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

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PRIMO SEMESTRE

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

Search **"Diving"[MeSH]** Limits: **Publication Date from 2004/01 to 2004/06**

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1: Undersea Hyperb Med. 2004 Winter;31(4):431-44.
Experimental trials to assess the risks of decompression sickness in flying after diving.
Vann RD, Gerth WA, Denoble PJ, Pieper CF, Thalmann ED.
Divers Alert Network, Department of Anesthesiology, Duke University Medical Center, Durham, NC, USA.
We conducted experimental trials of flying after diving using profiles near the no-decompression exposure limits for recreational diving. The objective was to determine the dependence of DCS occurrence during or after flight on the length of the preflight surface intervals (PFSI). One to three dives were conducted during a single day with dry, resting subjects in a hyperbaric chamber at depths of 40, 60, or 100 fsw (224, 286, 408 kPa). The dives were followed by PFSI of 3 to 17 hrs and a four-hour altitude exposure at 8,000 ft (75 kPa), the maximum permitted cabin altitude for pressurized commercial aircraft. Forty DCS incidents occurred during or after flight in 802 exposures of 495 subjects. The DCS incidence decreased as PFSI increased, and repetitive dives generally required longer PFSI to achieve low incidence than did single dives ($p = 0.0159$). No DCS occurred in 52 trials of a 17 hr PFSI, the longest PFSI tested. The results provide empirical information for formulating guidelines for flying in commercial aircraft after recreational diving.
PMID: 15686274 [PubMed - indexed for MEDLINE]

2: Undersea Hyperb Med. 2004 Winter;31(4):385-6.
Stability of pulmonary function in U.S. Navy divers.
Shykoff BE, Petryszyn JD.
Navy Experimental Diving Unit, Panama City, FL, USA.
PMID: 15686269 [PubMed - indexed for MEDLINE]

3: Wilderness Environ Med. 2004 Winter;15(4):284-8.
Stonefish poisoning.
Lyon RM.
University of Edinburgh, Edinburgh, Scotland, UK. lyon_richard@hotmail.com
Scuba diving is becoming an increasingly popular recreation. Divers are traveling further afield, often to remote dive locations. These locations are often home to poisonous marine creatures such as stonefish. A case of acute stonefish poisoning in a scuba diver is described, including his treatment, the difficulties encountered with his management and evacuation, and his subsequent return to full health. The proper management of stonefish poisoning is reviewed, and the implications for divers traveling to remote locations are given.
Publication Types: Case Reports
PMID: 15636379 [PubMed - indexed for MEDLINE]

4: Dermatitis. 2004 Mar;15(1):55-6.
Allergic contact dermatitis from dibutylthiourea in a wet suit.
Gudi VS, White MI, Ormerod AD.
Publication Types: Case Reports Letter
PMID: 15573652 [PubMed - indexed for MEDLINE]

5: Aviakosm Ekolog Med. 2004 May-Jun;38(3):63-4.
[On the founding of the department of diving medicine and gas inhalation treatment]
[Article in Russian]
Safina NF.
PMID: 15372804 [PubMed - indexed for MEDLINE]

6: MMW Fortschr Med. 2004 Feb 19;146(8):39-42.
[Before going on a diving holiday--consider this]
[Article in German]
Kemmer A.
Abt. f. Anasthesie--Intensivzentrum, Berufsgenossenschaftliche, Unfallklinik Murnau. kemmer@bgu-murnau.de
A prerequisite for all those who go in for the sport of scuba diving is mental and physical fitness. This must be checked within the framework of an examination for diving fitness before first taking up the sport, and should be rechecked every one to three years. For fitness for diving, not only lung function, ECG and tubal function need to be normal--the psychological profile of the holiday maker also plays an important role under water. For he or she must be able rapidly and reliably to recognize a dangerous situation and to react to it appropriately. Thorough training and the compliance with the rules of diving offer protection from many of the risks of this underwater sport--for example, problems with the ears or sinuses can be avoided. The most common cause of fatal diving accidents is a barotrauma of the lung with rupture of the alveoli on ascending.
Publication Types: Review Review, Tutorial
PMID: 15346936 [PubMed - indexed for MEDLINE]

7: Environ Manage. 2004 Feb;33(2):196-211.
Conflict and impacts of divers and anglers in a marine park.
Lynch TP, Wilkinson E, Melling L, Hamilton R, MacReady A, Feary S.
Jervis Bay Marine Park, NSW, 2540, Australia. jervis.bay@npws.nsw.gov.au
The New South Wales State Government (Australia) gazetted the Jervis Bay Marine Park (JBMP) in 1998. During the preparation of the draft zoning plan in 2000, societal data on two conflicting park user groups--recreational scuba divers and fishers (anglers)--was collected. While conflict resolution was a plan priority, other factors, such as cumulative

environmental impacts of users and protection for the critically endangered grey nurse shark (Carcharias taurus), further complicated planning. Both scuba diving and angling are primary summer activities and are disproportionately concentrated around the headlands of the bay. Furthermore, shore based game-fishing was concentrated on the northern headland, where the conflict was centered. However, when the exact locations of divers and anglers were determined, there was a partial partitioning of the available space, with only a small contested overlap. To resolve conflict and maximize positive environmental outcomes, a sanctuary zone and noanchoring zone option in the draft zoning plan was sought to formalize this partition. The human dimension data proved valuable in guiding environmental management in this politically volatile situation. A baseline study conducted 11 years previously was also used to gain a limited perspective on change in user numbers. Comparison between study periods indicated dive numbers had remained similar, while the number of dive charter trips was significantly less. The numbers of anglers, for the four months compared, had doubled and tripled. The actual data used to inform management is presented and the limitations of this "best available data" approach are discussed.
PMID: 15285398 [PubMed - indexed for MEDLINE]

8: Undersea Hyperb Med. 2004 Spring;31(1):1-183.
Oxygen 2002. Proceedings of the 10th Symposium on Underwater and Hyperbaric Physiology. La Jolla, California, USA, July 1-2, 2002. Symposium in honor of Dr. Christian J. Lambertsen.
Lambertsen CJ.
Publication Types: Biography Congresses Festschrift Historical Article
PMID: 15279000 [PubMed - indexed for MEDLINE]

9: Herz. 2004 Jun;29(4):406-13.
[Scuba diving and the heart. Cardiac aspects of sport scuba diving]
[Article in German]
Muth CM, Tetzlaff K.
Sektion Anasthesiologische Pathophysiologie und Verfahrensentwicklung, Universitatsklinik fur Anasthesiologie, Universitat Ulm, Ulm. claus-martin.muth@medizin.uni-ulm.de
Diving with self-contained underwater breathing apparatus (scuba) has become a popular recreational sports activity throughout the world. A high prevalence of cardiovascular disorders among the population makes it therefore likely that subjects suffering from cardiovascular problems may want to start scuba diving. Although scuba diving is not a competitive sport requiring athletic health conditions, a certain medical fitness is recommended because of the physical peculiarities of the underwater environment. Immersion alone will increase cardiac preload by central blood pooling with a rise in both cardiac output and blood pressure, counteracted by increased diuresis. Exposure to cold and increased oxygen partial pressure during scuba diving will additionally increase afterload by vasoconstrictive effects and may exert bradyarryhthmias in combination with breath-holds. Volumes of gas-filled body cavities will be affected by changing pressure (Figure 1), and inert gas components of the breathing gas mixture such as nitrogen in case of air breathing will dissolve in body tissues and venous blood with increasing alveolar inert gas pressure. During decompression a free gas phase may form in supersaturated tissues, resulting in the generation of inert gas microbubbles that are eliminated by the venous return to the lungs under normal circumstances. Certain cardiovascular conditions may have an impact on these physiological changes and pose the subject at risk of suffering adverse events from scuba diving. Arterial hypertension may be aggravated by underwater exercise and immersion. Symptomatic coronary artery disease and symptomatic heart rhythm disorders preclude diving. The occurrence of ventricular extrasystoles according to Lown classes I and II, and the presence of atrial fibrillation are considered relative contraindications in the absence of an aggravation following exercise. Asymptomatic subjects with Wolff-Parkinson-White syndrome may be allowed to dive, but in case of paroxysmal supraventricular tachycardia they must refrain from diving. Pacemakers will fail with increasing pressure, but some manufacturers have proven their products safe for pressure equivalents of up to 30 m of seawater, so that patients may dive uneventfully when staying within the 0-20 m depth range. Significant aortic or mitral valve stenosis will preclude diving, whereas regurgitation only will not be a problem. Right-to-left shunts have increasingly gained attention in diving medicine, since they may allow venous gas microbubbles to spill over to the arterial side of the circulation enabling the possibility of arterial gas embolism. Significant shunts thus preclude diving. The highly prevalent patent foramen ovale is considered a relative contraindication only when following certain recommendations for safe diving (Table 2). Metabolic disorders are of concern, since adiposity is associated with both, higher bubble grades in Doppler ultrasound detection after scuba dives when compared to normal subjects, and an increased epidemiologic risk of suffering from decompression illness. In conclusion, cardiovascular aspects are important in the assessment of fitness to dive, and certain cardiovascular conditions preclude scuba diving. Any history of cardiac disease or abnormalities detected during the routine medical examination should prompt to further evaluation and specialist referral.
Publication Types: Review Review, Tutorial
PMID: 15241540 [PubMed - indexed for MEDLINE]

10: Undersea Hyperb Med. 2004 Spring;31(1):81-95.
Oxygen and the diving seal.
Thornton SJ, Hochachka PW.
Dept. of Zoology, University of Otago, Dunedin, NZ.
PMID: 15233163 [PubMed - indexed for MEDLINE]

11: Undersea Hyperb Med. 2004 Spring;31(1):33-51.
The Predictive Studies Series: Correlation of physiologic responses to extreme environmental stresses.
Clark JM.
Environmental Biomedical Stress Data Center, Institute for Environmental Medicine, University of Pennsylvania Medical Center, Room One, John Morgan Building, 36th Street and Hamilton Walk, Philadelphia, PA 19104-6068, USA.
PMID: 15233158 [PubMed - indexed for MEDLINE]

12: Undersea Hyperb Med. 2004 Spring;31(1):21-31.
Lambertsen and O2: beginnings of operational physiology.
Vann RD.
Center for Hyperbaric Medicine and Environmental Physiology, Box 3823, Duke University Medical Center, Durham, NC 27710, USA.
Publication Types: Biography Historical Article
Personal Name as Subject: Lambertsen C
PMID: 15233157 [PubMed - indexed for MEDLINE]

13: Undersea Hyperb Med. 2004 Spring;31(1):3-20.
Closed-circuit oxygen diving in the U.S. Navy.
Butler FK Jr.
Naval Special Warfare Command Detachment, Pensacola, Florida, USA.
Publication Types: Biography Historical Article
Personal Name as Subject: Lambertsen CJ
PMID: 15233156 [PubMed - indexed for MEDLINE]

14: Hum Mov Sci. 2004 Jun;23(1):35-48.
Optimal jumping strategies from compliant surfaces: a simple model of springboard standing jumps.
Cheng KB, Hubbard M.
Sports Biomechanics Laboratory, Department of Mechanical and Aeronautical Engineering, University of California, Davis 95616, USA.
A simple model of standing dives is used to investigate optimal jumping strategies from compliant surfaces and applied to springboard diving. The human model consists of a massless leg actuated by knee torque, and a lumped torso mass centered above the leg. The springboard is modeled as a mass-spring system. Maximum jump height for a male and a female is calculated by controlling knee-torque activation level as a function of time. The optimization includes constraints on minimum and maximum knee angle, rate of change of normalized activation level, and contact duration. Simulation results for maximal springboard depression and diver takeoff velocity agree reasonably with experimental data, even though larger board tip velocities are necessarily predicted earlier during the contact period. Qualitatively similar multiple pulse knee-torque activation patterns are found over various conditions and are different from those in rigid-surface jumping. The model is less able to predict accurately jump height at high fulcrum number since jumpers may have difficulty behaving optimally at non-preferred fulcrum settings. If strength is proportional to the product of mass and leg length, increasing leg length is more effective in increasing jump height than is increasing mass.
PMID: 15201040 [PubMed - indexed for MEDLINE]

15: Aviat Space Environ Med. 2004 Jun;75(6):489-95.
Exercise effects during diving and decompression on postdive venous gas emboli.
Jankowski LW, Tikuisis P, Nishi RY.
Exercise Science Department, Concordia University, McGill University Montreal, Quebec, Canada.
BACKGROUND: Exercise and diving have generally been associated with an increased risk of decompression sickness (DCS), thus accounting for the lack of studies involving exercise during decompression. However, theoretical and observational evidence contrary to this association motivated the present investigation on the effects of moderate, intermittent exercise during diving and/or during decompression on venous gas emboli (VGE) activity following a dive. HYPOTHESIS: VGE observed at both the precordium and subclavian vein sites after diving should be reduced if moderate exercise is performed during decompression vs. remaining inactive. METHODS: In a water-filled hyperbaric chamber, 39 healthy male subjects were compressed to a pressure of 450 kPa (45 msw) for 30 min followed by 55 min of staged decompression. Subjects were either active or inactive at the bottom phase (450 kPa) and/or during the decompression. Activity comprised three 5-min intervals of moderate arm or leg exercise at the bottom and five such intervals during decompression. After decompression, VGE were monitored at the precordium and subclavian vein sites using Doppler detection. Bubble activity scores were converted to various indices and analyzed using non-parametric statistics. RESULTS: VGE activity was invariant as to whether subjects were active or sedentary during the bottom phase of the dive. However, it was significantly lower for all indices examined ($p < 0.05$) after dives in which exercise was performed during decompression vs. inactive decompression. CONCLUSION: Moderate, intermittent physical activity during decompression decreases VGE activity after diving.
PMID: 15198273 [PubMed - indexed for MEDLINE]

16: Eur Heart J. 2004 Jun;25(12):1014-20.
Risk of decompression illness among 230 divers in relation to the presence and size of patent foramen ovale.
Torti SR, Billinger M, Schwerzmann M, Vogel R, Zbinden R, Windecker S, Seiler C.
Department of Cardiology, University Hospital, CH-3010 Bern, Switzerland.
BACKGROUND: The risk of developing decompression illness (DCI) in divers with a patent foramen ovale (PFO) has not been directly determined so far; neither has it been assessed in

relation to the PFO's size. METHODS: In 230 scuba divers (age 39+/-8 years), contrast trans-oesophageal echocardiography (TEE) was performed for the detection and size grading (0-3) of PFO. Prior to TEE, the study individuals answered a detailed questionnaire about their health status and about their diving habits and accidents. For inclusion into the study, > or =200 dives and strict adherence to decompression tables were required. RESULTS: Sixty-three divers (27%) had a PFO. Overall, the absolute risk of suffering a DCI event was 2.5 per 10(4) dives. There were 18 divers (29%) with, and 10 divers (6%) without, PFO who had experienced > or =1 major DCI events P=0.016. In the group with PFO, the incidence per 10(4) dives of a major DCI, a DCI lasting longer than 24 h and of being treated in a decompression chamber amounted to 5.1 (median 0, interquartile range [IQR] 0-10.0), 1.9 (median 0, IQR 0-4.0) and 3.6 (median 0, IQR 0-9.8), respectively and was 4.8-12.9-fold higher than in the group without PFO (P<0.001). The risk of suffering a major DCI, of a DCI lasting longer than 24 h and of being treated by recompression increased with rising PFO size. CONCLUSION: The presence of a PFO is related to a low absolute risk of suffering five major DCI events per 10(4) dives, the odds of which is five times as high as in divers without PFO. The risk of suffering a major DCI parallels PFO size.
PMID: 15191771 [PubMed - indexed for MEDLINE]

17: Curr Biol. 2004 May 25;14(10):R376-7.
Cormorants keep their power: visual resolution in a pursuit-diving bird under amphibious and turbid conditions.
Strod T, Arad Z, Izhaki I, Katzir G.
Publication Types: Letter
PMID: 15186760 [PubMed - indexed for MEDLINE]

18: CMAJ. 2004 Jun 8;170(12):1792.
A 32-year-old man with acute bilateral leg weakness following recreational diving.
Dowlatshahi D, Hogan MJ, Sharma M, Wherrett CG.
University of Ottawa, ON.
Publication Types: Case Reports
PMID: 15184331 [PubMed - indexed for MEDLINE]

19: Schweiz Rundsch Med Prax. 2004 Apr 28;93(18):775-7.
[Severe vertigo after a scuba-dive to 29 meters]
[Article in German]
Frigg C, Stepanek J, Gmur A.
Ratisches Kantons- und Regionalspital, Departement ORL, Chur.
A 27-year-old flight instructor experienced 5 to 10 minutes after a scuba-dive to 29 m, which lasted totally 50 minutes, dizziness, nausea and severe vertigo. The symptoms lasted about an hour. The patient vomited several times and noted sudden onset headache and vertigo lasting the following three days. Hyperbaric oxygen therapy was started 30 hours after the event because decompression sickness was suspected. Transthoracic echocardiographic evaluation showed a patent foramen ovale. Diving accidents may be caused by decompression sickness, the formation of a free intravascular gas phase (bubbles) may result in transatrial shunting in the presence of a patent foramen ovale and may lead to neurological signs and symptoms. In this context the diver was advised to undergo closure of the atrial septal defect. Five months after the incident the patient underwent successful transcatheter occlusion of the PFO.
Publication Types: Case Reports
PMID: 15171513 [PubMed - indexed for MEDLINE]

20: J Laryngol Otol. 2004 May;118(5):348-51.
Prevalence of external auditory canal exostoses in Australian surfboard riders.
Hurst W, Bailey M, Hurst B.
Department of Otolaryngology, Frankston Hospital, Frankston, Clayton, Victoria, Australia. williamhurst@hotmail.com
This paper assessed 300 surfboard riders, comprising 229 males and 71 females to determine the prevalence and rate of growth of exostoses in this population. A group of cold water swimmers and a control group were also examined. Significant obstruction, defined as two thirds or more occlusion of the ear canal was noted in 90 of the male surfers and 10 female surfers. This degree of occlusion was found in seven of the 32 cold water swimmers. A male surfer who has surfed regularly for 20 years or more has a one in two chance of developing significant obstruction of the external ear canal resulting from exostoses and this is a three in seven chance for females.
PMID: 15165308 [PubMed - indexed for MEDLINE]

21: Int J Sports Med. 2004 May;25(4):314-22.
Trait anxiety predicts panic behavior in beginning scuba students.
Morgan WP, Raglin JS, O'Connor PJ.
Department of Kinesiology, University of Wisconsin-Madison, Madison, WI 53706-1189, USA. wmorgan@education.wisc.edu
Recreational scuba diving is associated with a significant number of fatalities and decompression illnesses each year, and there is evidence that permanent neuropsychological injury can occur in divers. There is also evidence that the principal cause of decompression illness and fatalities in divers is rapid ascent, and it appears that the primary stimulus for rapid ascent is panic. The primary purpose of this investigation was to evaluate the extent to which an objective measure of trait anxiety could be effective in predicting panic behavior in students undergoing scuba training. Trait anxiety was assessed at the outset of scuba instruction in 42 students, and the instructor recorded instances of panic behavior during the 4-month course. It was predicted that individuals scoring 39 or greater on the trait anxiety sub-scale of the State-Trait Anxiety Inventory would be more likely to experience panic behavior than individuals with scores below this cut-off. Predictions and actual

recordings of panic behavior were performed independently using a blinded paradigm. Eleven of the students exhibited panic behavior on two or more occasions during the instruction, and 35 of 42 (83 %) predictions were accurate ($p < 0.001$). It is concluded that an objective measure of trait anxiety can be employed a priori for prediction of panic behavior in beginning scuba students.
Publication Types: Validation Studies
PMID: 15162252 [PubMed - indexed for MEDLINE]

22: Aviat Space Environ Med. 2004 May;75(5):397-404.
Neoprene wet-suit hood affects low-frequency underwater hearing thresholds.
Fothergill DM, Sims JR, Curley MD.
Naval Submarine Medical Research Laboratory, Box 900, Groton, CT 06349-5900, USA. fothergill@nsmrl.navy.mil
INTRODUCTION: Psychophysical measures of wet-suit hood sound attenuation are needed to provide the diving community with guidance on protection from underwater sound. METHODS: Underwater hearing thresholds were obtained from 15 male and 5 female recreational divers with and without a 3-mm thick wet-suit hood. Dives were conducted at a depth of 1 m in a large quiet anechoic pool. Thresholds were determined using a two-interval forced-choice procedure with a 0.71 probability of positive response at convergence. A 1-s pure tone was presented with a 20-ms rise and fall time at 100, 200, 250, 300, 400, and 500 Hz. RESULTS: Without a wet-suit hood, mean thresholds decreased from 99 dB re 1 microPa at 100 Hz to 85 dB at 500 Hz. Thresholds were statistically similar at 100 to 300 Hz with and without the wet-suit hood, but were significantly increased at 400 and 500 Hz with the hood ($p < 0.001$). CONCLUSIONS: In conclusion, at shallow depths, a 3-mm neoprene wet-suit hood attenuates underwater sound by approximately 10 dB for frequencies between 400 Hz and 500 Hz. At frequencies below 400 Hz, a 3-mm neoprene wet-suit hood offers no sound protection.
PMID: 15152891 [PubMed - indexed for MEDLINE]

23: Ross Fiziol Zh Im I M Sechenova. 2004 Jan;90(1):20-31.
[Characteristics of the human cardiovascular system in the human diving response]
[Article in Russian]
Baranova TI.
St. Petersburg State University, 199034, St. Petersburg, University Emb., 7/9, Russia.
Comparative-evolutional research of diving response showed that mechanisms of its expression had much in common in humans and in animals. Firstly, it involves a reflex bradycardia, vasoconstriction of peripheral vessels, and blood flow centralization. But, unlike animals whose diving response has some typical species peculiarities, human diving response is rather diverse. Four types of cardiovascular system response to face submersion were revealed: over-reactive, reactive, paradoxical, and nonreactive. These types were chosen according to the bradycardia character. It is also supposed that the occurrence of individual maximal R--R-interval, while serving as a signal to apnea stopping, is among the reasons of apnea activity limitation.
PMID: 15143489 [PubMed - indexed for MEDLINE]

24: J Exp Biol. 2004 May;207(Pt 12):2101-14.
How do cormorants counter buoyancy during submerged swimming?
Ribak G, Weihs D, Arad Z.
Faculty of Biology, Technion - Israel Institute of Technology, Haifa 32000, Israel.
Buoyancy is a de-stabilizing force for diving cormorants that forage at shallow depths. Having to counter this force increases the cost of transport underwater. Cormorants are known to be less buoyant than most water birds but are still highly buoyant (rho= approximately 0.8 kg m(-3)) due to their adaptations for aerial flight. Nevertheless, cormorants are known to dive at a wide range of depths, including shallow dives where buoyancy is maximal. We analyzed the kinematics of underwater swimming of the great cormorant (Phalacrocorax carbo sinensis) in a shallow pool to discover and evaluate the mechanisms countering buoyancy while swimming horizontally. The birds maintained a very uniform cyclic paddling pattern. Throughout this cycle, synchronized tilting of the body, controlled by the tail, resulted in only slight vertical drifts of the center of mass around the average swimming path. We suggest that this tilting behavior serves two purposes: (1) the elongated bodies and the long tails of cormorants, tilted at a negative angle of attack relative to the swimming direction, generate downward directed hydrodynamic lift to resist buoyancy and (2) during the propulsive phase, the motion of the feet has a significant vertical component, generating a vertical component of thrust downward, which further helps to offset buoyancy. The added cost of the drag resulting from this tilting behavior may be reduced by the fact that the birds use a burst-and-glide pattern while swimming.
PMID: 15143144 [PubMed - indexed for MEDLINE]

25: Resuscitation. 2004 May;61(2):239-40; discussion 240; author reply 240.
Comment on: Resuscitation. 2003 Nov;59(2):171-80.
Diving emergencies.
Dueker CW.
Publication Types: Comment Letter
PMID: 15135203 [PubMed - indexed for MEDLINE]

26: Resuscitation. 2004 May;61(2):237-8; author reply 239.
Comment on: Resuscitation. 2003 Nov;59(2):171-80.
Diving emergencies.
Dey I, Poff D.
Publication Types: Comment Letter

PMID: 15135201 [PubMed - indexed for MEDLINE]

27: J Exp Biol. 2004 May;207(Pt 11):1953-67.
Swimming gaits, passive drag and buoyancy of diving sperm whales Physeter macrocephalus.
Miller PJ, Johnson MP, Tyack PL, Terray EA.
Sea Mammal Research Unit, University of St Andrews, Fife, KY16 8LB, Scotland. pm29@st-and.ac.uk
Drag and buoyancy are two primary external forces acting on diving marine mammals. The strength of these forces modulates the energetic cost of movement and may influence swimming style (gait). Here we use a high-resolution digital tag to record depth, 3-D orientation, and sounds heard and produced by 23 deep-diving sperm whales in the Ligurian Sea and Gulf of Mexico. Periods of active thrusting versus gliding were identified through analysis of oscillations measured by a 3-axis accelerometer. Accelerations during 382 ascent glides of five whales (which made two or more steep ascents and for which we obtained a measurement of length) were strongly affected by depth and speed at Reynold' s numbers of 1.4-2.8x10(7). The accelerations fit a model of drag, air buoyancy and tissue buoyancy forces with an r(2) of 99.1-99.8% for each whale. The model provided estimates (mean +/- S.D.) of the drag coefficient (0.00306+/-0.00015), air carried from the surface (26.4+/-3.9 l kg(-3) mass), and tissue density (1030+/-0.8 kg m(-3)) of these five animals. The model predicts strong positive buoyancy forces in the top 100 m of the water column, decreasing to near neutral buoyancy at 250-850 m. Mean descent speeds (1.45+/-0.19 m s(-1)) were slower than ascent speeds (1.63+/-0.22 m s(-1)), even though sperm whales stroked steadily (glides 5.3+/-6.3%) throughout descents and employed predominantly stroke-and-glide swimming (glides 37.7+/-16.4%) during ascents. Whales glided more during portions of dives when buoyancy aided their movement, and whales that glided more during ascent glided less during descent (and vice versa), supporting the hypothesis that buoyancy influences behavioural swimming decisions. One whale rested at approximately 10 m depth for more than 10 min without fluking, regulating its buoyancy by releasing air bubbles.
PMID: 15107448 [PubMed - indexed for MEDLINE]

28: J Exp Biol. 2004 May;207(Pt 11):1789-96.
Surface pauses in relation to dive duration in imperial cormorants; how much time for a breather?
Wilson RP, Quintana F.
Institut fur Meereskunde, Dusternbrooker Weg 20, D-24105 Kiel, Germany. rwilson@ifm.uni-kiel.de
Air-breathing animals diving to forage can optimize time underwater by diving with just enough oxygen for the projected performance underwater. By so doing they surface with minimal body oxygen levels, which leads to maximal rates of oxygen uptake. We examined whether imperial cormorants Phalacrocorax atriceps adhere to this by examining dive:pause ratios in birds diving for extended, continuous periods to constant depths, assuming that the oxygen used underwater was exactly replenished by the periods at the surface. Examination of the cumulative time spent in surface pauses relative to the cumulative time spent in diving showed that surface pauses increase according to a power curve function of time spent in the dive or water depth. In a simplistic model we considered the rate at which birds expended energy underwater to be constant and that the rate of oxygen replenishment during the surface pause was directly proportional to the oxygen deficit. We then worked out values for the rate constant for the surface pause before using this constant to examine bird body oxygen levels immediately pre- and post dive. The model predicted that imperial cormorants do not submerge with just enough oxygen to cover their projected dive performance but rather dive with substantial reserves, although these reserves decrease with increasing dive depth/duration. We speculate that these oxygen reserves may be used to enhance bird survival when rare events, such as the appearance of predators or discovery of large prey requiring extended handling time, occur. The form of the oxygen saturation curve over time at the surface means that the time costs for maintaining constant oxygen reserves become particularly onerous for long, deep dives, so the observed decrease in reserves with increasing dive duration is expected in animals benefiting by optimizing for time.
PMID: 15107434 [PubMed - indexed for MEDLINE]

29: Aviat Space Environ Med. 2004 Apr;75(4):350-3.
Decompression sickness in Miskito Indian lobster divers: review of 229 cases.
Barratt DM, Van Meter K.
Department of Neurology, Louisiana State University, New Orleans, LA, USA. dbarratt@bellsouth.net
BACKGROUND: The Miskito Indian lobster divers of Central America employ very provocative diving profiles and experience severe neurological decompression sickness (DCS) and/or arterial gas embolism (AGE). Scientific data are scarce regarding the clinical patterns of injury, response to treatment, and functional outcomes for such cases. METHODS: A retrospective review of 229 cases of DCS and/or AGE was conducted at 2 hyperbaric units in Central America. RESULTS: The following deficits were recorded on presentation: any neurological deficit: 94%; motor: 79%; sensory: 60%; urinary: 48%; reflex: 45%; and loss of consciousness: 20%. The patterns of weakness (n = 182) were as follows: paraparesis: 27%; paraplegia: 26%; lower extremity monoparesis: 14%; lower extremity monoplegia: 6%; quadriparesis: 4%; hemiparesis: 4%; hemiplegia: 3%; and quadriplegia: 2%. Treatment was delayed by a mean and median of 5 and 2 d, respectively. The majority received hyperbaric oxygen and systemic steroids. Motor function on discharge (n = 182) was as follows: normal: 30%; paraparesis: 15%; lower

extremity monoparesis: 15%; paraplegia: 3%; quadriparesis: 2%; hemiparesis: 2%; and missing data/other: 33%. Gait on discharge (n = 182) was as follows: normal: 19%; abnormal: 19%; required one crutch: 10%; required two crutches: 16%; not ambulatory: 5%; and missing data: 31%. DISCUSSION: The majority of severe injuries could be localized to the thoracolumbar spinal cord. One-fifth had bilateral cerebral dysfunction manifested by loss of consciousness. Despite long delays to treatment, divers responded to hyperbaric oxygen. At the time of discharge, almost a third had complete recovery of strength and the majority were ambulatory.
PMID: 15086125 [PubMed - indexed for MEDLINE]

30: Nature. 2004 Apr 15;428(6984):1 p following 716; discussion 2 p following 716.
Comment on: Nature. 2003 Oct 9;425(6958):575-6.
Pathology: whales, sonar and decompression sickness.
Piantadosi CA, Thalmann ED.
Center for Hyperbaric Medicine and Environmental Physiology, Duke University Medical Center, Durham, North Carolina 27710, USA. piant001@mc.duke.edu
We do not yet know why whales occasionally strand after sonar has been deployed nearby, but such information is important for both naval undersea activities and the protection of marine mammals. Jepson et al. suggest that a peculiar gas-forming disease afflicting some stranded cetaceans could be a type of decompression sickness (DCS) resulting from exposure to mid-range sonar. However, neither decompression theory nor observation support the existence of a naturally occurring DCS in whales that is characterized by encapsulated, gas-filled cavities in the liver. Although gas-bubble formation may be aggravated by acoustic energy, more rigorous investigation is needed before sonar can be firmly linked to bubble formation in whales.
Publication Types: Comment
PMID: 15085881 [PubMed - indexed for MEDLINE]

31: Sports Biomech. 2004 Jan;3(1):29-41.
Technique and timing in women' s and men' s reverse one and one half somersault with two and one half twists (5335D) and men' s reverse one and one half somersault with three and one half twists (5337D) 3 m springboard dives.
Sanders R, Burnett A.
University of Edinburgh, Edinburgh, UK.
The purpose of this study was to compare timing and technique of males and females performing reverse twisting dives in elite international competition. Video data of the dives performed at the 1999 FINA World Diving Cup were captured and digitised to obtain times and postures of the divers at specific events including takeoff and entry. Estimates of flight height and mass-normalised work done on the springboard were obtained from flight times. The data indicated that many males are able to complete an additional twist rotation because they attain more height, and therefore more time in the air, than females.
Publication Types: Clinical Trial
PMID: 15079986 [PubMed - indexed for MEDLINE]

32: J Exp Biol. 2004 Apr;207(Pt 10):1615-24.
Metabolic rates of captive grey seals during voluntary diving.
Sparling CE, Fedak MA.
Sea Mammal Research Unit, Gatty Marine Laboratory, University of St Andrews, St Andrews, Scotland, UK, KY16 8LB. ces6@st-and.ac.uk
The energetic cost of diving in marine mammals is a difficult value to derive given the problems of assessing metabolic rate for an animal at sea. Nevertheless, it is fundamental to our understanding of the foraging strategies of air-breathers exploiting underwater food sources. We measured the metabolic rates of eight captive grey seals, voluntarily diving in a quasi-natural setting. Oxygen consumption during post-dive surface periods was measured using open-flow respirometry, and dive behaviour of the seals was recorded using time depth recorders (TDRs). Mean diving metabolic rate (DMR) for both adults and juveniles was 1.7 times the predicted standard metabolic rate of terrestrial animals of equal size. For all animals, DMR was lower than the rate of metabolism measured whilst they were resting at the water' s surface. On a dive-by-dive basis, DMR decreased with dive duration but increased with mean swim speed. Regressing the maximum 5% of DMRs against dive duration resulted in a significant negative relationship that was not significantly different from the relationship between the calculated maximum rate of aerobic metabolism and dive duration, suggesting that these seals were diving within, and up to, their aerobic limits. We developed a model that allows the prediction of DMR from information on dive behaviour of the type routinely collected in telemetry studies of wild seals. The model accurately predicts DMR using behavioural data from periods of diving with known metabolism data. This model can be used to predict the at-sea metabolic rate of wild grey seals, an important input into ecosystem models.
PMID: 15073194 [PubMed - indexed for MEDLINE]

33: JEMS. 2004 Apr;29(4):24.
Bubble, bubble, toil & trouble: hidden decompression sickness bewitches EMS.
Werfel PA.
University Medical Center at State University of New York, Stony Brook, USA. pwerfel@epo.hsc.sunysb.edu
PMID: 15067605 [PubMed - indexed for MEDLINE]

34: Proc R Soc Lond B Biol Sci. 2004 Feb 7;271(1536):227-31.
North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli.

Nowacek DP, Johnson MP, Tyack PL.
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North Atlantic right whales were extensively hunted during the whaling era and have not recovered. One of the primary factors inhibiting their recovery is anthropogenic mortality caused by ship strikes. To assess risk factors involved in ship strikes, we used a multi-sensor acoustic recording tag to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics and a signal designed to alert the whales. The whales reacted strongly to the alert signal, they reacted mildly to the social sounds of conspecifics, but they showed no such responses to the sounds of approaching vessels as well as actual vessels. Whales responded to the alert by swimming strongly to the surface, a response likely to increase rather than decrease the risk of collision.
PMID: 15058431 [PubMed - indexed for MEDLINE]

35: Lakartidningen. 2004 Feb 26;101(9):787-90.
[Breath-hold diving--an increasing adventure sport with medical risks]
[Article in Swedish]
Lindholm P, Gennser M.
Sektionen for omgivningsfysiologi, institutionen for fysiologi och farmakologi, Karolinska institutet, Stockholm.
Breath-hold diving as a recreational and competitive sports activity is on the increase. In this review physiological limitations and medical risks associated with breath-hold diving are discussed. Specific topics include hypoxia, ascent blackout, hyperventilation, squeeze or barotrauma of descent including effects on the pulmonary system, glossopharyngeal breathing, and decompression illness. It is also concluded that the health requirements for competitive breath-hold diving should follow essentially the same standards as used for SCUBA-diving.
Publication Types: Review Review, Tutorial
PMID: 15045843 [PubMed - indexed for MEDLINE]

36: Lakartidningen. 2004 Feb 26;101(9):780-6.
[Health fitness assessment for recreational diving requires special medical competence]
[Article in Swedish]
Ornhagen H.
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Recreational diving has become increasingly popular in Sweden over the last years and about half a million dives are made each year. During the same time the health requirements for diving have changed and today we allow asthmatics and diabetics to dive under certain conditions. Chest X-ray, that earlier was compulsory, is not required in the fitness to dive examination, and in the future Europe the minimal requirements will be a health declaration rather than a FTD examination by a doctor. Despite this there will be a need for doctors with competence in diving medicine to handle medical problems in connection to diving and to evaluate all the questions generated by the divers' answers in the health declarations.
PMID: 15045842 [PubMed - indexed for MEDLINE]

37: Lakartidningen. 2004 Feb 26;101(9):774-9.
[Recreational diving accidents in Sweden]
[Article in Swedish]
Ornhagen H, Hagberg M.
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Even if recreational diving is gradually becoming safer, the 2-6 fatalities each year is the most serious problem in recreational diving. Human factors are behind 75% of the fatalities and medical problems seldom cause fatalities. On average 40 recreational divers are treated with recompression each year. Signs and symptoms are in general mild and only few sequelas are seen. The number of traumas to ear/balance organs, sinuses, lungs etc are difficult to estimate but these are most likely not a large part of all patients in the health care. It is currently difficult to estimate the risks in recreational diving since there is no exact information on the number of dives that are performed each year.
PMID: 15045841 [PubMed - indexed for MEDLINE]

38: Mil Med. 2004 Feb;169(2):137-41.
Oral and maxillofacial aspects of diving medicine.
Brandt MT.
Division of Oral and Maxillofacial Surgery, University of Kentucky, D-512 Chandler Medical Center, College of Dentistry, Lexington, KY 40536-0297, USA.
Sport diving has witnessed explosive growth in the past decade, as 8.5 million people are certified in the United States alone. Even though scuba diving is a relatively safe sport, there are serious risks that all divers must consider. Beyond the better-known sequelae such as decompression sickness, middle ear dysfunction, and potential central nervous system effects, scuba diving also carries inherent risk to the maxillofacial region. Atypical facial pain, temporomandibular joint dysfunction, sinus barotraumas, and barodontalgia have all been reported by dentists and physicians treating military, commercial, and sport divers. Additionally, clinicians must address anatomic concerns for would-be divers, including cleft lip and palate, edentulism, or patients with pre-existing temporomandibular dysfunction, midfacial trauma, or craniomaxillofacial surgery. Health care professionals should have a thorough understanding of the implications of scuba diving for consultation and recommendation regarding diving fitness and the treatment of adverse effects of scuba diving to the maxillofacial region.
PMID: 15040636 [PubMed - indexed for MEDLINE]

39: Br J Sports Med. 2004 Apr;38(2):108-14.

Negative neurofunctional effects of frequency, depth and environment in recreational scuba diving: the Geneva "memory dive" study.
Slosman DO, De Ribaupierre S, Chicherio C, Ludwig C, Montandon ML, Allaoua M, Genton L, Pichard C, Grousset A, Mayer E, Annoni JM, De Ribaupierre A.
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OBJECTIVES: To explore relationships between scuba diving activity, brain, and behaviour, and more specifically between global cerebral blood flow (CBF) or cognitive performance and total, annual, or last 6 months' frequencies, for standard dives or dives performed below 40 m, in cold water or warm sea geographical environments. METHODS: A prospective cohort study was used to examine divers from diving clubs around Lac Leman and Geneva University Hospital. The subjects were 215 healthy recreational divers (diving with self-contained underwater breathing apparatus). Main outcome measures were: measurement of global CBF by (133)Xe SPECT (single photon emission computed tomography); psychometric and neuropsychological tests to assess perceptual-motor abilities, spatial discrimination, attentional resources, executive functioning, and memory; evaluation of scuba diving activity by questionnaire focusing on number and maximum depth of dives and geographical site of the diving activity (cold water v warm water); and body composition analyses (BMI). RESULTS: (1) A negative influence of depth of dives on CBF and its combined effect with BMI and age was found. (2) A specific diving environment (more than 80% of dives in lakes) had a negative effect on CBF. (3) Depth and number of dives had a negative influence on cognitive performance (speed, flexibility and inhibition processing in attentional tasks). (4) A negative effect of a specific diving environment on cognitive performance (flexibility and inhibition components) was found. CONCLUSIONS: Scuba diving may have long-term negative neurofunctional effects when performed in extreme conditions, namely cold water, with more than 100 dives per year, and maximal depth below 40 m.
PMID: 15039241 [PubMed - indexed for MEDLINE]

40: J Comp Physiol [B]. 2004 May;174(4):347-54. Epub 2004 Mar 19.
Blood-respiratory and acid-base changes during extended diving in the bimodally respiring freshwater turtle Rheodytes leukops.
Gordos MA, Franklin CE, Limpus CJ, Wilson G.
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Changes in blood-gas, acid-base, and plasma-ion status were investigated in the bimodally respiring turtle, Rheodytes leukops, during prolonged dives of up to 12 h. Given that R. leukops routinely submerges for several hours, the objective of this study was to determine whether voluntarily diving turtles remain aerobic and simultaneously avoid hypercapnic conditions over increasing dive lengths. Blood PO(2), PCO(2), and pH, as well as plasma concentrations of lactate, glucose, Na(+), K(+), Cl(-), total Ca, and total Mg were determined in venous blood collected from the occipital sinus. Blood PO(2) declined significantly with dive length; however, oxy-haemoglobin saturation remained greater than 30% for all R. leukops sampled. No changes were observed in blood PCO(2), pH, [HCO(3)(-)], or plasma glucose, with increasing dive length. Despite repeated dives lasting more than 2 h, plasma lactate remained less than 3 mmol l(-1) for all R. leukops sampled, indicating the absence of anaerobiosis. Compensatory acid-base adjustments associated with anaerobiosis (e.g. declining [Cl(-)], increasing total [Ca] and [Mg]) were likewise absent, with plasma-ion concentrations remaining stable with increasing dive length. Results indicate that R. leukops utilises aquatic respiration to remain aerobic during prolonged dives, thus effectively avoiding the development of a metabolic and respiratory acidosis.
PMID: 15034732 [PubMed - indexed for MEDLINE]

41: Aviat Space Environ Med. 2004 Mar;75(3):211-4.
Detection of leukocyte activation in pigs with neurologic decompression sickness.
Nyquist PA, Dick EJ Jr, Buttolph TB.
Naval Medical Research Center, Bethesda, MD, USA.
BACKGROUND: In a porcine model of neurological decompression sickness (DCS), perivascular leukocyte activation was a consistent finding in biopsies of associated cutaneous DCS. This prompted examination of other organs for similar changes; multifocal leukocyte activation was found in the lungs (pneumonitis) and liver (hepatitis). HYPOTHESIS: DCS in pigs induces leukocyte aggregation and activation in the liver and lungs. METHODS: Male Yorkshire swine, trained to run on a modified treadmill, were compressed to 200 ft of seawater (fsw) in a dry, air-filled compression chamber. Decompression varied according to the profile under study. RESULTS: In 106 pigs, evidence for association of leukocyte aggregation and activation with the clinical diagnosis of neurologic DCS was sought. The incidence of pneumonitis (20/68, 29% with DCS; 4/38, 10% without DCS) and hepatitis (23/68, 33% with DCS; 4/38, 10% without DCS) were strongly correlated with the incidence of neurologic DCS via Pearson Chi-squared analysis ($p = 0.026$ pneumonitis and $p = 0.008$ hepatitis). Additionally, Kruskal-Wallis rank analysis for numbers of organs involved and incidence of neurologic DCS showed a strong correlation between the increasing occurrence of neurologic DCS and the involvement of both the liver and lungs ($p = 0.004$). CONCLUSIONS: The results imply that, at least in pigs, DCS induces leukocyte aggregation and activation in the liver and lungs. These organs are not normally considered targets of DCS. Leukocyte

aggregation in these organs may be related to their roles as highly perfused organs. Leukocyte aggregation may be a marker for DCS, providing further evidence for wider, systemic effects of DCS.
Publication Types: Evaluation Studies
PMID: 15018287 [PubMed - indexed for MEDLINE]

42: Annu Rev Physiol. 2004;66:209-38.
Field physiology: physiological insights from animals in nature.
Costa DP, Sinervo B.
Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, California 95064, USA. costa@biology.ucsc.edu
Whereas comparative physiology documents the range of physiological variation across a range of organisms, field physiology provides insight into the actual mechanisms an organism employs to maintain homeostasis in its everyday life. This requires an understanding of an organism' s natural history and is prerequisite to developing hypotheses about physiological mechanisms. This review focuses on a few areas of field physiology that exemplify how the underlying physiology could not have been understood without appropriate field measurements. The examples we have chosen highlight the methods and inference afforded by an application of this physiological analysis to organismal function in nature, often in extreme environments. The specific areas examined are diving physiology, the thermal physiology of large endothermic fishes, reproductive physiology of air breathing vertebrates, and endocrine physiology of reproductive homeostasis. These areas form a bridge from physiological ecology to evolutionary ecology. All our examples revolve around the central issue of physiological limits as they apply to organismal homeostasis. We view this theme as the cornerstone of physiological analysis and supply a number of paradigms on homeostasis that have been tested in the context of field physiology.
Publication Types: Review Review, Tutorial
PMID: 14977402 [PubMed - indexed for MEDLINE]

43: Arch Otolaryngol Head Neck Surg. 2004 Feb;130(2):221-5.
Hearing threshold in sport divers: is diving really a hazard for inner ear function?
Klingmann C, Knauth M, Ries S, Tasman AJ.
Department of Otorhinolaryngology, Head and Neck Surgery, University of Heidelberg, Heidelberg, Germany. christoph_klingmann@med.uni-heidelberg.de
OBJECTIVE: To investigate the effect of scuba diving on the hearing threshold of sport divers who have no history of excessive noise exposure or of diving-related inner ear damage. DESIGN: Cross-sectional controlled comparison study. SETTING: General sports diving community. PARTICIPANTS: Sixty sport divers with an average of 650 dives each and at least 4 years of diving experience (mean, 10 years) were compared with a control group of 63 nondivers from our hospital staff or patients referred for rhinologic problems or benign tumors of the salivary gland. MAIN OUTCOME MEASURE: After microscopic otoscopy and tympanometry, we used pure-tone audiometry to measure the hearing threshold for air and bone conduction. The participants were divided into 3 age groups, and the hearing test results for both ears combined were statistically compared. RESULTS: There were no statistically significant differences in the hearing thresholds between sport divers and nondivers. CONCLUSIONS: The reduced hearing levels of professional divers found in other studies are probably due to the high noise levels that they have to deal with or may be a result of inner ear accidents.
PMID: 14967755 [PubMed - indexed for MEDLINE]

44: Eur J Appl Physiol. 2004 May;91(5-6):708-11. Epub 2004 Feb 10.
Cardiovascular responses to head-out water immersion in Korean women breath-hold divers.
Yun SH, Choi JK, Park YS.
Department of Physiology, Kosin University College of Medicine, 34 Amnam-dong, Seo-gu, 602-702 Busan, South Korea.
Head-out water immersion (HOI) increases cardiac output (CO) for a given oxygen consumption. To investigate whether professional breath-hold divers show a similar response, cardiovascular responses to HOI were compared between six Korean women breath-hold divers, six non-diving housewives and six non-diving young women at rest and while performing leg cycle exercise of moderate intensity (Deltametabolic rate = approximately 100 W m(-2)) in water at a thermoneutral temperature (34.5 degrees C). In all three groups, HOI increased CO markedly due to a rise in stroke volume, with no significant change in heart rate (HR) and arterial blood pressure (BP). Thus, total peripheral resistance (TPR) and arterio-venous oxygen content difference fell significantly. During dynamic exercise in water CO increased mainly due to a rise in HR. The arterial systolic BP rose slightly with no significant change in diastolic BP, and the TPR fell 20-40% with similar responses among the three groups of subjects. This study showed that both at rest and during exercise, cardiovascular responses to immersion do not vary significantly with age and water immersion experience.
Publication Types: Clinical Trial Controlled Clinical Trial
PMID: 14872246 [PubMed - indexed for MEDLINE]

45: J Exp Biol. 2004 Feb;207(Pt 6):973-82.
The cost of foraging by a marine predator, the Weddell seal Leptonychotes weddellii: pricing by the stroke.
Williams TM, Fuiman LA, Horning M, Davis RW.
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Foraging by mammals is a complex suite of behaviors that can entail high energetic costs associated with supporting basal metabolism, locomotion and the digestion of prey. To determine the contribution of these various costs in a free-ranging marine mammal, we measured the post-dive oxygen consumption of adult Weddell seals (N=9) performing foraging and non-foraging dives from an isolated ice hole in McMurdo Sound, Antarctica. Dives were classified according to behavior as monitored by an attached video-data logging system (recording activity, time, depth, velocity and stroking). We found that recovery oxygen consumption showed a biphasic relationship with dive duration that corresponded to the onset of plasma lactate accumulation at approximately 23 min. Locomotor costs for diving Weddell seals increased linearly with the number of strokes taken according to the relationship: locomotor cost = -3.78+0.04 x stroke number (r(2)=0.74, N=90 dives), where locomotor cost is in ml O(2) kg(-1). Foraging dives in which seals ingested Pleuragramma antarcticum resulted in a 44.7% increase in recovery oxygen consumption compared to non-foraging dives, which we attributed to the digestion and warming of prey. The results show that the energy expended in digestion for a free-ranging marine mammal are additive to locomotor and basal costs. By accounting for each of these costs and monitoring stroking mechanics, it is possible to estimate the aerobic cost of diving in free-ranging seals where cryptic behavior and remote locations prevent direct energetic measurements.
PMID: 14766956 [PubMed - indexed for MEDLINE]

46: J Physiol. 2004 Mar 16;555(Pt 3):637-42. Epub 2004 Jan 30.
Comment in: J Physiol. 2004 Mar 16;555(Pt 3):588.
Aerobic exercise before diving reduces venous gas bubble formation in humans.
Dujic Z, Duplancic D, Marinovic-Terzic I, Bakovic D, Ivancev V, Valic Z, Eterovic D, Petri NM, Wisloff U, Brubakk AO.
Department of Physiology and Biophysics, University of Split School of Medicine, Split, Croatia. zdujic@bsb.mefst.hr
We have previously shown in a rat model that a single bout of high-intensity aerobic exercise 20 h before a simulated dive reduces bubble formation and after the dive protects from lethal decompression sickness. The present study investigated the importance of these findings in man. Twelve healthy male divers were compressed in a hyperbaric chamber to 280 kPa at a rate of 100 kPa min(-1) breathing air and remaining at pressure for 80 min. The ascent rate was 9 m min(-1) with a 7 min stop at 130 kPa. Each diver underwent two randomly assigned simulated dives, with or without preceding exercise. A single interval exercise performed 24h before the dive consisted of treadmill running at 90% of maximum heart rate for 3 min, followed by exercise at 50% of maximum heart rate for 2 min; this was repeated eight times for a total exercise period of 40 min. Venous gas bubbles were monitored with an ultrasonic scanner every 20 min for 80 min after reaching surface pressure. The study demonstrated that a single bout of strenuous exercise 24h before a dive to 18 m of seawater significantly reduced the average number of bubbles in the pulmonary artery from 0.98 to 0.22 bubbles cm(-2)(P= 0.006) compared to dives without preceding exercise. The maximum bubble grade was decreased from 3 to 1.5 (P= 0.002) by pre-dive exercise, thereby increasing safety. This is the first report to indicate that pre-dive exercise may form the basis for a new way of preventing serious decompression sickness.
Publication Types: Clinical Trial Randomized Controlled Trial
PMID: 14755001 [PubMed - indexed for MEDLINE]

47: Br J Sports Med. 2004 Feb;38(1):102.
Scuba diving can induce stress of the temporomandibular joint leading to headache.
Balestra C, Germonpre P, Marroni A, Snoeck T.
Publication Types: Letter
PMID: 14751960 [PubMed - indexed for MEDLINE]

48: Br J Sports Med. 2004 Feb;38(1):69-73.
Prevalence of temporomandibular dysfunction in a group of scuba divers.
Aldridge RD, Fenlon MR.
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BACKGROUND: Temporomandibular dysfunction (TMD) has been reported to be a common problem in divers, with a prevalence of up to 68%. No evidence for this is available. OBJECTIVE: To investigate the prevalence of TMD in divers. METHOD: Sixty three subjects were asked to retrospectively complete a questionnaire on symptoms of TMD after diving in warm and cold water areas and in daily life. RESULTS: The prevalence of TMD was greater in female divers. The prevalence of TMD while diving was about 26%, comparable to that experienced in daily life. CONCLUSION: Improvements in mouthpiece design and lighter demand valves mean that TMD is now probably exacerbated by diving rather than caused by it.
PMID: 14751950 [PubMed - indexed for MEDLINE]

49: Br J Sports Med. 2004 Feb;38(1):2-3.
Should computed tomography of the chest be recommended in the medical certification of professional divers?
Millar IL.
Publication Types: Editorial
PMID: 14751933 [PubMed - indexed for MEDLINE]

50: Clin Rheumatol. 2004 Feb;23(1):19-20. Epub 2004 Jan 13.

Low bone mineral density in professional scuba divers.
Pereira Silva JA, Costa Dias F, Fonseca JE, Canhao H, Resende C, Viana Queiroz M.
Rheumatology Unit, Santa Maria Hospital, Av. Prof Egas Moniz, 1600, Lisbon, Portugal.
Scuba diving is associated with a 90% reduction in effective weight and with the loss of a weight-bearing effect on joints. These conditions are very similar to the continuous weightlessness that occurs in spaceflight and bed-rest, which are clearly associated with significant bone mass loss. Here, we studied the bone mineral density (BMD) of 66 professional scuba divers using a dual-photon densitometer, and have depicted a reduction in the BMD in comparison to a matched control group of non-divers. Our results suggest that diving is also an activity where the unloading effect alters bone metabolism, leading to a reduction in BMD.
PMID: 14749976 [PubMed - indexed for MEDLINE]

51: J Exp Biol. 2004 Feb;207(Pt 5):881-90.
In situ cardiac performance of Pacific bluefin tuna hearts in response to acute temperature change.
Blank JM, Morrissette JM, Landeira-Fernandez AM, Blackwell SB, Williams TD, Block BA.
Department of Biological Sciences, Stanford University, Oceanview Boulevard, Pacific Grove, CA 93950, USA.
This study reports the cardiovascular physiology of the Pacific bluefin tuna (Thunnus orientalis) in an in situ heart preparation. The performance of the Pacific bluefin tuna heart was examined at temperatures from 30 degrees C down to 2 degrees C. Heart rates ranged from 156 beats min(-1) at 30 degrees C to 13 beats min(-1) at 2 degrees C. Maximal stroke volumes were 1.1 ml x kg(-1) at 25 degrees C and 1.3 ml x kg(-1) at 2 degrees C. Maximal cardiac outputs were 18.1 ml x kg(-1) min(-1) at 2 degrees C and 106 ml x kg(-1) min(-1) at 25 degrees C. These data indicate that cardiovascular function in the Pacific bluefin tuna exhibits a strong temperature dependence, but cardiac function is retained at temperatures colder than those tolerated by tropical tunas. The Pacific bluefin tuna' s cardiac performance in the cold may be a key adaptation supporting the broad thermal niche of the bluefin tuna group in the wild. In situ data from Pacific bluefin are compared to in situ measurements of cardiac performance in yellowfin tuna and preliminary results from albacore tuna.
PMID: 14747418 [PubMed - indexed for MEDLINE]

52: J Physiol. 2004 Mar 16;555(Pt 3):825-9. Epub 2004 Jan 14.
Exercise and nitric oxide prevent bubble formation: a novel approach to the prevention of decompression sickness?
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Department of Circulation and Medical Imaging, Norwegian University of Science and Technology, Trondheim, Norway. ulrik.wisloff@medisin.ntnu.no
Nitrogen dissolves in the blood during dives, but comes out of solution if divers return to normal pressure too rapidly. Nitrogen bubbles cause a range of effects from skin rashes to seizures, coma and death. It is believed that these bubbles form from bubble precursors (gas nuclei). Recently we have shown that a single bout of exercise 20 h, but not 48 h, before a simulated dive prevents bubble formation and protects rats from severe decompression sickness (DCS) and death. Furthermore, we demonstrated that administration of N(omega)-nitro-l-arginine methyl ester, a non-selective inhibitor of NO synthase (NOS), turns a dive from safe to unsafe in sedentary but not exercised rats. Therefore based upon previous data an attractive hypothesis is that it may be possible to use either exercise or NO-releasing agents before a dive to inhibit bubble formation and thus protect against DCS. Consequently, the aims of the present study were to determine whether protection against bubble formation in ' diving' rats was provided by (1) chronic and acute administration of a NO-releasing agent and (2) exercise less than 20 h prior to the dive. NO given for 5 days and then 20 h prior to a dive to 700 kPa lasting 45 min breathing air significantly reduced bubble formation and prevented death. The same effect was seen if NO was given only 30 min before the dive. Exercise 20 h before a dive suppressed bubble formation and prevented death, with no effect at any other time (48, 10, 5 and 0.5 h prior to the dive). Pre-dive activities have not been considered to influence the growth of bubbles and thus the risk of serious DCS. The present novel findings of a protective effect against bubble formation and death by appropriately timed exercise and an NO-releasing agent may form the basis of a new approach to preventing serious decompression sickness.
PMID: 14724207 [PubMed - indexed for MEDLINE]

53: Comput Methods Programs Biomed. 2004 Jan;73(1):13-21.
Application of the Max-Lloyd quantizer for ECG compression in diving mammals.
Rodriguez M, Ayala A, Rodriguez S, Rosa F, Diaz-Gonzalez M.
Departamento de Fisica Fundamental y Experimental, Universidad de La Laguna, 38203 La Laguna, Tenerife, Canary Islands, Spain.
This article presents a practical implementation of an ECG compression algorithm using a Max-Lloyd quantizer, to optimize the low resources of an ECG acquisition and transmission system (telemetry system) for dolphins and human divers. The algorithm scheme is based on a first-order differential pulse code modulation (DPCM) and uses a Max-Lloyd quantizer to code the difference between the current and predicted samples. The use of the non-uniform quantizer instead of a uniform quantizer improves the percent root mean-square difference (PRD), thereby producing a low distortion in the reconstructed signals. Due to its low computational complexity, the compression process can be

accomplished on-line during the ECG acquisition process.
PMID: 14715163 [PubMed - indexed for MEDLINE]

54: Dtsch Med Wochenschr. 2004 Jan 2;129(1-2):27-30.
[Patent foramen ovale: an underrated risk for divers?]
[Article in German]
Lier H, Schroeder S, Hering R.
Klinik fur Anasthesiologie und Spezielle Intensivmedizin, Rheinische Friedrich-Wilhelms-Universitat Bonn. Heiko.Lier@ukb.uni-bonn.de
The foramen ovale which is the fetal connection between the right and left atrium persists in about 30 % of the adult population. In the presence of a persistent foramen ovale (PFO) shunting of blood may occur from the right to the left atrium, and bubbles can reach the systemic circulation during or after the decompression phase of a dive with compressed air. Therefore, divers with PFO may have an increased risk to develop ischemic cerebral lesions and neurologic decompression sickness (DCS). Significant right-to-left shunting may be diagnosed using transcranial doppler ultrasound of the medial cerebral artery and echocardiography with echo contrast media and Valsalva provocation. However, there are no official guidelines concerning PFO screening in medical fitness exams for professional or recreational divers in Germany. Therefore, it remains in the diver' s choice to be screened for PFO. Divers with a history of DCS should be monitored for PFO, especially when diving strictly adhered to decompression tables. Divers with PFO who refuse to stop diving after DCS should be advised to adhere to very save dive profiles.
Publication Types: Review Review, Tutorial
PMID: 14703578 [PubMed - indexed for MEDLINE]

55: Biochem Biophys Res Commun. 2004 Jan 16;313(3):727-32.
Control of pulmonary surfactant secretion in adult California sea lions.
Miller NJ, Daniels CB, Costa DP, Orgeig S.
Environmental Biology, School of Earth and Environmental Sciences, University of Adelaide, Adelaide SA 5005, Australia.
Marine mammals have a spectacular suite of respiratory adaptations to deal with the extreme pressures associated with deep diving. In particular, maintaining a functional pulmonary surfactant system at depth is critical for marine mammals to ensure that inspiration is possible upon re-emergence. Pulmonary surfactant is secreted from alveolar type II (ATII) cells and is crucial for normal lung function. It is not known whether ATII cells have the ability to continue to secrete pulmonary surfactant under pressure, or how secretion is maintained and controlled. We show here that surfactant secretion in California sea lions (Zalophus californianus) was increased after high pressures (25 and 50 atm) of short duration (30 min), but was unaffected by high pressures of long duration (2 h). This is in contrast to a similar sized terrestrial mammal (sheep), where surfactant secretion was increased after high pressures of both long and short duration. Z. californianus and terrestrial mammals also show similar responses to stimulatory hormones and autonomic neurotransmitters. It therefore seems that an increase in the quantity of surfactant in seal lungs after diving is most likely caused by mechanostimulation induced by pressure and volume changes, and that seals are adapted to maintain constant levels of surfactant under long periods of high pressure.
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56: J Appl Physiol. 2004 May;96(5):1626-32. Epub 2003 Dec 19.
Surfactant from diving aquatic mammals.
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Diving mammals that descend to depths of 50-70 m or greater fully collapse the gas exchanging portions of their lungs and then reexpand these areas with ascent. To investigate whether these animals may have evolved a uniquely developed surfactant system to facilitate repetitive alveolar collapse and expansion, we have analyzed surfactant in bronchoalveolar lavage fluid (BAL) obtained from nine pinnipeds and from pigs and humans. In contrast to BAL from terrestrial mammals, BAL from pinnipeds has a higher concentration of phospholipid and relatively more fluidic phosphatidylcholine molecular species, perhaps to facilitate rapid spreading during alveolar reexpansion. Normalized concentrations of hydrophobic surfactant proteins B and C were not significantly different among pinnipeds and terrestrial mammals by immunologic assay, but separation of proteins by gel electrophoresis indicated a greater content of surfactant protein B in elephant seal surfactant than in human surfactant. Remarkably, surfactant from the deepest diving pinnipeds produced moderately elevated in vitro minimum surface tension measurements, a finding not explained by the presence of protein or neutral lipid inhibitors. Further study of the composition and function of pinniped surfactants may contribute to the design of optimized therapeutic surfactants.
PMID: 14688033 [PubMed - indexed for MEDLINE]

57: Mol Ecol. 2004 Jan;13(1):179-93.
Speciation of Iberian diving beetles in Pleistocene refugia (Coleoptera, Dytiscidae).
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The Mediterranean basin is an area of high diversity and endemicity, but the age and origin of its fauna are

still largely unknown. Here we use species-level phylogenies based on approximately 1300 base pairs of the genes 16S rRNA and cytochrome oxidase I to establish the relationships of 27 of the 34 endemic Iberian species of diving beetles in the family Dytiscidae, and to investigate their level of divergence. Using a molecular clock approach, 18-19 of these species were estimated to be of Pleistocene origin, with four to six of them from the Late Pleistocene (approximately 100 000 years). A second, lower speciation frequency peak was assigned to Late Miocene or Early Pliocene. Analysis of the distributional ranges showed that endemic species placed in the tip nodes of the trees are significantly more likely to be allopatric with their sisters than endemic species at lower node levels. Allopatric sister species are also significantly younger than sympatric clades, in agreement with an allopatric mode of speciation and limited subsequent range movement. These results strongly suggest that for some taxa Iberian populations were isolated during the Pleistocene long enough to speciate, and apparently did not expand their ranges to recolonize areas north of the Pyrenees. This is in contradiction to observations from fossil beetles in areas further north, which document large range movements associated with the Pleistocene glacial cycles hypothesized to suppress population isolation and allopatric speciation.
PMID: 14653798 [PubMed - indexed for MEDLINE]

58: Clin Sci (Lond). 2004 Apr;106(4):389-95.
Haemodynamic effects of hyperbaric hyperoxia in healthy volunteers: an echocardiographic and Doppler study.
Molenat F, Boussuges A, Grandfond A, Rostain JC, Sainty JM, Robinet C, Galland F, Meliet JL.
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In the present study, we observed the haemodynamic changes, using echocardiography and Doppler, in ten healthy volunteers during 6 h of compression in a hyperbaric chamber with a protocol designed to reproduce the conditions as near as possible to a real dive. Ambient pressure varied from 1.6 to 3 atm (1 atm=101.325 kPa) and partial pressure of inspired O2 from 1.2 to 2.8 atm. Subjects performed periods of exercise with breathing through a closed-circuit self-contained underwater breathing apparatus (SCUBA). Subjects did not eat or drink during the study. Examinations were performed after 15 min and 5 h. After 15 min, stroke volume (SV), left atrial (LA) diameter and left ventricular (LV) end-diastolic diameter (LVEDD) decreased. Heart rate (HR) and cardiac output (CO) did not vary, but indices of the LV systolic performance decreased by 10% and the LV meridional wall stress increased by 17%. After 5 h, although weight decreased, the serum protein concentration increased. Compared with values obtained after 15 min, SV and CO decreased, but LV systolic performance, LA diameter, LVEDD and LV meridional wall stress remained unchanged. Compared with the reference values obtained at sea level, total arterial compliance decreased, HR remained unchanged and CO decreased. In conclusion, hyperbaric hyperoxia results in significant haemodynamic changes. Initially, hyperoxia and the SCUBA system are responsible for reducing LV preload, increasing LV afterload and decreasing LV systolic performance, although CO did not change. Prolonged exposure resulted in a further decrease in LV preload, because of dehydration, and in a further increase in LV afterload, due to systemic vasoconstriction, with the consequence of decreasing CO.
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59: J Comp Physiol [B]. 2004 Mar;174(2):139-47. Epub 2003 Nov 25.
The development of diving bradycardia in bottlenose dolphins (Tursiops truncatus).
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Bradycardia is an important component of the dive response, yet little is known about this response in immature marine mammals. To determine if diving bradycardia improves with age, cardiac patterns from trained immature and mature bottlenose dolphins (Tursiops truncatus) were recorded during three conditions (stationary respiration, voluntary breath-hold, and shallow diving). Maximum (mean: 117+/-1 beats.min(-1)) and resting (mean: 101+/-5 beats.min(-1)) heart rate (HR) at the water surface were similar regardless of age. All dolphins lowered HR in response to apnea; mean steady state breath-hold HR was not correlated with age. However, the ability to reduce HR while diving improved with age. Minimum and mean steady state HR during diving were highest for calves. For example, 1.5-3.5-year-old calves had significantly higher mean steady state diving HR (51+/-1 beats.min(-1)) than 3.5-5.5-year-old juveniles (44+/-1 beats.min(-1)). As a result, older dolphins demonstrated greater overall reductions in HR during diving. Longitudinal studies concur; the ability to reduce HR improved as individual calves matured. Thus, although newly weaned calves as young as 1.7 years exhibit elements of cardiac control, the capacity to reduce HR while diving improves with maturation up to 3.5 years postpartum. Limited ability for bradycardia may partially explain the short dive durations observed for immature marine mammals.
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60: Pflugers Arch. 2004 Jan;447(4):405-7. Epub 2003 Nov 21.
Melatonin reduces noradrenaline-induced vasoconstriction in the uterine artery of pregnant hooded seals (Cystophora cristata).

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In pregnant seals the dive-associated constriction of the uterine artery is inhibited for unknown reasons. The seal fetus has an extremely large and active pineal gland, not found in any other mammals. We have investigated if the pineal hormone melatonin affects fetal blood supply during diving. Using isolated ring segments of the uterine artery from pregnant hooded seals (Cystophora cristata), we measured the change in isometric tension caused by noradrenaline (NA) with and without physiological concentrations of melatonin. Melatonin alone had no effects while NA increased the tension in a dose-dependent manner. The NA-induced tension was about 70% reduced by melatonin, but was completely recovered after washout of melatonin. These results indicate that the large and active pineal gland of the fetal seal may be involved in upholding maternal uterine blood flow during diving.
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61: J Appl Physiol. 2004 Mar;96(3):1005-10. Epub 2003 Oct 24.
Cardiovascular and respiratory responses to apneas with and without face immersion in exercising humans.
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The effect of the diving response on alveolar gas exchange was investigated in 15 subjects. During steady-state exercise (80 W) on a cycle ergometer, the subjects performed 40-s apneas in air and 40-s apneas with face immersion in cold (10 degrees C) water. Heart rate decreased and blood pressure increased during apneas, and the responses were augmented by face immersion. Oxygen uptake from the lungs decreased during apnea in air (-22% compared with eupneic control) and was further reduced during apnea with face immersion (-25% compared with eupneic control). The plasma lactate concentration increased from control (11%) after apnea in air and even more after apnea with face immersion (20%), suggesting an increased anaerobic metabolism during apneas. The lung oxygen store was depleted more slowly during apnea with face immersion because of the augmented diving response, probably including a decrease in cardiac output. Venous oxygen stores were probably reduced by the cardiovascular responses. The turnover times of these gas stores would have been prolonged, reducing their effect on the oxygen uptake in the lungs. Thus the human diving response has an oxygen-conserving effect.
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