CUHMA ACMHS
Canadian Undersea and Hyperbaric Medical Association
Association Canadienne de Médecine Hyperbare et Subaquatique

E-NEWS

EDITORIAL NOTE – June 2018

The E-News is the monthly newsletter of CUHMA used to share news and information. We invite relevant content, including announcements, meeting information, new publication abstracts, job postings, and relevant underwater images. Past issues are available at https://cuhma.ca, serving an ongoing role as an information repository.

Neal W. Pollock

NEWS/ANNOUNCEMENTS

Physiological and genetic adaptations to diving in Sea Nomads
Genetic and physiological adaptations enable the remarkable breath-holding ability of marine mammals. The newspaper article is available in its entirety.
https://www.nytimes.com/2018/04/19/science/bajau-evolution-ocean-diving.html?partner=rss&emc=rss

Call for Abstracts – CUHMA 2018
The program for the November annual scientific meeting is approaching completion. Abstracts (100-150 words) can still be submitted for a poster session. Posters may present original research or material presented elsewhere within that last year. The submission deadline is June 15, 2018.

UPCOMING EVENTS

UHMS Annual Scientific Meeting
The 2018 Undersea and Hyperbaric Medical Society annual scientific meeting will be held June 28-30 in Orlando, FL. Visit: https://www.uhms.org. Note: CUHMA members are eligible to receive a 50% discount on UHMS annual membership dues.

Second Tricontinental Scientific Conference on Diving and Hyperbaric Medicine
The second Tricontinental Scientific Conference will be held in Durban, KwaZulu Natal, South Africa, September 23-29, 2018. The week will combine scientific meetings, diving workshops, and social events. The joint organizing committee includes EUBS, SPUMS, SAUHMA and the Scott Haldane Foundation, working with local Durban Hyperbaric Centre staff and a South Africa event management bureau. The weather in September is ideal with temperatures in the low 20s for both land and sea and little chance of rain. For more information, visit: www.tricon2018.org.

AAUS Diving for Science Symposium 2018
The 2018 American Academy of Underwater Sciences Diving for Science Symposium will be held October 09-13 in Tahoe City, CA. University of California (UC) Berkeley and UC Davis will serve as hosts. This meeting is relevant to diving scientists, students, diving safety officers, and anyone with an interest in diving science. The intent to submit an abstract or full manuscript should be filed by June 15th. For more details: www.aaus.org/annual_symposium.

CUHMA Annual Scientific Meeting 2018
The 2018 CUHMA ASM will be held November 01-04, in Quebec City, hosted by Université Laval and Hôtel-Dieu de Lévis. Two days of pre-conference workshops, courses and exams will be followed by two days of scientific talks. Pre-conference events include:
- Transcutaneous oximetry (TCOM) workshop
- Problem wound management workshop
- CHT exam offered by the National Board of Diving and Hyperbaric Medical Technology (NBDHMT)
- Hyperbaric emergency team simulation (HETS) course to be held at the hyperbaric chamber at Hôtel-Dieu de Lévis
- Board of Directors meeting

A welcome reception with be held on Friday evening, and the awards banquet on Saturday evening. Visit our website for updates and future registration: https://cuhma.ca.

STUDENT OPPORTUNITIES

Doctoral Studies in Diving Research
Active recruitment is underway at Université Laval for qualified and motivated students wanting to pursue doctoral studies in environmental physiology related to diving. The research focus is health and safety in extreme environments, with concentration in decompression stress, monitoring technology, and diver safety. Students will also gain experience with a variety of studies in hyperbaric medicine. Contact Dr. Neal Pollock (neal.pollock@kin.ulaval.ca) for more information. Inquiries would best include concise CVs and a description of key interests and goals.

RECENT PUBLICATIONS

Bosco G, Rizzato A, Quartesan S, Camporesi E, Mrakic-Sposta S, Moretti S, Balestra C, Rubini A. Spirometry and oxidative stress after rebreather diving in warm water. Undersea Hyperb Med. 2018;45(2):191-8.

INTRODUCTION: Hyperbaric oxygen (HBO_2) therapy and use of enriched air can result in oxidative injury affecting the brain, lungs and eyes. HBO_2 exposure during diving can lead to a decrease in respiratory parameters. However, the possible effects of acute exposure to oxygen-enriched diving on subsequent spirometric performance and oxidative state in humans have not been recently described recently. We aim to investigate possible effects of acute (i) hyperbaric and (ii) hyperbaric hyperoxic exposure using scuba or closed-circuit rebreather (CCR) on subsequent spirometry and to assess the role of oxidative state after hyperoxic diving. METHODS: Spirometry and urine samples were obtained from six well-trained divers (males, mean±SD, age: 43.3±9.2 years; weight: 79.0±4.9 kg; height: 1.77±0.07 m) before (CTRL) and after a dive breathing air, and after a dive using CCR (PO_2 1.4). In the crossover design (two dives separated by six hours) each subject performed a 20-min session of light underwater exercise at a depth of 15 m in warm water (31-32°C). We measured urinary 8-isoprostane and 8-OH-2-deoxyguanosine evaluating lipid and DNA oxidative damages. RESULTS: Different breathing conditions (air vs. CCR) did not significantly affect spirometry. A significant increase of 8-OH-dG (1.85±0.66 vs. 4.35±2.12; P<0.05) and 8-isoprostane (1.35±0.20 vs. 2.59±0.61; P<0.05) levels after CCR dive with respect to the CTRL was observed. Subjects did not have any ill effects during diving. CONCLUSIONS: Subjects using CCR showed elevated oxidative stress, but this did not correlate with a reduction in pulmonary function.

Garcia Párraga D, Moore M, Fahlman A. Pulmonary ventilation-perfusion mismatch: a novel hypothesis for how diving vertebrates may avoid the bends. Proc Biol Sci. 2018 Apr 25;285(1877). pii: 20180482. doi: 10.1098/rspb.2018.0482.

Hydrostatic lung compression in diving marine mammals, with collapsing alveoli blocking gas exchange at depth, has been the main theoretical basis for limiting N_2 uptake and avoiding gas emboli (GE) as they ascend. However, studies of beached and bycaught cetaceans and sea turtles imply that air-breathing marine vertebrates may, under unusual circumstances, develop GE that result in decompression sickness (DCS) symptoms. Theoretical modelling of tissue and blood gas dynamics of breath-hold divers suggests that changes in perfusion and blood flow distribution may also play a significant role. The results from the modelling work suggest that our current understanding of diving physiology in many species is poor, as the models predict blood and tissue N_2 levels that would result in severe DCS symptoms (chokes, paralysis and death) in a large fraction of natural dive profiles. In this review, we combine published results from marine mammals and turtles to propose alternative mechanisms for how marine vertebrates control gas exchange in the lung, through management of the pulmonary distribution of alveolar ventilation ([Formula: see text]) and cardiac output/lung perfusion ([Formula: see text]), varying the level of [Formula: see text] in different regions of the lung. Man-made disturbances, causing stress, could alter the [Formula: see text] mismatch level in the lung, resulting in an abnormally elevated uptake of N_2, increasing the risk for GE. Our hypothesis provides avenues for new areas of research, offers an explanation for how sonar exposure may alter physiology causing GE and provides a new mechanism for how air-breathing marine vertebrates usually avoid the diving-related problems observed in human divers.

Hadanny A, Lang E, Copel L, Meir O, Bechor Y, Fishlev G, Bergan J, Zisman A, Efrati S. Hyperbaric oxygen can induce angiogenesis and recover erectile function. Int J Impot Res. 2018 May 18. doi: 10.1038/s41443-018-0023-9.

Erectile dysfunction (ED) is caused by microvascular or macrovascular insufficiency in the majority of patients. Recent studies have shown that hyperbaric oxygen therapy (HBOT) can induce angiogenesis in different body organs. The effect of HBOT on the non-surgery-related ED has not been investigated yet. The aim of the current study was to evaluate the effects of HBOT on sexual function and penile vascular bed in non-surgical ED patients. A prospective analysis of patients suffering from chronic ED treated with 40 daily HBOT sessions. Clinical efficacy was assessed using the International Index of Erectile Function questionnaire (IIEF) and a global efficacy question (GEQ). The effect on the penile vascular bed was evaluated by perfusion MRI. Thirty men (mean age of 59.2±1.4) suffering from ED for 4.2±0.6 years completed the protocol. HBOT significantly improved all IIEF domains by 15-88% (p<0.01). Erectile function improved by 88% (p<0.0001) and 80% of the patients reported positive outcome according to the GEQ. Angiogenesis was indicated by perfusion MRI that showed a significant increase by 153.3±43.2% of K-trans values in the corpous cavernous (p<0.0001). HBOT can induce penile angiogenesis and improve erectile function in men suffering from EcD. HBOT reverses the basic common pathophysiology, atherosclerosis and decreased penile perfusion, responsible for most cases of ED.

Hampson NB. Carboxyhemoglobin: a primer for clinicians. Undersea Hyperb Med. 2018;45(2):165-71.

One of carbon monoxide's several mechanisms of toxicity is binding with circulating hemoglobin to form carboxyhemoglobin, resulting in a functional anemia. While patients with carbon monoxide poisoning are often said to be "cherry-red," such discoloration is rarely seen. Carboxyhemoglobin levels cannot be measured with conventional pulse oximetry, can be approximated with pulse CO-oximetry, and are most accurately measured with a laboratory CO-oximeter. Carboxyhemoglobin levels are quite stable and can be accurately measured on a transported blood sample. For clinical purposes, arterial and venous carboxyhemoglobin levels can be considered to be equivalent. Carboxyhemoglobin levels are typically lower than 2% in non-smokers and lower than 5% in smokers. A level over 9% is almost always due to exogenous carbon monoxide exposure, even among smokers. Conversely, a low level does not exclude significant exposure under certain circumstances. As carboxyhemoglobin levels of poisoned patients do not correlate with symptoms or outcome, their greatest utility is a marker of exposure.

Hentia C, Rizzato A, Camporesi E, Yang Z, Muntean DM, Săndesc D, Bosco G. An overview of protective strategies against ischemia/reperfusion injury: the role of hyperbaric oxygen preconditioning. Brain Behav. 2018;8(5):e00959.

INTRODUCTION: Ischemia/reperfusion (I/R) injury, such as myocardial infarction, stroke, and peripheral vascular disease, has been recognized as the most frequent causes of devastating disorders and death currently. Protective effect of various preconditioning stimuli, including hyperbaric oxygen (HBO), has been proposed in the management of I/R. METHODS: In this study, we searched and reviewed up-to-date published papers to explore the pathophysiology of I/R injury and to understand the mechanisms underlying the protective effect of HBO as conditioning strategy. RESULTS: Animal study and clinic observation support the notion that HBO therapy and conditioning provide beneficial effect against the deleterious effects of postischemic reperfusion. Several explanations have been proposed. The first likely mechanism may be that HBO counteracts hypoxia and reduces I/R injury by improving oxygen delivery to an area with diminished blood flow. Secondly, by reducing hypoxia-ischemia, HBO reduces all the pathological events as a consequence of hypoxia, including tissue edema, increased affective area permeability, postischemia derangement of tissue metabolism, and inflammation. Thirdly, HBO may directly affect cell apoptosis, signal transduction, and gene expression in those that are sensitive to oxygen or hypoxia. HBO provides a reservoir of oxygen at cellular level not only carried by blood, but also by diffusion from the interstitial tissue where it reaches high concentration that may last for several hours, improves endothelial function and rheology, and decreases local inflammation and edema. CONCLUSION: Evidence suggests the benefits of HBO when used as a preconditioning stimulus in the setting of I/R injury. Translating the beneficial effects of HBO into current practice requires, as for the "conditioning strategies," a thorough consideration of risk factors, comorbidities, and comedications that could interfere with HBO-related protection

Huang L, Boling W, Zhang JH. Hyperbaric oxygen therapy as adjunctive strategy in treatment of glioblastoma multiforme. Med Gas Res. 2018;8(1):24-8.

Glioblastoma multiforme (GBM) is the most common type of malignant intracranial tumor in adults. Tumor tissue hypoxia, high mitotic rate, and rapid tumor spread account for its poor prognosis. Hyperbaric oxygen therapy (HBOT) may improve the sensitivity of radio-chemotherapy by increasing oxygen tension within the hypoxic regions of the neoplastic tissue. This review summarizes the research of HBOT applications within the context of experimental and clinical GBM. Limited clinical trials and preclinical studies suggest that radiotherapy immediately after HBOT enhances the effects of radiotherapy in some aspects. HBOT also is able to strengthen the anti-tumor effect of chemotherapy when applied together. Overall, HBOT is well tolerated in the GBM patients and does not significantly increase toxicity. However, HBOT applied by itself as curative strategy against GBM is controversial in preclinical studies and has not been evaluated rigorously in GBM patients. In addition to HBOT favorably managing the therapeutic resistance of GBM, future research needs to focus on the multimodal or cocktail approaches to treatment, as well as molecular strategies targeting GBM stem cells.

Ilardo MA, Moltke I, Korneliussen TS, Cheng J, Stern AJ, Racimo F, de Barros Damgaard P, Sikora M, Seguin-Orlando A, Rasmussen S, van den Munckhof ICL, Ter Horst R, Joosten LAB, Netea MG, Salingkat S, Nielsen R, Willerslev E. Physiological and genetic adaptations to diving in Sea Nomads. Cell. 2018;173(3):569-80.e15.

Understanding the physiology and genetics of human hypoxia tolerance has important medical implications, but this phenomenon has thus far only been investigated in high-altitude human populations. Another system, yet to be explored, is humans who engage in breath-hold diving. The indigenous Bajau people ("Sea Nomads") of Southeast Asia live a subsistence lifestyle based on breath-hold diving and are renowned for their extraordinary breath-holding abilities. However, it is unknown whether this has a genetic basis. Using a comparative genomic study, we show that natural selection on genetic variants in the PDE10A gene have increased spleen size in the Bajau, providing them with a larger reservoir of oxygenated red blood cells. We also find evidence of strong selection specific to the Bajau on BDKRB2, a gene affecting the human diving reflex. Thus, the Bajau, and possibly other diving populations, provide a new opportunity to study human adaptation to hypoxia tolerance.

Lee KJ, Sanou AZ. Decompression sickness in the F/A-18C after atypical Cabin pressure fluctuations. Aerosp Med Hum Perform. 2018;89(5):478-82.

BACKGROUND: The spectrum of altitude decompression sickness (DCS) is evolving as more cases of atypical pressure fluctuations occur. This ongoing change makes it a difficult condition to diagnose and even more difficult to identify. Both Flight Surgeons and Undersea Medical Officers (UMOs) must keep DCS on the differential. These two cases describe altitude DCS after unique pressure patterns, with one at a markedly lower than expected altitude for DCS. CASE REPORT: Both cases occurred in the F/A-18C and resulted in DCS requiring hyperbaric chamber treatment. The aviator in case 1 experienced an over-pressurization to an unknown depth with a subsequent rapid decompression during a carrier approach at 600 ft (182.9 m) above sea level. The aviator in case 2 experienced cabin pressure fluctuations between 9000 ft (2743.2 m) and 18,000 ft (5486.4 m). Both cases demonstrate the progression of DCS after partial treatment on ground-level oxygen therapy, and the case sequence illustrates how evaluations and protocols changed with experience. DISCUSSION: Decompression sickness is difficult to identify since it does not have a diagnostic test. These cases were even more difficult because of subtle exam findings, reliance on subjective symptoms, and atypical pressure profiles. Environmental, physiological, and psychosocial factors specific to the aviation community can delay the diagnosis and treatment. Descending in altitude and using in-flight emergency oxygen or ground-level oxygen partially treats and masks symptoms for both the aviator and the physician. The Flight Surgeons' integration within the squadron and collaboration with UMOs is important to identify the first signs of DCS and decrease time to treatment.

Schirato SR, El-Dash I, El-Dash V, Natali JE, Starzynski PN, Chaui-Berlinck JG. Heart rate variability changes as an indicator of decompression-related physiological stress. Undersea Hyperb Med. 2018;45(2):173-82.

Many aspects of the physiological stress related to the exposure to the hyperbaric environment have been studied, but no research has been made to evaluate the impacts of scuba diving on heart rate variability (HRV). We investigated the effects of a simulated dive to 557 KPa (45 m of salt water) for a 30-min bottom time on the frequency and time domains estimators of HRV. Electrocardiogram records were obtained with superficial electrodes for 30 min before the simulated dive and, subsequently, for one hour after the dive. Each of these time-series was then subdivided into non-overlapping windows of 256 consecutive R-R intervals. A control group was submitted to the same protocol, breathing the same gases used in the simulated dive, while not being exposed to the hyperbaric environment. In the control group we observed a significant increase in SDNN (the square root of the variance of the R-R intervals), RMSSD (the square root of the mean squared differences of successive R-R intervals), and in two bands (high and low) of the power spectrum of frequencies. The subjects in the simulated dive presented only an increase in the low-frequency estimator without any further relevant changes in other estimators of HRV. This study suggests that the low-frequency increase without concomitant high-frequency increase might be an indicator of the physiological stress caused by decompression and that such a dissimilarity in responses might be correlated to the dive-related impairment of the endothelial function.

Villela MA, Dunworth S, Harlan NP, Moon RE. Can my patient dive after a first episode of primary spontaneous pneumothorax? A systematic review of the literature. Undersea Hyperb Med. 2018;45(2):199-208.

INTRODUCTION: Patients with prior primary spontaneous pneumothorax (PSP) frequently seek clearance to dive. Despite wide consensus in precluding compressed-air diving in this population, there is a paucity of data to support this decision. We reviewed the literature reporting the risk of PSP recurrence. METHODS: A literature search was performed in PubMed and Web of Science using predefined terms. Studies published in English reporting the recurrence rate after a first PSP were included. RESULTS: Forty studies (n=3,904) were included. Risk of PSP recurrence ranged 0-67% (22±15.5%; mean ± SD). Mean follow-up was 36 months, and 63±39% of recurrences occurred during the first year of follow-up. Elevated height/weight ratio and emphysema-like changes (ELCs) are associated with PSP recurrence. ELCs are present in 59%-89% (vs. 0-15%) of patients with recurrence and can be detected effectively with high-resolution CT scan (sensitivity of 84-88%). Surgical pleurodesis reduces the risk of recurrence substantially (4.0± 4% vs 22±15.5%). CONCLUSIONS: Risk of PSP recurrence seems to decline over time and is associated to certain radiological and clinical risk factors. This could be incremented by the stresses of compressed-air diving. A basis for informed patient-physician discussions regarding future diving is provided in this review.

Weaver LK. Wilson SH, Lindblad AS, Churchill S, Deru K, Price RC, Williams CS, Orrison WW, Walker JM, Meehan A, Mirow S. Hyperbaric oxygen for post-concussive symptoms in United States military service members: a randomized clinical trial. Undersea Hyperb Med. 2018;45(2):129-56.

BACKGROUND: In prior military randomized trials, participants with persistent symptoms after mild traumatic brain injury (TBI) reported improvement regardless of receiving hyperbaric oxygen (HBO_2) or sham intervention. This study's objectives were to identify outcomes for future efficacy trials and describe changes by intervention. METHODS: This Phase II, randomized, double-blind, sham-controlled trial enrolled military personnel with mild TBI and persistent post-concussive symptoms. Participants were randomized to receive 40 HBO_2 (1.5 atmospheres absolute (ATA), >99% oxygen, 60 minutes) or sham chamber sessions (1.2 ATA, room air, 60 minutes) over 12 weeks. Participants and evaluators were blinded to allocation. Outcomes assessed at baseline, 13 weeks and six months included symptoms, quality of life, neuropsychological, neurological, electroencephalography, sleep, auditory, vestibular, autonomic, visual, neuroimaging, and laboratory testing. Participants completed 12-month questionnaires. Intention-to-treat results are reported. RESULTS: From 9/11/2012 to 5/19/2014, 71 randomized participants received HBO_2 (n=36) or sham (n=35). At baseline, 35 participants (49%) met post-traumatic stress disorder (PTSD) criteria. By the Neurobehavioral Symptom Inventory, the HBO_2 group had improved 13-week scores (mean change -3.6 points, P=0.03) compared to sham (+3.9 points). In participants with PTSD, change with HBO_2 was more pronounced (-8.6 vs. +4.8 points with sham, P=0.02). PTSD symptoms also improved in the HBO_2 group, and more so in the subgroup with PTSD. Improvements regressed at six and 12 months. Hyperbaric oxygen improved some cognitive processing speed and sleep measures. Participants with PTSD receiving HBO_2 had improved functional balance and reduced vestibular complaints at 13 weeks. CONCLUSIONS: By 13 weeks, HBO_2 improved post-concussive and PTSD symptoms, cognitive processing speed, sleep quality, and balance function, most dramatically in those with PTSD. Changes did not persist beyond six months. Several outcomes appeared sensitive to change; additional studies are warranted.

CUHMA-ACMHS is the Canadian voice for the advancement of hyperbaric and diving medicine throughout our country and beyond. Our activities include continuous medical education for physicians, nurses, respiratory therapists and anyone involved in the fields of hyperbaric and diving medicine. We are also promoting dissemination of clinical research, publishing position statements, liaising with related professional associations and government agencies. Our main goal is advocating on behalf of our patients. Our vision is to be the reference for the development and delivery of hyperbaric and diving medicine in Canada and beyond. Our mission is to promote excellence in hyperbaric and diving medicine through leadership in education, promotion of best practices and advocacy for our patients. Our values are excellence, leadership, collaboration, communication, and integrity.

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