

E-NEWS

EDITOR'S NOTE – December 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.

Best of the season to all.

Neal W. Pollock, PhD
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NEWS/ANNOUNCEMENTS

BSAC 2022 Annual Diving Incident Report

The British Sub-Aqua Club has released the 2022 annual diving incident report. It includes a total of 248 incidents captured for 2022. The report can be downloaded at no cost: [ehttps://www.bsac.com/safety/diving-incidents/annual-diving-incident-report](https://www.bsac.com/safety/diving-incidents/annual-diving-incident-report)

The organization will be providing a webinar going through the report for diving industry professionals on December 05. This is also open to all who register: <https://www.bsac.com/forms/incident-report-dive-industry-presentation-non-bsac-member>.

Rebreather Forum 4 Presentations

One of the goals of the April 2023 RF4 meeting was to release the relevant video lectures at no cost to the community. The complete collection of those to be released is now available, covering a wide range of topics, including health, safety, use, design, future direction, and exploration: <https://rebreatherforum.tech/program>

or GUE.tv: <https://gue.tv/programs/rebreather-forum-4>
The consensus statements generated in the meeting have also been formally published:

Mitchell SJ, Pollock NW. Rebreather Forum Four consensus statements. Diving Hyperb Med. 2023; 53(2): 142-6. doi: 10.28920/dhm53.2.142-146. PMID: 37365132.

The written proceedings of the meeting will be available in the coming months.

CUHMA Member Profile Updates

All CUHMA members are asked to logon through the online portal (<https://cubhma.ca>) and ensure that member profile information is current, including address preferences for electronic communications.

UPCOMING EVENTS

Boston Sea Rovers International Ocean Symposium

The 70th international ocean symposium and film festival will be held March 15-17 in Danvers, MA. For more information: <https://bostonsearovers.com/clinic-home>.

Ponza Rebreather Conference

The eighth iteration of the Ponza Rebreather Conference will be held May 8-12, 2024 on the island of Ponza, Italy (south of Rome and west of Naples in the Tyrrhenian Sea). An international roster of speakers will present to an enthusiastic cadre of technical divers. Each day will include lectures and boat dives organized by the Ponza Diving Center. Space is limited. For more information visit: www.ponzadiving.com or info@ponzadiving.com.

UMC Level 2 Advanced Diving Medicine Course

Undersea Medicine Canada is offering a CSA Z275 Level 2 'Advanced Course in Diving Medicine: Diagnosis and Treatment.' This 6-day course will be held May 20-25, 2024 at the Atlantic Commercial Diving Centre in Summerside, PEI. Augmenting classroom instruction and case-based learning, site visits will allow observation of commercial diver training, diving, and hyperbaric chamber operations. A CSA Z275.2-15 Level 1 course or equivalent training is a prerequisite for this 45-h program. Find more information at <https://underseamedicine.ca> or contact Dr. Debbie Pestell at drdebl@ns.sympatico.ca or 902-225-8214.

UHMS Annual Scientific Meeting

The annual scientific meeting of the Undersea and Hyperbaric Medical Association will be held June 12-15, 2024 in French Quarter of New Orleans. Visit: <https://www.uhms.org/education/annual-scientific-meeting/asm-registration.html#read-bio>.

RECENT PUBLICATIONS

Castellani MP, Rioux TP, Castellani JW, Reed MD, Whalen S, Cisternelli M, Python G, Lewandowski MJ, Xu X. Validation of a human thermoregulatory model during prolonged immersion in warm water. *Comput Biol Med.* 2023;167:107575. doi: 10.1016/j.compbio.2023.107575. Epub 2023 Oct 12.

This study validates the Six Cylinder Thermoregulatory Model (SCTM) during prolonged warm water immersion, which underpins the Probability of Survival Decision Aid (PSDA) currently in use by the United States Coast Guard (USCG). PSDA predicts survival time for hypothermia and dehydration. USCG has been using PSDA for search and rescue operation since 2010. In 2019, USCG organized a workshop to review PSDA performance and concluded that PSDA is an essential tool for operation, although it occasionally overestimates survival times in warm waters above 16°C. Forty-six human subjects were immersed from the neck down in 18, 22, and 26°C water for 45 min up to 10 h. Rectal temperature (T_{core}), 10-site mean skin temperature (T_{sk}), and water loss were measured. At the end of immersion, T_{core} ranged from 35.2 to 38.0°C, and T_{sk} ranged from 19.7 to 27.4°C. The SCTM-predicted T_{core} , T_{sk} and water loss were compared to the measured values. Root mean squared deviation (RMSD) was used to test for acceptable predictions. T_{core} RMSDs were 0.2, 0.14, and 0.3°C in 18, 22, and 26°C water respectively. T_{sk} RMSDs were 1.44, 0.76, and 1.1°C in 18, 22, and 26°C water respectively. SCTM underpredicted water loss by 84%. Overall, SCTM predicted T_{core} and T_{sk} with acceptable accuracy in 18 and 22°C water for up to 10 h, but overpredicted in 26°C water. Future studies and algorithm development are required to improve water loss prediction as well as T_{core} and T_{sk} prediction in 26°C water.

Eker A, Celik S, Ozer EE, Basmacı I, Sefik E, Bozkurt IH, Gunlusoy B, Degirmenci T. Comparison of the effect of hyperbaric oxygen therapy and tadalafil daily use on erectile function: a prospective, double controlled study. *Int Urol Nephrol.* 2023 Nov 1. doi: 10.1007/s11255-023-03852-2. Online ahead of print.

Purpose: Erectile dysfunction (ED) is a worldwide health problem. Oral phosphodiesterase type 5 inhibitors (PDE5I) are used in its first-line treatment. This study aimed to compare the effects of hyperbaric oxygen (HBO) treatment with PDE5I treatment and determine the patient-dependent factors affecting the efficacy of the HBO treatment and duration of action of HBO treatment. Methods: Adult male patients who presented to the HBO unit for HBO treatment with non-urological indications and had ED based on the International Index for Erectile Function (IIEF-5) constituted the target population of this study. Participants were given HBO treatment (Group 1), no treatment (Group 2), or daily oral tadalafil 5 mg treatment (Group 3). The treatment duration was 1 month. Patients were assessed by

IIEF-5 both initially and after the completion of 1 month. Results: There were significant increases in the mean IIEF-5 scores of the patients in Group 1 and Group 3 ($p<0.001$, $p<0.001$). However, there was no significant improvement in Group 2 ($p=0.496$). Also, the post-treatment IIEF-5 scores of Group 1 and Group 3 were significantly higher than Group 2 ($p<0.001$). There was no significant difference between the IIEF-5 scores and Δ IIEF-5 values of Group 1 and Group 3 ($p=0.166$, $p=0.093$). Evaluation regarding comorbidities revealed that patients with the peripheral vascular disease did not improve with HBO treatment ($p=0.285$). Conclusion: HBO can improve erectile functions, and it can be a reasonable alternative for patients who cannot use PDE5Is due to comorbidities or treatment side effects.

Lee A, Katznelson R, Ouzounian M, Au D, Chung J, Djaiani G, Lindsay T. Adjunctive hyperbaric oxygen therapy for spinal cord ischemia after complex aortic repair. *J Vasc Surg.* 2023 Nov 2:S0741-5214(23)02187-0. doi: 10.1016/j.jvs.2023.10.055. Online ahead of print.

Introduction: Spinal cord ischemia (SCI) with paraplegia or paraparesis is a devastating complication of complex aortic repair (CAR). Treatment includes cerebrospinal fluid drainage, maintenance of hemoglobin concentration (>10 g/L) and elevating mean arterial blood pressure. Animal and human case series have reported improvements in SCI outcomes with hyperbaric oxygen therapy (HBOT). We reviewed our center's experience with HBOT as a rescue treatment for spinal cord ischemia post-CAR in addition to standard treatment. Methods: A retrospective review of the UHN's Hyperbaric Medicine Unit treatment database identified HBOT sessions for patients with SCI post-CAR between January 2013 and June 2021. Mean estimates of overall motor function scores were determined for post-operative, pre-HBOT, post-HBOT (within 4 hours of the final HBOT session) and at the final assessment (last available in-hospital evaluation) using a linear mixed model. A subgroup analysis compared the mean estimates of overall motor function scores between improvement and non-improvement groups at given timepoints. Improvement of motor function was defined as either a >2 point increase in overall muscle function score in patients with paraparesis or an upward change in motor deficit categorization (MDC: para/monoplegia, paraparesis and no deficit). Subgroup analysis was performed by stratifying by improvement or non-improvement of motor function from pre-HBOT to final evaluation. Results: Thirty patients were treated for SCI. Pre-HBOT, the MDC was 10 paraplegia, 3 monoplegia, 16 paraparesis and 1 unable to assess. At the final assessment, 14 patients demonstrated variable degrees of motor function improvement; eight patients demonstrated full motor function recovery. Seven of the ten patients with paraplegia remained paraplegic despite HBOT. The estimated mean of overall muscle function score for pre-HBOT was 16.6 ± 2.9 (95%CI: 10.9,

22.3) and for final assessment was 23.4±2.9 (95%CI: 17.7, 29.1). The estimated mean difference between pre-HBOT and final assessment overall muscle function score was 6.7±3.1 (95%CI: 0.6, 16.1). The estimated mean difference of the overall muscle function score between pre-HBOT and final assessment for the improved group was 16.6±3.5 (95%CI: 7.5, 25.7) vs. -4.9±4.2 (95%CI: -16.0, 6.2) for the non-improved group. Conclusion: HBOT, in addition to standard treatment, may potentially improve recovery in spinal cord function following SCI post-CAR. However, the potential benefits of HBOT are not equally distributed amongst subgroups.

Rezentes C, Scott C. Pulmonary barotrauma after diving without breathing equipment. Cureus. 2023 Oct 20;15(10):e47382. doi: 10.7759/cureus.47382. eCollection 2023 Oct.

A case of a 19-year-old male with mediastinal and subcutaneous emphysema consistent with pulmonary barotrauma after diving is reported. He presented with facial swelling, voice change, chest pain, and shortness of breath after multiple dives between 8 and 12 feet deep without underwater breathing equipment in a river. Relevant radiology, including radiographs and computed tomography (CT imaging), and a discussion of pulmonary barotrauma are presented.

van Riel L, van Hulst RA, van Hest L, van Moorselaar R, Boerrigter BG, Franken SM, Wolthuis R, Dubbink HJ, Marciniak SJ, Gupta N, van de Beek I, Houweling AC. Recommendations on scuba diving in Birt-Hogg-Dubé syndrome. Expert Rev Respir Med. 2023 Nov 22;1-6. doi: 10.1080/17476348.2023.2284375.

Introduction: Although very uncommon, severe injury and death can occur during scuba diving. One of the main causes of scuba diving fatalities is pulmonary barotrauma due to significant changes in ambient pressure. Pathology of the lung parenchyma, such as cystic lesions, might increase the risk of pulmonary barotrauma. Areas covered: Birt-Hogg-Dubé syndrome (BHD), caused by pathogenic variants in the FLCN gene, is characterized by skin fibrofolliculomas, an increased risk of renal cell carcinoma, multiple lung cysts and spontaneous pneumothorax. Given the pulmonary involvement, in some countries patients with BHD are generally recommended to avoid scuba diving, although evidence-based guidelines are lacking. We aim to provide recommendations on scuba diving for patients with BHD, based on a survey of literature on pulmonary cysts and pulmonary barotrauma in scuba diving. Expert opinion: In our opinion, although the absolute risks are likely to be low, caution is warranted. Given the relative paucity of literature and the potential fatal outcome, patients with BHD with a strong desire for scuba diving should be informed of the potential risks in a personal assessment. If available a diving physician should be consulted, and a low radiation dose chest computed

tomography (CT)-scan to assess pulmonary lesions could be considered.

Vinkel J, Rib L, Buil A, Hedetoft M, Hyldegaard O. Key pathways and genes that are altered during treatment with hyperbaric oxygen in patients with sepsis due to necrotizing soft tissue infection (HBOmic study). Eur J Med Res. 2023 Nov 10;28(1):507. doi: 10.1186/s40001-023-01466-z

Background: For decades, the basic treatment strategies of necrotizing soft tissue infections (NSTI) have remained unchanged, primarily relying on aggressive surgical removal of infected tissue, broad-spectrum antibiotics, and supportive intensive care. One treatment strategy that has been proposed as an adjunctive measure to improve patient outcomes is hyperbaric oxygen (HBO₂) treatment. HBO₂ treatment has been linked to several immune modulatory effects; however, investigating these effects is complicated due to the disease's acute life-threatening nature, metabolic and cell homeostasis dependent variability in treatment effects, and heterogeneity with respect to both patient characteristics and involved pathogens. To embrace this complexity, we aimed to explore the underlying biological mechanisms of HBO₂ treatment in patients with NSTI on the gene expression level. Methods: We conducted an observational cohort study on prospective collected data, including 85 patients admitted to the intensive care unit (ICU) for NSTI. All patients were treated with one or two HBO₂ treatments and had one blood sample taken before and after the intervention. Total RNAs from blood samples were extracted and mRNA purified with rRNA depletion, followed by whole-transcriptome RNA sequencing with a targeted sequencing depth of 20 million reads. A model for differentially expressed genes (DEGs) was fitted, and the functional aspects of the obtained set of genes was predicted with GO (Gene Ontology) and KEGG (Kyoto Encyclopedia of genes and Genomes) enrichment analyses. All analyses were corrected for multiple testing with FDR. Results: After sequential steps of quality control, a final of 160 biological replicates were included in the present study. We found 394 protein coding genes that were significantly DEGs between the two conditions with FDR <0.01, of which 205 were upregulated and 189 were downregulated. The enrichment analysis of these DEGs revealed 20 GO terms in biological processes and 12 KEGG pathways that were significantly overrepresented in the upregulated DEGs, of which the term; "adaptive immune response"(GO:0002250) (FDR=9.88E-13) and "T cell receptor signaling pathway" (hsa04660) (FDR=1.20E-07) were the most significant. Among the downregulated DEGs two biological processes were significantly enriched, of which the GO term "apoptotic process" (GO:0006915) was the most significant (FDR=0.001), followed by "Positive regulation of T helper 1 cell cytokine production" (GO:2000556), and "NF-kappa B signaling pathway" (hsa04064) was the only KEGG pathway that

was significantly overrepresented (FDR=0.001). Conclusions: When one or two sessions of HBO₂ treatment were administered to patients with a dysregulated immune response and systemic inflammation due to NSTI, the important genes that were regulated during the intervention were involved in activation of T helper cells and downregulation of the disease-induced highly inflammatory pathway NF-κB, which was associated with a decrease in the mRNA level of pro-inflammatory factors. Trial registration: Biological material was collected during the INFECT study, registered at ClinicalTrials.gov (NCT01790698).

Wolff D, Castagna O, Morin J, Lehot H, Roffi R, Druelle A, Blatteau JÉ. Characterizing immersion pulmonary edema (IPE): a comparative study of military and recreational divers. Sports Med Open. 2023 Nov 18;9(1):108. doi: 10.1186/s40798-023-00659-4.

Background: Immersion pulmonary edema (IPE) is a common and potentially serious diving accident that can have significant respiratory and cardiac consequences and, in some cases, be fatal. Our objective was to characterize cases of IPE among military trainees and recreational divers and to associate their occurrence with exposure and individual background factors such as age and comorbidity. We conducted a retrospective analysis on the medical records and diving parameters of all patients who were treated for IPE at the Hyperbaric Medicine Department of Sainte-Anne Military Hospital in Toulon, France, between January 2017 and August 2019. In total, 57 subjects were included in this study, with ages ranging from 20 to 62 years. These subjects were divided into two distinct groups based on exposure categories: (1) underwater/surface military training and (2) recreational scuba diving. The first group consisted of 14 individuals (25%) with a mean age of 26.5±2.6 years; while, the second group comprised 43 individuals (75%) with a mean age of 51.2±7.5 years. All divers under the age of 40 were military divers. Results: In 40% of cases, IPE occurred following intense physical exercise. However, this association was observed in only 26% of recreational divers, compared to 86% of military divers. Among civilian recreational divers, no cases of IPE were observed in subjects under the age of 40. The intensity of symptoms was similar between the two groups, but the duration of hospitalization was significantly longer for the recreational subjects. Conclusion: It seems that the occurrence of IPE in young and healthy individuals requires their engagement in vigorous physical activity. Additionally, exposure to significant ventilatory constraints is a contributing factor, with the intensity of these conditions seemingly exclusive to military diving environments. In contrast, among civilian recreational divers, IPE tends to occur in subjects with an average age twice that of military divers. Moreover, these individuals exhibit more prominent

comorbidity factors, and the average level of environmental stressors is comparatively lower.

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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