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

E-NEWS

EDITOR'S NOTE – June 2020

The E-News is the monthly newsletter of CUHMA, our primary outlet to share news and information. We invite relevant content, including news/announcements, upcoming events, new publication abstracts, job postings, professional perspectives, incident reports, and images of relevant professional scenes. Please feel free to share the publication with interested colleagues. Past issues are available at https://cuhma.ca.

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NEWS/ANNOUNCEMENTS

COVID-19 and Diving Medicine

The COVID-19 pandemic has affected many diving and hyperbaric medicine conferences and courses. Both the CUHMA annual scientific meeting and the fall Undersea Medicine Canada course have been cancelled for 2020.

UPCOMING EVENTS

UHN Introductory Hyperbaric Medicine Course

The University Health Network, Toronto General Hospital, course runs November 24-28. The program is suitable for physicians and other health professionals looking to become CHT certified or obtain Level 1 certification. It is accredited by the Undersea and Hyperbaric Medical Society for 40 CME credits, and by the National Board of Diving and Hyperbaric Medical Technology for 40 CME credits. For more information and registration:
https://www.uhn.ca/Surgery/Treatments_Procedures/Hyperbaric_Medicine_Unit#tab4

RECENT PUBLICATIONS

Boet S, Martin L, Cheng-Boivin O, Etherington N, Louge P, Pignel R, Pellégrini M, Magnan MA, Bennett M. Can preventive hyperbaric oxygen therapy optimise surgical outcome?: a systematic review of randomised controlled trials. Eur J Anaesthesiol. 2020 Apr 29.

Background: A primary underlying cause of postoperative complications is related to the surgical stress response, which may be mitigated by hyperbaric oxygen therapy (HBOT), the intermittent administration of oxygen at a pressure higher than the atmospheric pressure at sea level. Promising clinical studies have emerged suggesting HBOT's efficacy for reducing some postoperative complications. Notwithstanding, the effectiveness (if any) of HBOT across a range of procedures and postoperative outcomes has yet to be clearly quantified. Objective: This systematic review aimed to summarise the existing literature on peri-operative HBOT to investigate its potential to optimise surgical patient outcome. Design: A systematic review of randomised controlled trials (RCTs) with narrative summary of results. Data sources: MEDLINE, EMBASE, CINAHL and the Cochrane Central Register of Controlled Trials were searched without language restrictions through to 19 June 2018. Eligibility criteria: Studies were included if they involved patients of any age undergoing any surgical procedure and provided with at least one HBOT session in the peri-operative period. Two independent reviewers screened the initial identified trials and determined those to be included. Risk of bias was assessed using the Cochrane Risk of Bias tool for RCTs. Results: The search retrieved 775 references, of which 13 RCTs were included (627 patients). Ten RCTs (546 patients) reported treatment was effective for improving at least one of the patient outcomes assessed, while two studies (55 patients) did not find any benefit and one study (26 patients) found a negative effect. A wide range of patient outcomes were reported, and several other methodological limitations were observed among the included studies, such as limited use of sham comparator and lack of blinding. Conclusion: Peri-operative preventive HBOT may be a promising intervention to improve surgical patient outcome. However, future work should consider addressing the methodological weaknesses identified in this review.

Corbier C, Chouchou F, Roche F, Barthélémy JC, Pichot V. Causal analyses to study autonomic regulation during acute head-out water immersion, head-down tilt and supine position. Exp Physiol. 2020 May 21. doi: 10.1113/EP088640. Online ahead of print.

Thermoneutral head-out water immersion (WI) and 6° head-down tilt (HDT) are used to simulate scuba diving, swimming and microgravity because these models induce an increase in central blood volume. Standard methods to analyze autonomic regulations have shown increase in parasympathetic activity and baroreflex sensitivity during these experimental conditions. However, such methods are not adapted to quantify all close-loop interactions involved by respiratory and cardiovascular regulations. To overcome this limitation, we used Granger causality analysis between RR intervals (RR), systolic blood pressure (SBP), and respiration (RE) in eight young healthy subjects, recorded during 30-minute periods, in supine position, WI and HDT. For all experimental conditions, we found a bidirectional causal relationship between RE and RR and between RR and SBP, with a dominant direction from RR to SBP, and an unidirectional causality from RE to SBP. These causal relationships remained unchanged for the three experimental tests. Interestingly, there was a lower causal relationship from RR to RE during WI compared to HDT. This causal link from RR to RE could be modulated by peripheral resistances. These results highlight differences in cardiovascular regulations during WI and HDT, and confirm that Granger causality may reveal physiological mechanisms not accessible with standard methods.

Elia A, Barlow MJ, Wilson OJ, O'Hara JP. Splenic responses to a series of repeated maximal static and dynamic apnoeas with whole body immersion in water. Exp Physiol. 2020 May 18. doi: 10.1113/EP088404. [Epub ahead of print]

Splenic contractions occur in response to apnoea-induced hypoxia with and without facial water immersion. However, the splenic responses to a series of static or dynamic apnoeas with whole body water immersion in non-divers (ND) and elite breath-hold divers (EBHD) are unknown. Methods EBHD (n=8), ND (n=10) and control (n=8) participants were recruited. EBHD and ND performed a series of five maximal DYN or STA apnoeas on separate occasions. Control performed a static eupnoeic (STE) protocol to control against any effects of water immersion and diurnal variation on splenic volume and haematology. Heart rate (HR) and peripheral oxygen saturation (SpO_2) were monitored within 30s after each apnoea. Pre- and post-apnoeic splenic volumes were quantified ultrasonically, and blood samples were drawn for haematology. Results EBHD and ND end-apnoeic HR was higher ($p<0.001$) and SpO_2 was lower in DYN ($p=0.024$) versus STA. EBHD attained lower end-apnoeic SpO_2 during DYN and STA than ND ($p<0.001$). Splenic contractions occurred following DYN (EBHD,-47±6%;ND,-37±4%,$p<0.001$) and STA (EBHD,-26±4%;ND,-26±8%,$p<0.01$). DYN-associated splenic contractions were greater than STA in EBHD only ($p=0.042$). Haemoglobin was greater following DYN only (EBHD, +5±8 g/L, +4±2%; ND, +8±3 g/L, +4.9±3%, $p=0.019$). Haematocrit remained unchanged after each protocol. There were no between group differences in post-apnoeic splenic volume or haematology. Conclusions In both groups, splenic contractions occurred in response to STA and DYN when combined with whole body immersion. DYN apnoeas were effective at increasing haemoglobin concentration but not STA apnoeas. Thus, the magnitude of the splenic response relates to the hypoxemic stress encountered during apnoeic epochs.

Hall C, Bukowinski AT, Jewell JA, Conlin AMS. Infant health outcomes among offspring of male US military divers. Arch Environ Occup Health. 2020 May 7;1-4.

While there are suggestions that the extreme hyperbaric conditions encountered during deep saturation diving may impact male reproductive function, few studies have investigated whether paternal occupational diving influences offspring health outcomes. To examine this, Department of Defense Birth and Infant Health Research program data were used to identify the offspring of male active duty divers and non-divers in the US military, 2001-2016. Log-binomial regression models estimated associations with infant outcomes (eg, major structural birth defects, low birthweight). Among 1,148,252 identified singleton infants, 3,843 were considered the offspring of male divers; paternal occupational diving was not positively associated with any adverse infant outcome under study. These findings corroborate existing literature and further suggest that male divers in the US military are not occupationally exposed to reproductive hazards that adversely influence offspring infant health outcomes.

Khademi E, Mahabadi VP, Ahmadvand H, Akbari E, Khalatbary AR. Anti-inflammatory and anti-apoptotic effects of hyperbaric oxygen preconditioning in a rat model of cisplatin-induced peripheral neuropathy. Iran J Basic Med Sci. 2020;23(3):321-8.

Objectives: Cisplatin-induced peripheral neuropathy is a debilitating side effect in patients receiving this drug. Recent studies suggest hyperbaric oxygen (HBO) therapy as a new treatment approach for models of neural injury. The aim of the current study was to determine the protective effects of HBO preconditioning against peripheral neuropathy induced by Cisplatin (CDDP). Materials and methods: The present study was conducted on 4 groups of rats: Sham group; HBO group (60 min/d); Control group (CDDP 2 mg/kg/d); Precondition group (HBO+CDDP). Mechanical threshold testing was weekly carried out using von Frey filament. Sciatic nerve and associated ganglia were removed five weeks after the first

CDDP injection for biochemical evaluation of malondialdehyde (MDA) content and myeloperoxidase (MPO) activity, immunohistochemistry of terminal deoxynucleotidyl transferase dUTP nick end labeling (TUNEL), TNF-α, caspase-3 and iNOS, and transmission electron microscopic (TEM) assessments. Results: MDA levels and MPO activities were significantly decreased in preconditioned rats. Attenuated TUNEL reaction along with attenuated caspase-3, TNF-α, and iNOS expression could be significantly detected in preconditioned rats. Also, HBO preconditioning improved the nociceptive threshold. Conclusion: The results suggest that HBO preconditioning can attenuate peripheral neuropathy caused by cisplatin in rats.

Lee DW, Jung SJ, Ju JS. The effects of heliox non-saturation diving on the cardiovascular system and cognitive functions. Undersea Hyperb Med. 2020; 47(1):93-100.

The purpose of this study was to investigate the effects of a single bout of heliox non-saturation diving on the cardiovascular system and cognitive function. Ten recreational scuba divers (10 males, ~35 years old) participated in this study. These subjects made two pool dives within a one-week interval, alternating gases with compressed air (21% O_2, 79% N_2) and with heliox (21% O_2 and 79% He). The depth was to 26 meters over a 20-minute duration. The results showed that heliox diving significantly increased blood O_2 saturation by 1.15% and significantly decreased blood lactate levels by ~57% when compared with air diving ($P<0.05$). However, there were no significant differences in resting heart rate, systolic or diastolic pressure, core body blood pressure, and pulse wave velocity between the heliox and air dives. The Stroop test showed that the heliox dive significantly increased cognitive function compared with the air dive in both the simple test (Offtime) and interference test (Ontime) ($P<0.05$). It was concluded that the heliox dive increases blood O_2 saturation and decreases blood lactate concentration when compared with air dives. These conditions are likely to help divers reduce hypoxia in the water, reduce the risk of loss of consciousness, reduce fatigue and allow them to dive for longer. Heliox diving may also help judgment and risk coping skills in the water due to the improvement of cognitive ability as compared to air breathing dives.

Moore L, Eggleton P, Smerdon G, Newcombe J, Holley JE, Gutowski NJ Smallwood M. Engagement of people with multiple sclerosis to enhance research into the physiological effect of hyperbaric oxygen therapy. Mult Scler Relat Disord. 2020 Apr 29;43:102084. doi: 10.1016/j.msard.2020.102084. Online ahead of print.

Background: Thousands of people with multiple sclerosis (MS) have used self-administered oxygen therapy in the UK. Clinical trials have been performed, with scant evidence that people with MS have been consulted to explore how they benefit from or how to optimize this treatment. The conventional MS disease disability scores used in trials seldom reflect the effects individuals report when using oxygen therapy to treat their symptoms. Methods: Three people with MS and the manager of an MS Centre formed a public involvement group and collaborated with clinicians and scientists to inform a lab-based study to investigate the physiological effects of oxygen therapy on microvascular brain endothelial cells. Results: People with MS often use oxygen therapy at a later stage when their symptoms worsen and only after using other treatments. The frequency of oxygen therapy sessions and hyperbaric pressure is individualized and varies for people with MS. Despite direct comparisons of efficacy proving difficult, most individuals are exposed to 100% O_2 at 1.5 atmosphere absolute (ATA; 1140 mmHg absolute) for 60 min. In a laboratory-based study human brain endothelial cells were exposed in vitro to 152 mmHg O_2 for 60 min with and without pressure, as this equates to 20% O_2 achievable via hyperbarics, which was then replicated at atmospheric pressure. A significant reduction in endothelial cells ICAM-1 (CD54) implicated in inflammatory cell margination across the blood brain barrier was observed under oxygen treatment. Conclusions: By collaborating with people living with MS, we were able to design laboratory-based experimental protocols that replicate their treatment regimens to advance our understanding of the physiological effects of hyperbaric oxygen treatment on brain cells and their role in neuroinflammation.

Öztürk Ö, Bozkurt Z. The surgical management of recurrent acute and chronic barosinusitis in sports self-contained underwater breathing apparatus (scuba) divers. Eur Arch Otorhinolaryngol. 2020 May 14. doi: 10.1007/s00405-020-06034-3. [Epub ahead of print]

PURPOSE: The aim of this retrospective study is to evaluate the feasibility of functional endoscopic sinus surgery (FESS) with supplementary surgical procedures in scuba divers with recurrent acute barosinusitis (RABS) and chronic barosinusitis (CBS). METHODS: In this retrospective study, 25 divers were classified into RABS (n:11) and CBS (n:14) groups. The presentation of divers have been reviewed. The PNS CT images were scored according to Lund-Mackay (L-M) system. A score has been assigned to the extent of endoscopic procedures performed. The outcome of surgery and life quality were determined by SNOT-22 and dive-related questions (DRQ) tests. RESULTS: The average L-M score was 3.8±2 for RABS and 12.2±3.4 for CBS groups. L-M score of CBS group was found to be statistically higher than RBS group ($p<0.05$). The FESS score of CBS group (8.7±2.4) was higher than RABS group (5.6±2) which showed that the endoscopic sinus procedures were performed more extensively in CBS group ($p<0.05$). The

difference between the preoperative and postoperative SNOT-22 scores indicates that the degree of sinus symptoms improved better in RABS group than CBS group ($p<0.05$). When DRQ test was evaluated, RABS group showed a better improvement in diving performance symptoms than the CBS group ($p<0.05$). CONCLUSION: Our study demonstrated that divers with RABS and CBS can be managed successfully with FESS and supplementary surgical procedures. The improvement in the RABS group was superior to the CBS group, a difference attributed to the severity of chronic inflammation in CBS.

Takemura A, Pajevic PD, Egawa T, Teshigawara R, Hayashi T, Ishihara A. Effects of mild hyperbaric oxygen on osteoporosis induced by hindlimb unloading in rats. J Bone Miner Metab. 2020 Apr 29.

Introduction: Disuse-induced bone loss is caused by a suppression of osteoblastic bone formation and an increase in osteoclastic bone resorption. There are few data available for the effects of environmental conditions, i.e., atmospheric pressure and/or oxygen concentration, on osteoporosis. This study examined the effects of mild hyperbaric oxygen at 1317 hPa with 40% oxygen on unloading-induced osteoporosis. Materials and Methods: Eighteen 8-week old male Wistar rats were randomly divided into three groups: the control for 21 days without unloading and mild hyperbaric oxygen (NOR, n=6), the unloading for 21 days and recovery for 10 days without mild hyperbaric oxygen (HU+NOR, n=6), and the unloading for 21 days and recovery for 10 days with mild hyperbaric oxygen (HU+MHO, n=6). Results: The cortical thickness and trabecular bone surface area were decreased in the HU+NOR group compared to the NOR group. There were no differences between the NOR and HU+MHO groups. Osteoclast surface area and Sclerostin (Sost) mRNA expression levels were decreased in the HU+MHO group compared to the HU+NOR group. These results suggested that the loss of the cortical and trabecular bone is inhibited by mild hyperbaric oxygen, because of an inhibition of osteoclasts and enhancement of bone formation with decreased Sost expression. Conclusions: We conclude that exposure to mild hyperbaric oxygen partially protects from the osteoporosis induced by hindlimb unloading.

Tan TXZ, Yunkai A, Sng JJ, Lim M, Tan ZX, Ang HX, Ho BH, Zhiwei D, Hsu AAL. A diver's dilemma - a case report on bronchopulmonary sequestration. BMC Pulm Med. 2020 May 4;20(1):121.

Background: An asymptomatic scuba (self-contained underwater breathing apparatus) diver was discovered to have an intralobar bronchopulmonary sequestration during routine pre-course screening. This is the first reported case of a diver who, having previously completed several recreational and military diving courses, was subsequently diagnosed with a congenital lung condition, possibly contraindicating diving. Presently, there is no available literature providing guidance on the diving fitness of patients with such a condition. Case presentation: An asymptomatic 26-year-old male diver was nominated to attend an overseas naval diving course. Prior to this, he had been medically certified to participate in, and had successfully completed other military and recreational diving courses. He had also completed several hyperbaric dives up to a depth of 50 m and 45 recreational dives up to a depth of 30 m. He did not have a history of diving-related injuries or complications. He had never smoked and did not have any medical or congenital conditions, specifically recurrent respiratory infections. As part of pre-course screening requirements, a lateral Chest X-ray was performed, which revealed a left lower lobe pulmonary nodule. This was subsequently diagnosed as a cavitatory left lower lobe intralobar bronchopulmonary sequestration on Computed Tomography Thorax. The diver remains asymptomatic and well at the time of writing and has been accepted to participate in another overseas course involving only dry diving in a hyperbaric chamber, with no prerequisites for him to undergo surgery. Conclusion: Although bronchopulmonary sequestrations lack communication with the tracheobronchial tree, they may still contain pockets of air, even if not radiologically visible. This can be attributed to anomalous connections which link them to other bronchi, lung parenchyma and/or pores of Kohn. As such, there is a higher theoretical risk of pulmonary barotrauma during diving, leading to pneumothorax, pneumomediastinum, or cerebral arterial gas embolism. Taking these into consideration, the current clinical consensus is that bronchopulmonary sequestrations and all other air-containing lung parenchymal lesions should be regarded as contraindications to diving. Patients who have undergone definitive and uncomplicated surgical resection may be considered fit to dive.

Thibodeaux K, Speyrer M, Raza A, Yaakov R, Serena TE. Hyperbaric oxygen therapy in preventing mechanical ventilation in COVID-19 patients: a retrospective case series. J Wound Care. 2020 May 1;29(Sup5a):S4-8. doi: 10.12968/jowc.2020.29.Sup5a.S4.

OBJECTIVE: A pandemic afflicts the entire world. The highly contagious SARS-CoV-2 virus originated in Wuhan, China in late 2019 and rapidly spread across the entire globe. According to the World Health Organization (WHO), the novel Coronavirus (COVID-19)has infected more than two million people worldwide, causing over 160,000 deaths. Patients with COVID-19 disease present with a wide array of symptoms, ranging from mild flu-like complaints to life threatening pulmonary and cardiac complications. Older people and patients with underlying disease have an increased risk of developing severe acute respiratory syndrome (SARS) requiring mechanical

ventilation. Once intubated, mortality increases exponentially. A number of pharmacologic regimens, including hydroxychloroquine-azithromycin, antiviral therapy (eg, remdesevir), and anti-IL-6 agents (e.g., toclizumab), have been highlighted by investigators over the course of the pandemic, based on the therapy's potential to interrupt the viral life-cycle of SARS-CoV-2 or preventing cytokine storm. At present, there have been no conclusive series of reproducible randomised clinical trials demonstrating the efficacy of any one drug or therapy for COVID-19. CASES: COVID-19 positive patients (n=5) at a single institution received hyperbaric oxygen therapy (HBOT) between 13 and 20 April 2020. All the patients had tachypnoea and low oxygen saturation despite receiving high F_IO_2. HBOT was added to prevent the need for mechanical ventilation. A standard dive profile of 2.0ATA for 90 minutes was employed. Patients received between one and six treatments in one of two dedicated monoplace hyperbaric chambers. RESULTS: All the patients recovered without the need for mechanical ventilation. Following HBOT, oxygen saturation increased, tachypnoea resolved and inflammatory markers fell. At the time of writing, three of the five patients have been discharged from the hospital and two remain in stable condition. CONCLUSION: This small sample of patients exhibited dramatic improvement with HBOT. Most importantly, HBOT potentially prevented the need for mechanical ventilation. Larger studies are likely to define the role of HBOT in the treatment of this novel disease.

Yücel A, Özbuğday Y. Comparison of steroid treatment with and without hyperbaric oxygen therapy for idiopathic sudden sensorineural hearing loss. J Audiol Otol. 2020 May 14. doi: 10.7874/jao.2019.00486. Online ahead of print.

Background and objectives: In this study, we compared the outcomes of patients with idiopathic sudden sensorineural hearing loss who underwent steroid treatment with or without hyperbaric oxygen (HBO) therapy and were followed-up in our clinic. Subjects and methods: Patients were divided into two groups according to their treatment regimen. Steroid group received intravenous 1 mg/kg methylprednisolone which was due to be completed in 2-3 weeks with decreasing doses, and five doses of 0.5 mL intratympanic dexamethasone. Steroid+HBO group received the same steroid treatment with the addition of HBO therapy. The audiologic results of both treatment groups were compared after considering the patients' risk factors. Results: There was no significant difference between the steroid and Steroid+HBO groups in terms of hearing gain and degree of recovery, both at all degrees of hearing loss, and in severe and profound hearing loss. Hearing gain was similar when evaluated by audiogram type and admission time in both treatment groups. Conclusions: We found that the addition of HBO therapy to systemic plus intratympanic steroid treatment did not affect hearing gain at all degrees of hearing loss in this study. Furthermore, audiogram type and admission time did not affect hearing gain between the two groups.

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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