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

E-NEWS

EDITOR'S NOTE – May 2023

The E-News is the monthly newsletter of CUHMA, the primary outlet to share news/announcements, upcoming events, abstracts of recent publications, job postings, professional perspectives, and images of relevant professional scenes. Submission of applicable content is welcome. New issues are released on the last business day of each month. Past issues are available at https://cuhma.ca. Direct correspondence to info@cuhma.ca.

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NEWS/ANNOUNCEMENTS

Full-Face Snorkel Mask Safety Concerns

Full-face snorkeling masks were brought to market with a big push in 2014. They were designed to maximize the visual field and reduce mask fogging. Concerns have been raised since 2017 about the potential for CO_2 buildup, most notably in cheaper knockoff versions. CO_2 can produce cognitive impairment, more so in persons who are relatively insensitive to rising levels (an insensitivity that is generally unknown). A respiratory response to rising CO_2 may also increase the risk of immersion pulmonary edema. These masks are not as easy to remove as a traditional snorkel, which could be problematic when in a compromised state. Full-face masks are now banned in a number of places, and additional scrutiny is put on them if used when any incidents occur. For more information:
https://www.cbsnews.com/news/hawaii-full-face-snorkel-mask-related-deaths.
https://divemagazine.com/scuba-diving-news/full-face-snorkel-mask-causes-ipo-fatality.

US Navy DSEND System Testing

The US Navy is testing the Deep Sea Expeditionary with No Decompression (DSEND) lightweight atmospheric suit system as an option to enhance capabilities while avoiding decompression obligations. For more information:
https://newatlas.com/military/dsend-suit-protects-deep-sea-divers-pressure-dangers.

Rebreather Forum 4 Conference Completion

RF4 was successfully completed in Valletta, Malta with just under 300 participants from around the world. Proceedings of the meeting and selected videos will be released later in the year. To check updates: https://rebreatherforum.tech.
https://xray-mag.com/content/report-rebreather-forum-4.
https://pdfs.xray-mag.com/articles/RF4_118_protected.pdf.

UPCOMING EVENTS

SPUMS Annual Scientific Meeting 2023

The South Pacific Underwater Medicine Society annual scientific meeting will be held June 04-09 in Cairns, Australia. The theme is diver health and ocean health amid the storm clouds of climate change. Details and registration: https://spums.au.

UHMS Annual Scientific Meeting 2023

The Undersea and Hyperbaric Medical Society (UHMS) annual scientific meeting will be held June 16-18 in San Diego, CA. Visit: https://www.uhms.org.

UMC Introductory Diving Medicine Course

Undersea Medicine Canada is offering a Level 1 'Introductory Course in Diving Medicine - Fitness to Dive' September 18-22 in Quebec City, QC. An optional half-day pre-course will be held September 17 for those wanting additional preparation for the program. For more information visit: https://underseamedicine.ca.

WMS Diving and Environmental Medicine CME

The Wilderness Medical Society is holding a continuing medical education course September 30-October 07, 2023 in Cayman Brac (travel on Saturdays on both ends). Each of six days includes four hours of interactive lectures and two tank boat dives. Visit: https://wms.org/DM23.

International Congress of Hyperbaric Medicine

The 20th ICHM will be held November 02-04, 2023 at the Windsor Barra Hotel in Rio de Janeiro, Brazil, hosted by the Brazilian Society of Hyperbaric Medicine. The ICHM is generally held every three years, and is unusual in not being linked to any single institution. There will be simultaneous translation of speeches and question and answer periods. Website details available soon.

RECENT PUBLICATIONS

Helfrich ET, Saraiva CM, Chimiak JM, Nochetto M. A review of 149 Divers Alert Network emergency call records involving diving minors. Diving Hyperb Med. 2023 Mar 31;53(1):7-15. doi: 10.28920/dhm53.1.7-15.

Introduction: Minors have been scuba diving for decades, and while the initial concerns about potential long-term complications related to bone development appear to be unfounded, the incidence of scuba diving injuries among them has been poorly studied. Methods: We reviewed 10,159 cases recorded in the DAN Medical Services call centre database from 2014 through 2016 and identified 149 cases of injured divers younger than 18 years. Records were analysed for case categorisation on the most common dive injuries. Information about demographics, level of training, risk factors, and relevant behavioural aspects were collected when available. Results: While the most common reason for the call was to rule out decompression sickness, the majority of cases pertained to ear and sinus issues. However, 15% of the dive-related injuries involving minors had a final diagnosis of pulmonary barotrauma (PBt). While no reliable data is available on the incidence of PBt in adult divers, the authors' impression based on personal experience suggests that the number of cases of PBt in minors trends higher than in the general diving population. The narratives on some relevant records describe unmanageable levels of anxiety leading to panic. Conclusions: Based on the results and narratives on these cases, it is reasonable to infer that psychological immaturity, suboptimal management of adverse situations, and inadequate supervision might have led to severe injuries among these minor divers.

Jüttner B, Wölfel C, Camponovo C, Schöppenthau H, Meyne J, Wohlrab C, Werr H, Klein T, Schmeißer G, Theiß K, Wolf P, Müller O, Janisch T, Naser J, Blödt S, Muche-Borowski C. S2k guideline for diving accidents. Ger Med Sci. 2023 Mar 3;21:Doc01. doi: 10.3205/000315. eCollection 2023.

For the purposes of this guideline, a diving accident is defined as an event that is either potentially life-threatening or hazardous to health as a result of a reduction in ambient pressure while diving or in other hyperbaric atmospheres with and without diving equipment. This national consensus-based guideline (development grade S2k) presents the current state of knowledge and recommendations on the diagnosis and treatment of diving accident victims. The treatment of a breath-hold diver as well as children and adolescents does not differ in principle. In this regard only unusual tiredness and itching without visible skin changes are mild symptoms. The key action statements: on-site 100% oxygen first aid treatment, immobilization/no unnecessary movement, fluid administration and telephone consultation with a diving medicine specialist are recommended. Hyperbaric oxygen therapy (HBOT) remains unchanged as the established treatment in severe cases, as there are no therapeutic alternatives. The basic treatment scheme recommended for diving accidents is hyperbaric oxygenation at 280 kPa.

Lalieu RC, Bol Raap RD, Smit C, Dubois EFL, van Hulst RA. Hyperbaric oxygen therapy for nonhealing wounds - a long-term retrospective cohort study. Adv Skin Wound Care. 2023 Apr 4. doi: 10.1097/01.ASW.0000922696.61546.31.

Objective: To analyze wound healing results of hyperbaric oxygen therapy (HBOT) for a variety of different wound types. Methods: This retrospective cohort study included all patients treated with HBOT and wound care at a single hyperbaric center between January 2017 and December 2020. The primary outcome was wound healing. Secondary outcome measures were quality of life (QoL), number of sessions, adverse effects, and treatment cost. Investigators also examined possible influencing factors, including age, sex, type and duration of wound, socioeconomic status, smoking status, and presence of peripheral vascular disease. Results: A total of 774 treatment series were recorded, with a median of 39 sessions per patient (interquartile range, 23-51 sessions). In total, 472 wounds (61.0%) healed, 177 (22.9%) partially healed, 41 (5.3%) deteriorated, and 39 (5.0%) minor and 45 (5.8%) major amputations were performed. Following HBOT, median wound surface area decreased from 4.4 cm^2 to 0.2 cm^2 ($P<0.01$), and patient QoL improved from 60 to 75 on a 100-point scale ($P<0.01$). The median cost of therapy was €9,188 (interquartile range, €5,947-€12,557). Frequently recorded adverse effects were fatigue, hyperoxic myopia, and middle ear barotrauma. Attending fewer than 30 sessions and having severe arterial disease were both associated with a negative outcome. Conclusions: Adding HBOT to standard wound care increases wound healing and QoL in selected wounds. Patients with severe arterial disease should be screened for potential benefits. Most reported adverse effects are mild and transient.

Le DQ, Hoang AH, Azarang A, Lance RM, Natoli M, Gatrell A, Blogg SL, Dayton PA, Tillmans F, Lindholm P, Moon RE, Papadopoulou V. An open-source framework for synthetic post-dive Doppler ultrasound audio generation. PLoS One. 2023 Apr 27;18(4):e0284922. doi: 10.1371/journal.pone.0284922.

Doppler ultrasound (DU) measurements are used to detect and evaluate venous gas emboli (VGE) formed after decompression. Automated methodologies for assessing VGE presence using signal processing have been developed on varying real-world datasets of limited size and without ground truth values preventing objective evaluation. We develop and report a method to generate synthetic post-dive data using DU signals collected in both precordium and subclavian vein with varying degrees of

bubbling matching field-standard grading metrics. This method is adaptable, modifiable, and reproducible, allowing for researchers to tune the produced dataset for their desired purpose. We provide the baseline Doppler recordings and code required to generate synthetic data for researchers to reproduce our work and improve upon it. We also provide a set of pre-made synthetic post-dive DU data spanning six scenarios representing the Spencer and Kisman-Masurel (KM) grading scales as well as precordial and subclavian DU recordings. By providing a method for synthetic post-dive DU data generation, we aim to improve and accelerate the development of signal processing techniques for VGE analysis in Doppler ultrasound.

Lundell RV, Ojanen T. A systematic review of HRV during diving in very cold water. Int J Circumpolar Health. 2023;82(1):2203369. doi: 10.1080/22423982.2023.2203369.

Heart rate variability (HRV) is a useful method to study the autonomic nervous system (ANS) status. As measuring devices have developed and become smaller, many researchers have become interested in the possibilities to implement the method for diving medicine research. The aim of this study was to review human ANS responses in cold water diving (water temperature <5°C), and to comprise the current knowledge of HRV studies in diving and hyperbaric exposure into one review article. A literature search was conducted on 5 December 2022, with the search terms "HRV" or "heart rate variability" and "diving" or "diver" or "divers", with search functions of the data bases PubMed and Ovid Medline. Peer reviewed original articles, review articles and case reports were accepted to this review. Twenty-six articles met the pre-defined criteria and were included in this review. Studies from very cold water conditions were rare, but suggested that cold strengthens the ANS responses of diving - especially parasympathetic nervous system (PNS) activity due to the trigeminocardiac reflex and baroreceptor and cardiac stretch receptor activity, caused cold and pressure-induced centralisation of the blood. Overall, studies showed predominant PNS activity when putting the face in water, during immersion and when ambient pressure increased.

Mazo SEM, Peña FY, Ramírez JVO. Intraocular pressure changes under an atmospheric pressure spectrum in a multiplace hyperbaric chamber. Arq Bras Oftalmol. 2023 Mar 24;S0004-27492023005002306. doi: 10.5935/0004-2749.2022-0085. Online ahead of print.

Purpose: To evaluate the influence of atmospheric pressure changes on the behavior of intraocular pressure of healthy military individuals-students and instructors of the National Navy's Diving & Rescue School at the "ARC BOLÍVAR" naval base-during a simulated immersion in the hyperbaric chamber of the Naval Hospital of Cartagena. Methods: A descriptive exploratory study was performed. The intraocular pressure was measured at different atmospheric pressures during 60-min sessions in the hyperbaric chamber while breathing compressed air. The maximum simulated depth was 60 feet. Participants were students and instructors of the Naval Base's Diving and Rescue Department. Results: A total of 48 eyes from 24 divers were studied, of which 22 (91.7%) were male. The mean age of the participants was 30.6 (SD=5.5) years, ranging from 23 to 40. No participant had a history of glaucoma or ocular hypertension. The mean base intraocular pressure at sea level was 14 mmHg, which decreased to 13.1 mmHg (decreased by 1.2 mmHg) at 60 feet deep (p=0.0012). However, during the safety stop at 30 feet, the mean IOP kept decreasing until reaching 11.9 mmHg (p<0.001). By the end of the session, the mean intraocular pressure reached 13.1 mmHg, which is inferior and statistically significant when compared with the intraocular pressure base mean (p=0.012). Conclusions: In healthy individuals, the intraocular pressure decreases when reaching a depth of 60 feet (2.8 absolute atmosphere pressure) and it decreases even more during ascension at 30 feet. Measurements at both points were significantly different when compared with base intraocular pressure. The final intraocular pressure was lower than the baseline intraocular pressure, suggesting a residual and prolonged effect of the atmospheric pressure on intraocular pressure.

Möller F, Jacobi E, Hoffmann U, Vogt T. Physiological and cognitive responses to hyperoxic exercise in full water submersion. Eur J Sport Sci. 2023 Apr 3;1-21. doi: 10.1080/17461391.2023.2193942. Online ahead of print.

The positive effects of combined hyperoxia and physical exercise on physiological parameters and cognitive functioning are established for normobaric laboratory contexts. Still, increased practicability exists in hyperbaric settings like underwater activities and scuba diving, where environmental and sport-specific factors might moderate effects. Improved cognition, reduced ventilation (V_E), and lower blood lactate concentrations [Lac-] are highly relevant, especially during high-stress and rescue scenarios. Fifteen participants performed 3 × 8 min of continuous underwater fin-swimming at 25% (low), 45% (moderate), and 75% (vigorous) heart rate reserve (HRR) in each test. Three separate test days differed solely by the inspiratory oxygen partial pressure (P_IO_2: 29 kPa, 56 kPa, and 140 kPa). V_E was measured continuously, whereas breathing gas analysis, blood sampling, and Eriksen Flanker tasks for inhibitory control (100 stimuli) were performed post-exercise. Two-way ANOVAs with repeated measures on the factors P_IO_2 and exercise intensity investigated physiological outcome variables and reactions times (RT) and accuracy (ACC) of inhibitory control. V_E was significantly reduced for 140 kPa during moderate and vigorous and for 56 kPa during vigorous compared to 29 kPa. 56 kPa and 140 kPa showed no differences. [Lac-], post-exercise VCO_2, and velocity were

unaffected by P_IO_2. Faster RTs but lower ACC of inhibitory control were observed following exercise at 75% HRR compared to rest, 25%, and 45% HRR, while P_IO_2 produced no effects. Underwater performance in hyperoxia presents reduced V_E, possible by dampened chemoreceptor sensitivity, and effects on cognition that differ from laboratory results and emphasize the moderating role of sport-specific factors.

Pernett F, Bergenhed P, Holmström P, Mulder E, Schagatay E. Effects of hyperventilation on oxygenation, apnea breaking points, diving response, and spleen contraction during serial static apneas. Eur J Appl Physiol. 2023 Apr 15. doi: 10.1007/s00421-023-05202-7. Online ahead of print.

Purpose: Hyperventilation is considered a major risk factor for hypoxic blackout during breath-hold diving, as it delays the apnea breaking point. However, little is known about how it affects oxygenation, the diving response, and spleen contraction during serial breath-holding. Methods: 18 volunteers with little or no experience in freediving performed two series of 5 apneas with cold facial immersion to maximal duration at 2-min intervals. In one series, apnea was preceded by normal breathing and in the other by 15 s of hyperventilation. End-tidal oxygen and end-tidal carbon dioxide were measured before and after every apnea, and peripheral oxygen saturation, heart rate, breathing movements, and skin blood flow were measured continuously. Spleen dimensions were measured every 15 s. Results: Apnea duration was longer after hyperventilation (133 vs 111 s). Hyperventilation reduced pre-apnea end-tidal CO_2 (17.4 vs 29.0 mmHg) and post-apnea end-tidal CO_2 (38.5 vs 40.3 mmHg), and delayed onset of involuntary breathing movements (112 vs 89 s). End-tidal O_2 after apnea was lower in the hyperventilation trial (83.4 vs 89.4 mmHg) and so was the peripheral oxygen saturation nadir after apnea (90.6 vs 93.6%). During hyperventilation, the nadir peripheral oxygen saturation was lower in the last apnea than in the first (94.0% vs 86.7%). There were no differences in diving response or spleen volume reduction between conditions or across series. Conclusions: Serial apneas revealed a previously undescribed aspect of hyperventilation; a progressively increased desaturation across the series, not observed after normal breathing and could heighten the risk of a blackout.

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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