breaths taken after a dive. Maximum dive durations during foraging were approximately half of those previously reported for singing (i.e. non-feeding) humpback whales. At the highest lunge frequencies (10 to 15 lunges per dive), respiratory rate was at least threefold higher than that of singing humpback whales that underwent a similar degree of apnea. These data suggest that the high energetic cost associated with lunge feeding in blue and fin whales also occurs in intermediate sized rorquals.

Publication Types: Research Support, Non-U.S. Gov't Research Support, U.S. Gov't, Non-P.H.S. PMID: 19011211

26: J Appl Physiol. 2009 Feb;106(2):668-77. Epub 2008 Nov 13.

Pulmonary gas exchange in diving. Moon RE, Cherry AD, Stolp BW, Camporesi EM.

Department of Anesthesiology, Duke University Medical Center, Durham, NC 27710, USA. richard.moon@duke.edu Diving-related pulmonary effects are due mostly to increased gas density, immersion-related increase in pulmonary blood volume, and (usually) a higher inspired P_{O_2} . Higher gas density produces an increase in airways resistance and work of breathing, and a reduced maximum breathing capacity. An additional mechanical load is due to immersion, which can impose a static transrespiratory pressure load as well as a decrease in pulmonary compliance. The combination of resistive and elastic loads is largely responsible for the reduction in ventilation during underwater exercise. Additionally, there is a density-related increase in dead space/tidal volume ratio (V_d/V_t), possibly due to impairment of intrapulmonary gas phase diffusion and distribution of ventilation. The net result of relative hypoventilation and increased V_d/V_t is hypercapnia. The effect of high inspired P_{O_2} and inert gas narcosis on respiratory drive appear to be minimal. Exchange of oxygen by the lung is not impaired, at least up to a gas density of 25 g/l. There are few effects of pressure per se, other than a reduction in the P_{50} of hemoglobin, probably due to either a conformational change or an effect of inert gas binding.

Publication Types: Research Support, U.S. Gov't, Non-P.H.S. Review PMID: 19008484

27: J Travel Med. 2008 Sep-Oct;15(5):378-81.

Community-acquired methicillin-resistant *Staphylococcus aureus* infections in two scuba divers returning from the Philippines.

Bochet M, Francois P, Longtin Y, Gaide O, Renzi G, Harbarth S.

Infection Control Program, University of Geneva Hospitals and Medical School, Geneva, Switzerland.

We describe two patients who had skin infection due to identical strains of community-acquired methicillin-resistant *Staphylococcus*

aureus (CA-MRSA) after returning from the Philippines. Both patients did not share risk factors for CA-MRSA acquisition besides scuba diving. Scuba diving equipment may represent a possible new mode of acquisition of CA-MRSA.
Publication Types: Case Reports
PMID: 19006518

28: J Trauma. 2008 Nov;65(5):1180-5.
Spinal cord injuries due to diving: a framework and call for prevention.
Cusimano MD, Mascarenhas AM, Manoranjan B.
Department of Neurosurgery, St. Michael's Hospital, Toronto, Ontario, Canada.
injuryprevention@smh.toronto.on.ca
PMID: 19001991

29: Aviat Space Environ Med. 2008 Nov;79(11):1073-4.
You're the flight surgeon: salt-water aspiration syndrome.
Lehman R.
Publication Types: Case Reports
PMID: 18998493

30: Aviat Space Environ Med. 2008 Nov;79(11):1071-2.
On beginning a second century of decompression sickness research: where are we and what comes next?
Kayar SR.
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It is just 100 years since the publication of J. S. Haldane's groundbreaking work on the prevention of decompression sickness (DCS). While we still do not know the exact mechanisms that underlie DCS, probabilistic modeling now allows good estimation of risk for a given set of conditions, although reduction of risk to zero remains impractical. Unfortunately, individual monitoring for intravascular bubbles has not proven a good predictor of symptomatic DCS. Current research aims to identify underlying biological factors that, once understood, may allow development of preventive measures and treatment that go beyond recompression. With one or more drugs to combat DCS, we should be able to eliminate the residual risk, extend dive profiles beyond current limits, and rescue people who have exceeded the limits and taken a hit.
PMID: 18998492

31: Am J Physiol Regul Integr Comp Physiol. 2009 Jan;296(1):R80-7. Epub 2008 Nov 5.

Repetitive paired stimulation of nasotrigeminal and peripheral chemoreceptor afferents cause progressive potentiation of the diving bradycardia.

Rozloznik M, Paton JF, Dutschmann M. Dept. of Neuro and Sensory Physiology, Georg-August-Univ. Humboldtallee 23, 37073 Göttingen, Germany.

Hallmarks of the mammalian diving response are protective apnea and bradycardia. These

cardiorespiratory adaptations can be mimicked by stimulation of the trigeminal ethmoidal nerve (EN5) and reflect oxygen-conserving mechanisms during breath-hold dives. Increasing drive from peripheral chemoreceptors during sustained dives was reported to enhance the diving bradycardia. The underlying neuronal mechanisms, however, are unknown. In the present study, expression and plasticity of EN5-bradycardias after paired stimulation of the EN5 and peripheral chemoreceptors was investigated in the in situ working heart-brain stem preparation. Paired stimulations enhanced significantly the bradycardic responses compared with EN5-evoked bradycardia using submaximal stimulation intensity. Alternating stimulations of the EN5 followed by paired stimulation of the EN5 and chemoreceptors (10 trials, 3-min interval) caused a progressive and significant potentiation of EN5-evoked diving bradycardia. In contrast, bradycardias during paired stimulation remained unchanged during repetitive stimulation. The progressive potentiation of EN5-bradycardias was significantly enhanced after microinjection of the 5-HT(3) receptor agonist (CPBG hydrochloride) into the nucleus tractus solitarius (NTS), while the 5-HT(3) receptor antagonist (zacopride hydrochloride) attenuated the progressive potentiation. These results suggest an integrative function of the NTS for the multimodal mediation of the diving response. The potentiation or training of a submaximal diving bradycardia requires peripheral

chemoreceptor drive and involves neurotransmission via 5-HT(3) receptor within the NTS.
Publication Types: In Vitro
Research Support, Non-U.S. Gov't
PMID: 18987289

32: J Appl Physiol. 2009
Jan;106(1):284-92. Epub 2008 Oct 30.
The physiology and pathophysiology of human breath-hold diving.
Lindholm P, Lundgren CE.

Department of Physiology and Pharmacology, Karolinska Institutet, Stockholm, Sweden.

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This is a brief overview of physiological reactions, limitations, and pathophysiological mechanisms associated with human breath-hold diving. Breath-hold duration and ability to withstand compression at depth are the two main challenges that have been overcome to an amazing degree as evidenced by the current world records in breath-hold duration at 10:12 min and depth of 214 m. The quest for even further performance enhancements continues among competitive breath-hold divers, even if absolute physiological limits are being approached as indicated by findings of pulmonary edema and alveolar hemorrhage postdive. However, a remarkable, and so far poorly understood, variation in individual disposition for such problems exists. Mortality connected with breath-hold diving is primarily concentrated to less well-trained recreational divers and competitive spearfishermen who fall victim to hypoxia. Particularly vulnerable are probably also individuals with preexisting cardiac problems and possibly, essentially healthy divers who may have suffered severe alternobaric vertigo as a complication to inadequate pressure equilibration of the middle ears. The specific topics discussed include the diving response and its expression by the cardiovascular system, which exhibits hypertension, bradycardia, oxygen conservation, arrhythmias, and contraction of the spleen. The respiratory system is challenged by compression of the lungs with barotrauma of descent, intrapulmonary hemorrhage, edema, and the effects of glossopharyngeal insufflation and exsufflation.

Various mechanisms associated with hypoxia and loss of consciousness are discussed, including hyperventilation, ascent blackout, fasting, and excessive postexercise O(2) consumption. The potential for high nitrogen pressure in the lungs to cause decompression sickness and N(2) narcosis is also illuminated.
Publication Types: Review
PMID: 18974367

33: Respir Physiol Neurobiol. 2009
Jan 1;165(1):28-39. Epub 2008 Oct 9.
Estimating the effect of lung collapse and pulmonary shunt on gas exchange during breath-hold diving: the Scholander and Kooyman legacy.
Fahlman A, Hooker SK, Olszowka A, Bostrom BL, Jones DR.
Global Diving Research, Ottawa, ON, Canada K2J 5E8.
andreas_fahlman@yahoo.com

We developed a mathematical model to investigate the effect of lung compression and collapse (pulmonary shunt) on the uptake and removal of O(2), CO(2) and N(2) in blood and tissue of breath-hold diving mammals. We investigated the consequences of pressure (diving depth) and respiratory volume on pulmonary shunt and gas exchange as pressure compressed the alveoli. The model showed good agreement with previous studies of measured arterial O(2) tensions (Pa(O)(2)) from freely diving Weddell seals and measured arterial and venous N(2) tensions from captive elephant seals compressed in a hyperbaric chamber. Pulmonary compression resulted in a rapid spike in Pa(O)(2) and arterial CO(2) tension, followed by cyclical variation with a periodicity determined by Q(tot). The model showed that changes in diving lung volume are an efficient behavioural means to adjust the extent of gas exchange with depth. Differing models of lung compression and collapse depth caused major differences in blood and tissue N(2) estimates. Our integrated modelling approach contradicted predictions from simple models, and emphasised the complex nature of physiological interactions between circulation, lung compression and gas exchange. Overall, our work suggests the need for caution in interpretation of previous model results based on

assumed collapse depths and all-or-nothing lung collapse models.

Publication Types: Research Support, Non-U.S. Gov't
Research Support, U.S. Gov't, Non-P.H.S.
PMID: 18973832

34: Clin Experiment Ophthalmol. 2008 Aug;36(6):581-2.

Barotraumatic ocular haemorrhage sustained while scuba diving.

Yeoh R, Yeoh R, Singh M.

Publication Types: Case Reports
Letter

PMID: 18954324

35: J Am Soc Echocardiogr. 2008 Oct;21(10):1150-5.

Chest sonography detects lung water accumulation in healthy elite apnea divers.

Frassi F, Pingitore A, Cialoni D, Picano E.

Institute of Clinical Physiology and Fondazione Gabriele Monasterio, National Research Council, Pisa, Italy.

BACKGROUND: Ultrasound lung comets (ULCs) detected by chest sonography are a simple, noninvasive, semiquantitative sign of increased extravascular lung water. Pulmonary edema may occur in elite apnea divers, possibly triggered by centralization of blood flow from the periphery to pulmonary vessels. We assessed the prevalence of ULCs in top-level breath-hold divers after immersion. METHODS: We evaluated 31 consecutive healthy, top-level, breath-hold divers (10 female, 21 male; age 31 +/- 5 years) participating in a yearly international apnea diving contest in Sharm-el-Sheik, Egypt, November 1 to 3, 2007. We performed chest and cardiac sonography with a transthoracic probe (2.5-3.5 MHz, Esaote Mylab) in all divers, both on the day before and 10 +/- 9 minutes after immersion. In a subset of 4 divers, chest scan was also repeated at 24 hours after immersion. ULCs were evaluated on the anterior and posterior chest at 61 predefined scanning sites. An independent sonographer, blind to both patient identity and status (pre- or post-diving), scored ULCs. RESULTS: Diving depth ranged from 31 to 112 m. Duration of immersion ranged from 120 to 225 seconds. The ULC score was 0.5 +/- 1.5 at

baseline and 13 +/- 21 after diving (P = .012). At individual patient analysis, ULCs appeared in 14 athletes (45%) after diving. Of these 14 athletes, 4 were asymptomatic, 6 showed aspecific symptoms with transient loss of motor control ("Samba"), 2 had palpitations with frequent premature ventricular contractions, and 2 had persistent cough with hemoptysis and pulmonary crackles. In a subset of 4 athletes with post-diving ULCs in whom late follow-up study also was available, chest sonography findings fully normalized at 24 hours of follow-up. CONCLUSION: In top-level breath-hold divers, chest sonography frequently reveals an increased number of ULCs after immersion, indicating a relatively high prevalence of (often subclinical) reversible extravascular lung water accumulation.

PMID: 18926391

36: Environ Manage. 2009 Jan;43(1):1-16. Epub 2008 Sep 23.

Managing dive tourism for the sustainable use of coral reefs: validating diver perceptions of attractive site features.

Uyarra MC, Watkinson AR, Côté IM.

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It has been argued that strategies to manage natural areas important for tourism and recreation should integrate an understanding of tourist preferences for specific natural features. However, the accuracy of tourist recalled perceptions of environmental attributes, which are usually derived from post hoc surveys and used to establish management priorities, is currently unmeasured. We tested the validity of the relationship between tourist-stated preferences and actual condition of coral reefs around the Caribbean island of Bonaire. Using standardized questionnaires, we asked 200 divers to select their most and least favorite dive sites and the attributes that contributed to that selection. We also carried out ecological surveys at 76 of the 81 dives sites around the island to assess the actual conditions of the attributes indicated as important for site selection. Fish- and coral-

related attributes were key features affecting dive enjoyment. In general, divers appeared to be able to perceive differences between sites in the true condition of biological attributes such as fish species richness, total number of fish schools, live coral cover, coral species richness, and reef structural complexity, although men and women divers differed in their ability to perceive/recall some of the attributes. Perceived differences in environmental attributes, such as surface conditions, underwater current, and the likelihood of encountering rare fish and sea turtles, were not empirically validated. The fact that divers perceive correctly differences in the condition of some of the key biological attributes that affect dive enjoyment reinforces the need to maintain overall reef condition at satisfactory levels. However, variation in accuracy of perceptions owing to demographic factors and attribute type suggests the need for caution when using public perceptions to develop environmental management strategies, particularly for coral reefs.

Publication Types: Comparative Study
Research Support, Non-U.S. Gov't
PMID: 18810525

37: Med Monatsschr Pharm. 2008 Jul;31(7):266.
[Can asthma patients engage in diving sports?]
[Article in German]
Ahrens P.
PMID: 18808076

38: J Appl Physiol. 2009 Jan;106(1):298-301. Epub 2008 Sep 18.
Selective vulnerability of the inner ear to decompression sickness in divers with right-to-left shunt: the role of tissue gas supersaturation.
Mitchell SJ, Doolette DJ.
Dept. of Anesthesiology, University of Auckland, Auckland, New Zealand. dr.m@extra.co.nz
Inner ear decompression sickness has been strongly associated with the presence of right-to-left shunts. The implied involvement of intravascular bubbles shunted from venous to arterial circulations is

inconsistent with the frequent absence of cerebral symptoms in these cases. If arterial bubbles reach the labyrinthine artery, they must also be distributing widely in the brain. This discrepancy could be explained by slower inert gas washout from the inner ear after diving and the consequent tendency for arterial bubbles entering this supersaturated territory to grow because of inward diffusion of gas. Published models for inner ear and brain inert gas kinetics were used to predict tissue gas tensions after an air dive to 4 atm absolute for 25 min. The models predict half-times for nitrogen washout of 8.8 min and 1.2 min for the inner ear and brain, respectively. The inner ear remains supersaturated with nitrogen for longer after diving than the brain, and in the simulated dive, for a period that corresponds with the latency of typical cases. It is therefore plausible that prolonged inner ear inert gas supersaturation contributes to the selective vulnerability of the inner ear to short latency decompression sickness in divers with right-to-left shunt.
Publication Types: Comparative Study
PMID: 18801958

39: J Appl Physiol. 2009 Jan;106(1):316-25. Epub 2008 Sep 11.
Predictors of increased PaCO₂ during immersed prone exercise at 4.7 ATA.
Cherry AD, Forkner IF, Frederick HJ, Natoli MJ, Schinazi EA, Longphre JP, Conard JL, White WD, Freiberger JJ, Stolp BW, Pollock NW, Doar PO, Boso AE, Alford EL, Walker AJ, Ma AC, Rhodes MA, Moon RE.
Department of Anesthesiology, Duke University Medical Center, Durham, NC 27710, USA.
During diving, arterial P_{co}(2) (Pa(CO(2))) levels can increase and contribute to psychomotor impairment and unconsciousness. This study was designed to investigate the effects of the hypercapnic ventilatory response (HCVR), exercise, inspired P_o(2), and externally applied transrespiratory pressure (P(tr)) on Pa(CO(2)) during immersed prone exercise in subjects breathing oxygen-nitrogen mixes at 4.7 ATA. Twenty-five subjects were studied at rest and during 6 min of exercise while dry and submersed at

1 ATA and during exercise submersed at 4.7 ATA. At 4.7 ATA, subsets of the 25 subjects (9-10 for each condition) exercised as P(tr) was varied between +10, 0, and -10 cmH₂O; breathing gas P_o(2) was 0.7, 1.0, and 1.3 ATA; and inspiratory and expiratory breathing resistances were varied using 14.9-, 11.6-, and 10.2-mm-diameter-aperture disks. During exercise, Pa(CO₂) (Torr) increased from 31.5 +/- 4.1 (mean +/- SD for all subjects) dry to 34.2 +/- 4.8 (P = 0.02) submersed, to 46.1 +/- 5.9 (P < 0.001) at 4.7 ATA during air breathing and to 49.9 +/- 5.4 (P < 0.001 vs. 1 ATA) during breathing with high external resistance. There was no significant effect of inspired P_o(2) or P(tr) on Pa(CO₂) or minute ventilation (V_e). V_e (l/min) decreased from 89.2 +/- 22.9 dry to 76.3 +/- 20.5 (P = 0.02) submersed, to 61.6 +/- 13.9 (P < 0.001) at 4.7 ATA during air breathing and to 49.2 +/- 7.3 (P < 0.001) during breathing with resistance. We conclude that the major contributors to increased Pa(CO₂) during exercise at 4.7 ATA are increased depth and external respiratory resistance. HCVR and maximal O₂ consumption were also weakly predictive. The effects of P(tr), inspired P_o(2), and O₂ consumption during short-term exercise were not significant.
Publication Types: Research Support, U.S. Gov't, Non-P.H.S.
PMID: 18787095

40: Aviat Space Environ Med. 2008 Sep;79(9):883-7.
Pulmonary function among professional divers over 12 years and the effect of total number of dives.
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Marit.Skogstad@stami.no
INTRODUCTION: Past studies indicate that lung function in professional divers, compared to non-divers, shows a reduction in maximal expiratory flow rates at low lung volumes and a reduction in the transfer factor for carbon monoxide. The objective in this study was to examine possible effects of long-term diving on pulmonary function among Norwegian professional divers.

METHODS: The 37 male divers, 24.6 yr (SD = 4.2) at baseline, were examined 4 times during a 12-yr follow-up. The median total number of dives was 503 (range: 40-7054). The effect of diving on pulmonary function was analyzed using linear additive mixed models. The number of dives was used as an explanatory variable. Assessment of lung function included dynamic lung volumes, flows, and transfer factor for carbon monoxide. RESULTS: The dynamic lung function and the transfer factor for Tl(CO) decreased significantly during follow-up. The observed decline of lung function is mostly due to age. When adjusted for age, follow-up year, smoking status at baseline, height, and weight, the effect of total number of dives on the different lung variables was not significant, except for FEF(25-75%) (L x s⁻¹) (P = 0.029). CONCLUSIONS: During a 12-yr follow-up of 37 divers the results show a decrease of lung function, but only expiratory flows at low lung volumes were significantly related to diving exposures.
Publication Types: Research Support, Non-U.S. Gov't
PMID: 18785357

41: Voen Med Zh. 2008 Jul;329(7):30-3, 96.
[Adaptation of divers in the European North]
[Article in Russian]
Myznikov IL, Ostrovskii DV, Ermakova SI.
The article gives a value of physiological condition of plungers's organisme during the most unfavorable season of the year-- polar night--in condition of based planed readiness (n = 26). Data of researches concluded necessary parameters of anthropometry, homodynamic, respirator functions. Supplementary diagnostic base was made by methods from the program of express-control of functional conditions. The results of the searches gave an opportunity to esteem the examined group of service men as people with tight vegetal nervous system, high level of neurohumoral regularity, which common for the physically strong people. It confirms the effectiveness of existing system of choice of plungers. The authors

offer to fix a system of physiological monitoring of the health of all the service men. The purpose of this action is an early revelation of donozoological conditions.

Publication Types: English
Abstract
PMID: 18777868

42: Int J Sports Med. 2009 Feb;30(2):150-3. Epub 2008 Sep 4.
Erratum in: Int J Sports Med. 2009 Feb;30(2):153.

Relation between right-to-left shunts and spinal cord decompression sickness in divers.

Gempp E, Blatteau JE, Stephant E, Louge P.

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The role of right-to-left shunting (RLS) in spinal cord decompression sickness (DCS) remains uncertain and could differ according to the distribution of lesion in spinal cord with a higher risk of upper spinal cord involvement in divers presenting a large patent foramen ovale. The aims of this study were to assess the prevalence of RLS with transcranial doppler ultrasonography in 49 divers referred for spinal cord DCS and compare it with the prevalence of RLS in 49 diving controls, and to determine a potential relation between RLS and lesion site of spinal cord. The proportion of large RLS was greater in DCS divers than in healthy control divers (odds ratio, 3.6 [95 % CI, 1.3 to 9.5]; $p = 0.017$). Shunting was not associated with the increased incidence of cervical spinal cord DCS (OR, 1.1 [95 % CI, 0.3 to 3.9]; $p = 0.9$) while a significant relationship between large RLS and spinal cord DCS with thoracolumbar involvement was demonstrated (OR, 6.9 [95 % CI, 2.3 to 20.4]; $p < 0.001$). From the above results, we conclude that the risk of spinal cord DCS in divers with hemodynamically relevant RLS is higher than in divers without RLS, particularly in their lower localization.

PMID: 18773377

43: Eur J Appl Physiol. 2008 Dec;104(6):1007-11. Epub 2008 Aug 26.

Anticipatory control of impending postural perturbation in elite springboard divers.

Popa T, Bonifazi M, della Volpe R, Rossi A, Mazzocchio R.

Sezione di Neurofisiologia Clinica, Dipartimento di Scienze Neurologiche e del Comportamento, Università di Siena, Policlinico "Le Scotte", Viale Bracci, Siena, Italy.

Among athletes, elite springboard divers (ED) should develop an optimal anticipatory control of postural stability, as a result of specific training. Postural strategies of ED and healthy subjects (HS) while expecting an impending perturbation were compared. The mean center of pressure (COP) position was analyzed during control quiet stance (cQS) and during anticipatory quiet stance (aQS(1-4)), i.e., in expectation of four backward translations of the support surface. During cQS, COP position in ED was not significantly different as compared to HS. During aQS(1-4,) a significant increase in the mean COP position was observed in both groups with ED adopting a more forward inclined vertical alignment than HS. In ED specific training may have resulted in a reference frame offset in a more anterior direction while expecting an impending perturbation. We suggest that leaning more forward may represent a more reliable way of coping with predictable perturbations of postural stability.

Publication Types: Comparative Study
PMID: 18726612

44: Aviat Space Environ Med. 2008 Aug;79(8):797-8.

Comment on: Aviat Space Environ Med. 2008 Feb;79(2):123-8.

Decompression illness diagnosis and decompression study design.

Vann RD, Moon RE, Freiburger JJ, Denoble PJ, Dear GL, Stolp BW, Massey EW.

Divers Alert Network, Center for Hyperbaric Medicine and Environmental Physiology, Department of Anesthesiology, Duke University, Durham, NC 27710, USA. rvann@dan.duke.edu

Publication Types: Comment
PMID: 18717122

45: Aviat Space Environ Med. 2008 Aug;79(8):761-4.

Blood platelet count and severity of decompression sickness in rats after a provocative dive.

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INTRODUCTION: Previous animal studies reported that platelet count (PC) is decreased following decompression. Adherence and aggregation of platelets to the bubble surface has been demonstrated in severe decompression sickness (DCS). The present study was designed to clarify the relationship between post-dive platelet levels and the severity of DCS in a rat model. METHODS: A total of 57 male Sprague-Dawley rats were assigned to either one experimental group with a hyperbaric exposure (N = 22) or one control group (N = 27). Rats were compressed to 1000 kPa (90 msw) for 45 min while breathing air and decompressed to surface in 38 min with stops at 200, 160, and 130 kPa. Onset of neurological DCS and death time were recorded during a 120-min observation period after surfacing. In the control group, rats were maintained at atmospheric pressure in the same chamber for an equivalent period of time. Blood samples for PC were taken 30 min before and immediately after exposure in two groups. RESULTS: Blood PC after hyperbaric exposure had significantly decreased, whereas PC had increased in the control group. We found a correlation between % fall in PC and latency to death time. The platelet loss tended to decrease when fatal DCS was delayed. Rats suffering from severe DCS with a short latency to death presented a pronounced decline in platelets. DISCUSSION: The present study highlighted a relationship between the post-dive decrease in PC and DCS severity in rats. Platelet consumption could offer a new index for evaluating decompression stress. PMID: 18717114

46: Forensic Sci Int. 2008 Sep 18;180(2-3):e1-5. Epub 2008 Aug 15.

Fatal diving accidents: two case reports and an overview of the role of forensic examinations.

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During the years 2004-2006, seven divers, who had deadly accidents, underwent post-mortem examination at the Institute of Legal Medicine of the University of Munich. The cause of death in all divers was drowning with typical pathomorphological findings. This should be regarded as separated to the triggering reason for drowning. The trigger for accident was established in four of seven cases by technical analysis and police investigation. High risk-taking, lack of technical service, and deficiency of dive equipment care were main reasons for death. We present two of these cases which showed several problems occurring concurrently. Autopsy always is necessary to look for indices for application of force or to exclude competitive reasons for death.

Publication Types: Case Reports
PMID: 18706775

47: Mar Pollut Bull. 2008 Oct;56(10):1788-94. Epub 2008 Aug 12.

Diving down the reefs? Intensive diving tourism threatens the reefs of the northern Red Sea.

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Intensive recreational SCUBA diving threatens coral reef ecosystems. The reefs at Dahab, South Sinai, Egypt, are among the world's most dived (>30,000 dives y⁻¹). We compared frequently dived sites to sites with no or little diving. Benthic communities and condition of corals were examined by the point intercept sampling method in the reef crest zone (3m) and reef slope zone (12 m). Additionally, the abundance of corallivorous and herbivorous fish was estimated based on the visual census method. Sediments traps recorded the sedimentation rates caused by SCUBA divers. Zones subject to intensive SCUBA diving showed a significantly higher number of broken and damaged corals and significantly lower coral cover. Reef crest coral communities were

significantly more affected than those of the reef slope: 95% of the broken colonies were branching ones. No effect of diving on the abundance of corallivorous and herbivorous fish was evident. At heavily used dive sites, diver-related sedimentation rates significantly decreased with increasing distance from the entrance, indicating poor buoyancy regulation at the initial phase of the dive. The results show a high negative impact of current SCUBA diving intensities on coral communities and coral condition. Corallivorous and herbivorous fishes are apparently not yet affected, but are endangered if coral cover decline continues. Reducing the number of dives per year, ecologically sustainable dive plans for individual sites, and reinforcing the environmental education of both dive guides and recreational divers are essential to conserve the ecological and the aesthetic qualities of these dive sites.

PMID: 18701118

48: Resuscitation. 2008 Nov;79(2):187-8. Epub 2008 Aug 8.

Air in the right ventricle after a deep dive.

Maples CJ, Martin SW, Lo BM.

Department of Emergency Medicine, Eastern Virginia Medical School, Norfolk, VA 23507, United States.

Publication Types: Case Reports

PMID: 18691803

49: J Exp Biol. 2008 Aug;211(Pt 16):2566-75.

The role of infrequent and extraordinary deep dives in leatherback turtles (*Dermochelys coriacea*).

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Infrequent and exceptional behaviours can provide insight into the ecology and physiology of a particular species. Here we examined extraordinarily deep (300-1250 m) and protracted (>1h) dives made by critically endangered leatherback turtles (*Dermochelys coriacea*) in the context of three previously

suggested hypotheses: predator evasion, thermoregulation and exploration for gelatinous prey. Data were obtained via satellite relay data loggers attached to adult turtles at nesting beaches (N=11) and temperate foraging grounds (N=2), constituting a combined tracking period of 9.6 years (N=26,146 dives) and spanning the entire North Atlantic Ocean. Of the dives, 99.6% (N=26,051) were to depths <300 m with only 0.4% (N=95) extending to greater depths (subsequently termed 'deep dives'). Analysis suggested that deep dives: (1) were normally distributed around midday; (2) may exceed the inferred aerobic dive limit for the species; (3) displayed slow vertical descent rates and protracted durations; (4) were much deeper than the thermocline; and (5) occurred predominantly during transit, yet ceased once seasonal residence on foraging grounds began. These findings support the hypothesis that deep dives are periodically employed to survey the water column for diurnally descending gelatinous prey. If a suitable patch is encountered then the turtle may cease transit and remain within that area, waiting for prey to approach the surface at night. If unsuccessful, then migration may continue until a more suitable site is encountered. Additional studies using a meta-analytical approach are nonetheless recommended to further resolve this matter.

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

PMID: 18689410

50: J Exp Biol. 2008 Aug;211(Pt 16):2559-65.

The ontogeny of aerobic and diving capacity in the skeletal muscles of Weddell seals.

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Our objective was to determine the ontogenetic changes in the skeletal muscles of Weddell seals that transform a non-diving pup into an elite diving adult. Muscle biopsies were collected from pups, juveniles

and adults and analyzed for changes in fiber type, mitochondrial density, myoglobin concentrations and aerobic, lipolytic and anaerobic enzyme activities. The fiber type results demonstrated a decrease in slow-twitch oxidative (Type I) fibers and a significant increase in fast-twitch oxidative (Type IIA) fibers as the animals mature. In addition, the volume density of mitochondria and the activity of lipolytic enzymes significantly decreased as the seals matured. To our knowledge, this is the first quantitative account describing a decrease in aerobic fibers shifting towards an increase in fast-twitch oxidative fibers with a significant decrease in mitochondrial density as animals mature. These differences in the muscle physiology of Weddell seals are potentially due to their three very distinct stages of life history: non-diving pup, novice diving juvenile, and elite deep diving adult. During the first few weeks of life, pups are a non-diving terrestrial mammal that must rely on lanugo (natal fur) for thermoregulation in the harsh conditions of Antarctica. The increased aerobic capacity of pups, associated with increased mitochondrial volumes, acts to provide additional thermogenesis. As these future elite divers mature, their skeletal muscles transform to a more sedentary state in order to maintain the low levels of aerobic metabolism associated with long-duration diving.

Publication Types: Research Support, Non-U.S. Gov't
PMID: 18689409

51: Pediatrics. 2008 Aug;122(2):e388-94.

Diving-related injuries in children <20 years old treated in emergency departments in the United States: 1990-2006.

Day C, Stolz U, Mehan TJ, Smith GA, McKenzie LB.

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OBJECTIVE: The purpose of this work was to comprehensively examine diving-related injuries in the United States among children and adolescents <20 years of age.

METHODS: We conducted a retrospective analysis of diving-

related injury data from the National Electronic Injury Surveillance System, including patients aged <20 years old who were seen in an emergency department for a diving-related injury from 1990 through 2006. RESULTS: An estimated 111341 patients aged <or=19 years were treated in emergency departments for diving-related injuries over the 17-year period of the study. The average annual injury rate was 8.4 injuries per 100000 US residents <20 years old. Patients aged 10 to 14 years composed the largest group (36.3%) of injured divers. Injuries to the head and/or neck (38.2%) and face (21.7%) were the most common, with the most frequent diagnoses being lacerations (33.9%) and soft tissue injuries (24.3%). Collision with a diving board and/or platform was the leading cause of injuries (43.9%). Children <10 years old had increased odds of sustaining a laceration, children <5 years old had increased odds of injury to the face, and 10- to 19-year-olds had increased odds of sustaining a fracture or an injury to the extremities. The odds of injury caused by contact with the diving board dramatically increased if the child was performing a flip and/or handstand or a backward dive. CONCLUSIONS: To our knowledge, this is the first study to examine recreational and competitive diving-related injuries among children and adolescents using a nationally representative sample. These results can help inform pediatricians, parents, coaches, and trainers regarding injuries seen during recreational and competitive diving and can help guide future prevention efforts.

PMID: 18676525

52: Ann Fr Anesth Reanim. 2008 Sep;27(9):694-9. Epub 2008 Jul 31.

[Pulmonary oedema in scuba-diving: frequency and seriousness about a series of 19 cases]

[Article in French]

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OBJECTIVES: Pulmonary oedema in self-contained underwater breathing apparatus diving is an accident whose risk factors, conditions of occurrence and incidence are not well-known. The aim of this study was to evaluate the frequency, the risk factors and the evolution of this accident. **STUDY DESIGN:** Retrospective case study and prospective frequency study. **PATIENTS AND METHODS:** Study covering the Brittany region and performed in two steps with distinct objectives: a review of cases diagnosed between 2002 and 2007, and a one-year study of cases reported by emergency physicians. Diagnosis was based on the history, a respiratory distress, auscultation and radiologic features. **RESULTS:** Nineteen cases were reported, of which one was recurrent. The mean age of patients was 49 years. Divers without heart disease were involved, as well as divers with hypertension (eight cases) or valve abnormalities (three cases). Stress and/or physical exertion were involved. Dyspnoea, cough and haemoptysis were the most common symptoms; in addition, two cases of cardiac arrest and three of loss of consciousness were observed. Chest radiography was unsensitive (normal in four cases), contrasting with abnormal thoracic CT scan in all cases. Symptoms resolved rapidly with oxygen, except for two divers who died. We identified five cases over one year, one of which lethal. **CONCLUSION:** This accident is not a rare event and may have serious consequences. Oldest divers submitted to stress and/or effort are at higher risk.

Publication Types: English Abstract
PMID: 18674877

53: Arch Orthop Trauma Surg. 2009 Jan;129(1):87-90. Epub 2008 Jul 22. Upper lumbar burst fracture due to recreational high jumping into a river: report of five cases. Kikuike K, Uemura S, Miyamoto K, Horiya Y, Shimizu K. Department of Orthopaedic Surgery, Gifu University School of Medicine, Gujo City Hospital, Gifu, Japan. kikukensports@ybb.ne.jp

INTRODUCTION: Spinal injuries resulting from entering into water usually occur in the cervical region, with few reported in the thoracolumbar region. Although the mechanism of cervical spine injury caused by diving is known, less is known regarding the mechanism of upper lumbar spine injury. **MATERIALS AND METHODS:** The study subjects were five patients (mean age, 32.8 years), inexperienced in diving from heights, who were referred for burst fractures (Denis type B) at L1 caused while jumping into a river from a 12-m-high bridge between 2004 and 2005. Three patients were treated surgically and two were treated conservatively. Their clinical outcomes were reviewed and the mechanism of upper lumbar spine injury was discussed. **RESULTS:** No patient experienced neurological deficit or low back pain after treatment, and all returned to their previous activities within 1 year. Impact with the surface of the river with back and hip flexed may be a major cause of upper lumbar spine injury. **CONCLUSIONS:** To minimize the incidence of upper lumbar burst fracture during recreational high jumping into water, it is important that jumpers, especially inexperienced jumpers, should be instructed to jump with their backs and hips straight.

PMID: 18648825

54: Appl Physiol Nutr Metab. 2008 Aug;33(4):666-70.

[Influence of exercise on decompression sickness]

[Article in French]

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Exercise at depth and during decompression is a commonly accepted factor that affects the risk of decompression sickness in divers and aviators, but data documenting these effects are limited and conflicting. The mechanisms may be complex and influenced by several factors, such as the type and nature of exercise, the temporal course of the exercise in relation to the decompression procedure, and the diving profile. This paper reviews previous studies in this field of research, and

discusses current concepts in diving activities.

Publication Types: English
Abstract Review
PMID: 18641708

55: J Sports Sci. 2008
Aug;26(10):1091-5.

The "coherent majority average" for juries' evaluation processes.

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I propose a method to synthesize the performance scores for artistic sports such as rhythmic gymnastics, figure skating, synchronized swimming, and diving by taking into account inter-judge variability, while maintaining all the reliable scores. This procedure is based on the assumption that the majority of the scores in each event are reliable and they relate well to those scores that are closest to them. The method consists of putting scores in order and considering clusters of m consecutive scores, where m is the number of judges making up the simple majority. For each cluster, the difference between the highest and the lowest score is calculated. In cases where the minimum difference is positive, the arithmetic mean of those scores that belong to clusters where the difference is minimal is computed. In cases where the minimum difference is zero (i.e. if the majority of judges unanimously assign the same score), then the set of the scores to consider within the mean is extended to those scores that are very near to those of the majority of the judges. A comparison between the actual evaluation procedures and the proposed model is provided.

Publication Types: Evaluation
Studies Research Support, Non-
U.S. Gov't
PMID: 18608829

56: J Comp Physiol B. 2008
Aug;178(6):745-54. Epub 2008 Jun 25.

Pedestrian locomotion energetics and gait characteristics of a diving bird, the great cormorant, *Phalacrocorax carbo*.

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Great cormorants *Phalacrocorax carbo* are foot propelled diving birds that seem poorly suited to locomotion on land. They have relatively short legs, which are presumably adapted for the generation of high forces during the power stroke of aquatic locomotion, and walk with a pronounced "clumsy waddle". We hypothesise (1) that the speed, independent minimum cost of locomotion (C_{min} , ml O₂ m⁻¹) will be high for cormorants during treadmill exercise, and (2) that cormorants will have a relatively limited speed range in comparison to more cursorial birds. We measured the rate of oxygen consumption ($\dot{V}O_2$) of cormorants during pedestrian locomotion on a treadmill, and filmed them to determine duty factor (the fraction of stride period that the foot is in contact with the ground), foot contact time (t_c), stride frequency (f), swing phase duration and stride length. C_{min} was 2.1-fold higher than that predicted by their body mass and phylogenetic position, but was not significantly different from the C_{min} of runners (Galliformes and Struthioniformes). The extrapolated gamma-intercept of the relationship between $\dot{V}O_2$ and speed was 1.9-fold higher than that predicted by allometry. Again, cormorants were not significantly different from runners. Contrary to our hypothesis, we therefore conclude that cormorants do not have high pedestrian transport costs. Cormorants were observed to use a grounded gait with two double support phases at all speeds measured, and showed an apparent gait transition between 0.17 and 0.25 m s⁻¹. This transition occurs at a Froude number between 0.016 and 0.037, which is lower than the value of approximately 0.5 observed for many other species. However, despite the use of a limited speed range, and a gait transition at relatively low speed, we conclude that the pedestrian locomotion of these foot propelled diving birds is otherwise generally similar to that of cursorial birds at comparable relative velocities.

Publication Types: Comparative
Study Research Support, Non-U.S.
Gov't
PMID: 18575869

57: *Exp Biol Med* (Maywood). 2008
Sep;233(9):1181-8. Epub 2008 Jun 5.
Expression of endothelial selectin
ligands on human leukocytes
following dive.

Glavas D, Markotic A, Valic Z,
Kovacic N, Palada I, Martinic R,
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The fact that impaired endothelial-
dependent vasodilatation after scuba
diving often occurs without visible
changes in the endothelial layer
implies its biochemical origin.
Since Lewisx(CD15) and sialyl-
Lewisx(CD15s) are granulocyte and
monocyte carbohydrate antigens
recognized as ligands by endothelial
selectins, we assumed that they
could be sensitive markers for
impaired vasodilatation following
diving. Using flow cytometry, we
determined the CD15 and CD15s
peripheral blood mononuclear cells
of eight divers, 30 mins before and
50 mins after a single dive to 54 m
for 20 mins bottom time. The number
of gas bubbles in the right heart
was monitored by ultrasound. Gas
bubbles were seen in all eight
divers, with the average number of
bubbles/cm² 1.9+/-1.9. The
proportion of CD15+monocytes
increased 2-fold after the dive as
well as the subpopulation of
monocytes highly expressing CD15s.
The absolute number of monocytes was
slightly, but not significantly,
increased after the dive, whereas
the absolute number of granulocytes
was markedly elevated (up to 61%).
There were no significant
correlations between bubble
formation and CD15+monocyte
expression ($r=-0.56$; $P=0.17$), as
well as with monocytes highly
expressing CD15s ($r=0.43$; $P=0.29$).
This study suggests that biochemical
changes induced by scuba diving
primarily activate existing
monocytes rather than increase the
number of monocytes at a time of
acute arterial endothelial
dysfunction.

Publication Types: Clinical
Trial Research Support, Non-U.S.
Gov't
PMID: 18535169

58: *Biol Lett*. 2008 Aug 23;4(4):395-
8.

Transatlantic migration and deep
mid-ocean diving by basking shark.
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Despite being the second largest
fish, basking sharks (*Cetorhinus
maximus*) have been assumed to remain
in discrete populations. Their known
distribution encompasses temperate
continental shelf areas, yet until
now there has been no evidence for
migration across oceans or between
hemispheres. Here we present results
on the tracks and behaviour of two
basking sharks tagged off the
British Isles, one of which
released its tag off Newfoundland,
Canada. During the shark's transit
of the North Atlantic, she travelled
a horizontal distance of 9589 km and
reached a record depth of 1264 m.
This result provides the first
evidence for a link between European
and American populations and
indicates that basking sharks make
use of deep-water habitats beyond
the shelf edge.

Publication Types: Research
Support, Non-U.S. Gov't
PMID: 18511407

59: *Eur J Appl Physiol*. 2008
Sep;104(1):1-7. Epub 2008 May 22.

Heart rate and blood pressure time
courses during prolonged dry apnoea
in breath-hold divers.

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To define the dynamics of
cardiovascular adjustments to
apnoea, beat-to-beat heart rate (HR)
and blood pressure and arterial
oxygen saturation (SaO₂) were
recorded during prolonged breath-
holding in air in 20 divers. Apnoea
had a mean duration of 210 +/- 70 s.
In all subjects, HR attained a value
14 beats min⁻¹ lower than control

within the initial 30 s (phase I). HR did not change for the following 2-2.5 min (phase II). Then, nine subjects interrupted the apnoea (group A), whereas 11 subjects (group B) could prolong the breath-holding for about 100 s, during which HR continuously decreased (phase III). In both groups, mean blood pressure was 8 mmHg above control at the end of phase I; it then further increased by additional 12 mmHg at the end of the apnoea. In both groups, SaO₂ did not change in the initial 100-140 s of apnoea; then, it decreased to 95% at the end of phase II. In group B, SaO₂ further diminished to 84% at the end of phase III. A typical pattern of cardiovascular readjustments was identified during dry apnoea. This pattern was not compatible with a role for baroreflexes in phase I and phase II. Further readjustment in group B may imply a role for both baroreflexes and chemoreflexes. Hypothesis has been made that the end of phase II corresponds to physiological breakpoint.

Publication Types: Research Support, Non-U.S. Gov't
PMID: 18496707

60: Spinal Cord. 2008 Nov;46(11):743-7. Epub 2008 May 13. Venous gas bubble formation and decompression risk after scuba diving in persons with chronic spinal cord injury and able-bodied controls.

Breskovic T, Denoble P, Palada I, Obad A, Valic Z, Glavas D, Bakovic D, Dujic Z.

Department of Physiology, University of Split School of Medicine, Split, Croatia.

STUDY DESIGN: Prospective study. OBJECTIVE: To evaluate the formation of venous gas bubbles following open-sea scuba dives in persons with chronic spinal cord injury (SCI) and in able-bodied diving instructors (C) and to assess the risk for decompression sickness (DCS). SETTING: Field study at the Island of Krk, Croatia. METHODS: Gas bubbles were monitored with an ultrasound scanner 40 min after surfacing. The probability of DCS (P((DCS))) was estimated from the recorded depth-time profile using a decompression model. RESULTS: Divers completed six dives in 3 days using

a modified Bühlmann decompression model, and none developed signs of DCS. Mean P((DCS)) was similar in both groups, SCI (0.51+/-0.2%) and C (0.64+/-0.27%), and was seen to increase with subsequent dives. Number of bubbles (bubbles per cm²) was low in both groups on all 3 days of diving. CONCLUSIONS: We have used the P((DCS)) as a severity index of diving exposure. Overall, the severity of exposure in SCI subjects was consistent with the range of typical recreational dives, suggesting that the diving profile used is very safe.

Publication Types: Clinical Trial
Research Support, Non-U.S. Gov't
PMID: 18475278

61: Naturwissenschaften. 2008 Sep;95(9):793-801. Epub 2008 Apr 30. Decompression syndrome and the evolution of deep diving physiology in the Cetacea.

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Whales repetitively dive deep to feed and should be susceptible to decompression syndrome, though they are not known to suffer the associated pathologies. Avascular osteonecrosis has been recognized as an indicator of diving habits of extinct marine amniotes. Vertebrae of 331 individual modern and 996 fossil whales were subjected to macroscopic and radiographic examination. Avascular osteonecrosis was found in the Oligocene basal odontocetes (Xenorophoidea) and in geologically younger mysticetes, such as Aglaocetus [a sister taxon to Balaenopteridae + (Balaenidae + Eschrichtiidae) clade]. These are considered as early "experiments" in repetitive deep diving, indicating that they independently converged on their similar specialized diving physiologies.

PMID: 18446257

62: Eur J Appl Physiol. 2008 Jul;103(4):469-75.

Characteristics of the respiratory mechanical and muscle function of competitive breath-hold divers.

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Competitive breath-hold divers (BHD) employ glossopharyngeal insufflation (GI) to increase intrapulmonary oxygen stores and prevent the lungs from dangerous compressions at great depths.

Glossopharyngeal insufflation is associated with inflation of the lungs beyond total lung capacity (TLC). It is currently unknown whether GI transiently over-distends the lungs or adversely affects lung elastic properties in the long-term. Resting lung function, ventilatory drive, muscle strength, and lung compliance were measured in eight BHD who performed GI since 5.5 (range 2-6) years on average, eight scuba divers, and eight control subjects. In five BHD subsequent measures of static lung compliance (Cstat) were obtained after 1 and 3 min following GI. Breath-hold divers had higher than predicted ventilatory flows and volumes and did not differ from control groups with regard to gas transfer, inspiratory muscle strength, and lung compliance. A blunted response to CO₂ was obtained in BHD as compared to control groups. Upon GI there was an increase in mean vital capacity (VCGI) by 1.75 +/- 0.85 (SD) L compared to baseline (p < 0.001). In five BHD Cstat raised from 3.7 (range 2.9-6.8) L/kPa at baseline to 8.1 (range 3.4-21.2) L/kPa after maximal GI and thereafter gradually decreased to 5.6 (range 3.3-8.1) L/kPa after 1 min and 4.2 (range 2.7-6.6) L/kPa after 3 min (p < 0.01). We conclude that in experienced BHD there is a transient alteration in lung elastic recoil. Resting lung function did not reveal a pattern indicative of altered lung ventilatory or muscle function.

PMID: 18398589

63: Eur J Appl Physiol. 2008 Sep;104(2):237-44. Epub 2008 Mar 28. Effects of pressure, cold and gloves on hand skin temperature and manual performance of divers.
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Cold water immersion and protective gloves are associated with decreased manual performance. Although neoprene gloves slow hand cooling, there is little information on whether they provide sufficient protection when diving in cold water. Nine divers wearing three-fingered neoprene gloves and dry suits were immersed in water at 25 and 4 degrees C, at depths of 0.4 msw (101 kPa altitude adjusted) and 40 msw (497 kPa) in a hyperbaric chamber. Skin temperatures were measured at the fingers, hand, forearm, chest and head. Grip strength, tactile sensitivity and manual dexterity were measured at three time intervals. There was an exponential decay in finger and back of hand skin temperatures with exposure time in 4 degrees C water. Finger and back of hand skin temperatures were lower at 40 msw than at 0.4 msw (P < 0.05). There was no effect of pressure or temperature on grip strength. Tactile sensitivity decreased linearly with finger skin temperature at both pressures. Manual dexterity was not affected by finger skin temperature at 0.4 msw, but decreased with fall in finger skin temperature at 40 msw. Results show that neoprene gloves do not provide adequate thermal protection in 4 degrees C water and that impairment of manual performance is dependent on the type of task, depth and exposure time.

Publication Types: Research Support, Non-U.S. Gov't
PMID: 18369658

64: J Laryngol Otol. 2008 Nov;122(11):1162-7. Epub 2008 Mar 18.

Prevalence and severity of external auditory exostoses in breath-hold divers.

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OBJECTIVE: To explore the prevalence and severity of external auditory exostoses in a population of experienced breath-hold divers, and to compare these to the same

parameters within surfing and self-contained underwater breathing apparatus diving populations. DESIGN: A stepwise, multiple regression analysis of cross-sectional data examining the relative contributions of sea surface temperature, latitude of exposure and years of exposure to the prevalence and severity of stenosis due to external auditory exostoses. A chi-square analysis of the prevalence and severity of external auditory exostosis stenosis in the breath-hold divers was compared with previously published data for surfers and self-contained underwater breathing apparatus divers. SUBJECTS: Seventy-six male and thirty-five female breath-hold divers attending an international 'freedive' competition completed a questionnaire describing aquatic sports habits, geography of participation and symptomatology. Those completing the questionnaire (111/154 attendees) were examined otoscopically for evidence of external auditory exostoses. Images were digitally recorded, scored and graded. RESULTS: Exostoses were evident in 87.7 per cent of the 204 ears scored and graded for severity of stenosis due to external auditory exostoses. The prevalence of exostoses was no different from that found in previous studies of surfers and self-contained underwater breathing apparatus divers ($p = 0.101$). However, the pattern of affliction was more similar to that found in surfers. The severity of exostoses was significantly less than that found in surfing populations ($p < \text{or} = 0.001$ to 0.007), but greater than that found in self-contained underwater breathing apparatus diving populations ($p < \text{or} = 0.001$). Sea surface temperature at the location of open-water exposure was the most significant predictor of the prevalence and severity of external auditory exostoses in breath-hold divers ($p = 0.019$). CONCLUSION: The prevalence and severity patterns of stenosis due to external auditory exostoses in breath-hold divers are more similar to previously published results for surfing populations than to previously published results for self-contained underwater breathing apparatus

diving populations. In breath-hold divers, sea surface temperature is the strongest predictor of severity of stenosis due to external auditory exostoses.

PMID: 18346299

65: Br J Sports Med. 2008 Nov;42(11):634-6. Epub 2007 Dec 7. Influence of repetitive open sea dives and physical exercises on right-to-left shunting in healthy divers.

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OBJECTIVE: Paradoxical gas embolism through right-to-left (R/L) shunts is considered as a potential cause of certain types of decompression sickness. AIM: To assess whether 4 months of repetitive diving and strenuous exercises would lead to an increased prevalence of R/L shunting in a group of military divers. METHODS: Using a standardised contrast-enhanced transcranial Doppler technique, 17 divers were re-examined for the presence of a R/L shunt 4 months after their initial examinations. R/L shunts were classified as type I if observed only after a straining manoeuvre, and type II if present at rest. RESULTS: Initial prevalence of R/L shunt was 41%: six type I shunts and one type II. At the second examination, prevalence was 47%, with the appearance of one type I shunt that was not previously present. We found no significant increase in the prevalence and size of R/L shunts. CONCLUSION: It is speculated that diving-related phenomena, such as variations in right atrial pressures during the end stages of or events immediately after a dive could generate an R/L shunt. However, extreme conditions of repetitive diving and strenuous exercises do not cause permanent modification in R/L permeability over a period of 4 months.

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