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

E-NEWS

EDITOR'S NOTE – August 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.

Neal W. Pollock, PhD
Université Laval

NEWS/ANNOUNCEMENTS

Personal Decompression Monitoring

Decompression monitoring is important for many divers, with the long goal being tools to assess real-time individual physiological status and risk. We are nowhere close to that point, but those engaged in diving or interacting with divers may want to learn more about a new and optimistically marketed device. It incorporates dive profile data and limited self-captured ultrasonic assessment to generate an automated cloud-based interpretation. A critical read of a recent overview is a good start to understanding the device:
Menduno M. Oh Deco, Oh Doppler, O'Dive: assessing the world's first personal deco safety tool. InDepth. Posted July 14, 2020.
https://gue.com/blog/oh-deco-oh-doppler-odive-assessing-the-worlds-first-personal-decompression-safety-tool/

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

Caldwell HG, Hoiland RL, Barak OF, Mijacika T, Burma JS, Dujić Z, Ainslie PN. Alterations in resting cerebrovascular regulation do not affect reactivity to hypoxia, hyperoxia, or neurovascular coupling following a scuba dive. Exp Physiol. 2020 Jul 3. doi: 10.1113/EP088746. Online ahead of print.

Reductions in vascular function during a scuba dive - due to hyperoxia-induced oxidative stress, arterial and venous gas emboli, and altered endothelial integrity - may also extend to the cerebrovasculature following return to the surface. This study aimed to characterize cerebral blood flow (CBF) regulation following a single scuba dive to a depth of 18 m sea water with a 47-minute bottom time. Prior to and following the dive, participants (n=11) completed: 1) resting CBF in the internal carotid (ICA) and vertebral (VA) arteries (Duplex ultrasound) and intracranial blood velocity (v) of the middle and posterior cerebral arteries (MCAv and PCAv, respectively) (transcranial Doppler ultrasound); 2) cerebrovascular reactivity to acute poikilocapnic hypoxia (i.e., F_IO_2, 0.10) and hyperoxia (i.e., F_IO_2, 1.0); and 3) neurovascular coupling (NVC; regional CBF response to local increases in cerebral metabolism). Global CBF, cerebrovascular reactivity to hypoxia and hyperoxia, and NVC were unaltered following a scuba dive (all $P>0.05$); however, there were subtle changes in other cerebrovascular metrics post-dive, including; reductions in ICA (-13 ± 8%, $P=0.003$) and VA (-11 ± 14%, $P=0.021$) shear rate, lower ICAv (-10 ± 9%, $P=0.008$) and VAv (-9 ± 14%, $P=0.028$), increases in ICA diameter (+4 ± 5%, $P=0.017$), and elevations in PCAv (+10 ± 19%, $P=0.047$). Although we observed subtle alterations in CBF regulation at rest, these changes did not translate into any functional changes in cerebrovascular reactivity to hypoxia or hyperoxia, or NVC. Whether prolonged exposure to hyperoxia and hyperbaria during longer, deeper, colder, and/or repetitive scuba dives would provoke changes to the cerebrovasculature requires further investigation.

Harl MJ. Defining the role of hyperbaric oxygen therapy as an adjunct to reconstructive surgery. Surg Clin North Am. 2020;100(4):777-85.

The discipline of reconstructive surgery has been slow to accept the role of hyperbaric oxygen therapy (HBOT) as an adjunct to surgery, despite clinical and experimental

data showing potential benefits. Obstacles prevent this acceptance; one of the most potent is surgeon bias. This article attempts to lessen this bias by reviewing the benefits of HBOT in conditions where there is uniform acceptance of its role, such as carbon monoxide poisoning and decompression illness. It demonstrates that these conditions have similar pathophysiologic derangements to conditions commonly encountered by the reconstructive/wound care surgeon, including crush injuries, compartment syndrome, compromised flaps, and thermal burns.

Hess H, Hostler D, Clemency BM, Johnson BD. Carotid body chemosensitivity at 1.6 ATA breathing air versus 100% oxygen. J Appl Physiol. 2020 Jun 25. doi: 10.1152/japplphysiol.00275.2020. Online ahead of print.

Hyperoxia reduces the ventilatory response to hypercapnia by suppressing carotid body (CB) activation. This effect may contribute to CO_2 retention during underwater diving due to the high arterial O_2 content associated with hyperbaria. We tested the hypothesis that CB chemosensitivity to hypercapnia and hypoxia is attenuated during hyperbaria. Ten subjects completed two, 4-hour dry dives at 1.6 ATA breathing either 21% O_2 (Air) or 100% O_2 (100% O_2). CB chemosensitivity was assessed using brief hypercapnic ventilatory response ($CBCO_2$) and hypoxic ventilatory response (CBO2) tests pre-dive, 75 and 155 min into the dives, and 15 and 55 min post-dive. End-tidal CO_2 pressure increased during the dive at 75 and 155 min (Air: +9(4) mmHg and +8(4) mmHg vs. 100% O_2: +6(4) mmHg and +5(3) mmHg; all $p<0.01$) and was higher while breathing Air ($p<0.01$). $CBCO_2$ was unchanged during the dive ($p=0.73$) and was not different between conditions ($p=0.47$). However, CBO_2 was attenuated from pre-dive during the dive at 155 min breathing Air (-0.035(0.037) $L \cdot min^{-1} \cdot mmHg^{-1}$; $p=0.02$) and at both time points while breathing 100% O_2 (-0.035(0.052) $L \cdot min^{-1} \cdot mmHg^{-1}$ and -0.034(0.064) $L \cdot min^{-1} \cdot mmHg^{-1}$; $p=0.02$ and $p=0.02$, respectively). These data indicate that the CB chemoreceptors do not appear to contribute to CO_2 retention in hyperbaria.

Izquierdo-Alventosa R, Inglés M, Cortés-Amador S, Gimeno-Mallench L, Sempere-Rubio N, Chirivella J, Serra-Añó P. Comparative study of the effectiveness of a low-pressure hyperbaric oxygen treatment and physical exercise in women with fibromyalgia: randomized clinical trial. Ther Adv Musculoskelet Dis. 2020 Jun 24;12:1759720X20930493.

Background: Fibromyalgia (FM) is characterized by chronic pain and fatigue, among other manifestations, thus advising interventions that do not aggravate these symptoms. The main purpose of this study is to analyse the effect of low-pressure hyperbaric oxygen therapy (HBOT) on induced fatigue, pain, endurance and functional capacity, physical performance and cortical excitability when compared with a physical exercise program in women with FM. Methods: A total of 49 women with FM took part in this randomized controlled trial. They were randomly allocated to three groups: physical exercise group (PEG, n=16), low-pressure hyperbaric oxygen therapy group (HBG, n=17) and control group (CG, n=16). Induced fatigue, perceived pain, pressure pain threshold, endurance and functional capacity, physical performance and cortical excitability were assessed. To analyse the effect of the interventions, two assessments, that is, pre and post intervention, were carried out. Analyses of the data were performed using two-way mixed multivariate analysis of variance. Results: The perceived pain and induced fatigue significantly improved only in the HBG ($p<0.05$) as opposed to PEG and CG. Pressure pain threshold, endurance and functional capacity, and physical performance significantly improved for both interventions ($p<0.05$). The cortical excitability (measured with the resting motor threshold) did not improve in any of the treatments ($p>0.05$). Conclusions: Low-pressure HBOT and physical exercise improve pressure pain threshold, endurance and functional capacity, as well as physical performance. Induced fatigue and perceived pain at rest significantly improved only with low-pressure HBOT. Trial registration: ClinicalTrials.gov identifier NCT03801109.

Liang F, Sun L, Yang J, Liu XH, Zhang J, Zhu WQ, Yang L, Nan D. The effect of different atmosphere absolute hyperbaric oxygen on the expression of extracellular histones after traumatic brain injury in rats. Cell Stress Chaperones. 2020 Jul 23. doi: 10.1007/s12192-020-01137-6. Online ahead of print.

By observing the dynamic changes of extracellular histones H1, H2A, H4, and NF-κB expression in brain tissues after brain injury in rats, we explore the association among the expression of extracellular histones H1, H2A, H4, and NF-κB following traumatic brain injury (TBI), as well as the effect of different atmospheres absolute hyperbaric oxygen (HBO) intervention on the expression and possible mechanisms. A total of 120 SD rats were randomly divided into 4 groups: Sham-operated (SH), TBI (traumatic brain injury) group, traumatic brain injury and hyperbaric oxygen treatment 1.6ATA (TBI + HBO1) group, and traumatic brain injury and hyperbaric oxygen treatment2.2ATA (TBI + HBO2) group, with 30 rats in each group. The rats in each group were then randomly divided into five smaller time-specific sub-groups: 3 h, 6 h, 12 h, 24 h, and 48 h after surgery. TBI models were established, and the brain tissue around the lesion was taken at different time points. On the one hand,we detected the level of local histones H1, H2A, H4, and NF-κB by RT-PCR and Western Blot. On the other hand, we used immunohistochemical methods to detect the expression of NF-κB, while using the TUNEL method to observe the cell apoptosis in experimental groups after

brain injury. Extracellular histones H1, H2A, H4, and NF-κB proteins were highly expressed at 3 h, then with a slight fluctuation, reached to peak at 48 h after the injury. HBO can affect the expression of histones H1, H2A, H4, and NF-κB. The decline of each indicator in the 1.6 ATA group was significantly lower than that in the 2.2 ATA group, especially within 6 h (P<0. 05). In addition, NF-κB expression was consistent with the pathological changes of apoptosis in experimental groups. Hyperbaric oxygen therapy with relatively low pressure (1.6 ATA) at the early stage can significantly inhibit the expression of extracellular histones H1, H2A, H4, and NF-κB around the lesion, reduce the apoptosis of nerve cells, and thus play an important role in alleviating secondary brain injury.

Paganini M, Bosco G, Perozzo FAG, Kohlscheen E, Sonda R, Bassetto F, Garetto G, Camporesi EM, Thom SR. The role of hyperbaric oxygen treatment for COVID-19: a review. Adv Exp Med Biol. 2020 Jul 22. doi: 10.1007/5584_2020_568. Online ahead of print.

The recent coronavirus disease 2019 (COVID-19) pandemic produced high and excessive demands for hospitalizations and equipment with depletion of critical care resources. The results of these extreme therapeutic efforts have been sobering. Further, we are months away from a robust vaccination effort, and current therapies provide limited clinical relief. Therefore, several empirical oxygenation support initiatives have been initiated with intermittent hyperbaric oxygen (HBO) therapy to overcome the unrelenting and progressive hypoxemia during maximum ventilator support in intubated patients, despite high F_IO_2. Overall, few patients have been successfully treated in different locations across the globe. More recently, less severe patients at the edge of impending hypoxemia were exposed to HBO preventing intubation and obtaining the rapid resolution of symptoms. The few case descriptions indicate large variability in protocols and exposure frequency. This summary illustrates the biological mechanisms of action of increased O_2 pressure, hoping to clarify more appropriate protocols and more useful application of HBO in COVID-19 treatment.

Resanović I, Zarić B, Radovanović J, Sudar-Milovanović E, Gluvić Z, Jevremović D, Isenović ER. Hyperbaric oxygen therapy and vascular complications in diabetes mellitus. Angiology. 2020 Jul 8;3319720936925. doi: 10.1177/0003319720936925. Online ahead of print.

Vascular complications in patients with diabetes mellitus (DM) are common. Since impaired oxygen balance in plasma plays an important role in the pathogenesis of chronic DM-associated complications, the administration of hyperbaric oxygen therapy (HBOT) has been recommended to influence development of vascular complications. Hyperbaric oxygen therapy involves inhalation of 100% oxygen under elevated pressure from 1.6 to 2.8 absolute atmospheres in hyperbaric chambers. Hyperbaric oxygen therapy increases plasma oxygen solubility, contributing to better oxygen diffusion to distant tissues and preservation of the viability of tissues reversibly damaged by atherosclerosis-induced ischemia, along with microcirculation restoration. Hyperbaric oxygen therapy exerts antiatherogenic, antioxidant, and cardioprotective effects by altering the level and composition of plasma fatty acids and also by promoting signal transduction through membranes, which are impaired by hyperglycemia and hypoxia. In addition, HBOT affects molecules involved in the regulation of nitric oxide synthesis and in that way exerts anti-inflammatory and angiogenic effects in patients with DM. In this review, we explore the recent literature related to the effects of HBOT on DM-related vascular complications.

Thiankhaw K, Chattipakorn N, Chattipakorn SC. The effects of hyperbaric oxygen therapy on the brain with middle cerebral artery occlusion. J Cell Physiol. 2020 Jul 21. doi: 10.1002/jcp.29955. Online ahead of print.

Middle cerebral artery occlusion (MCAO) causes focal cerebral hypoperfusion, resulting in cerebral ischemia or ischemic stroke. The main therapeutic approach is to restore an adequate blood flow to the brain via the process of reperfusion. However, rapid reperfusion can itself aggravate brain damage; this adverse effect is known as ischemic/reperfusion (I/R) injury. The pathological conditions that occur after cerebral ischemia and cerebral I/R are microvascular injury, blood-brain barrier dysfunction, post-ischemic inflammation, increased oxidative stress/reactive oxygen species, and a reduction in neuronal survival, leading to brain infarction. Animal and clinical studies on hyperbaric oxygen therapy (HBOT) have recently been carried out, and there is evidence of positive effects on neurological outcomes after cerebral ischemia. However, some evidence has shown that HBOT may not affect the functional recovery after ischemic injury. This review describes the current evidence, both in vivo and clinical data, regarding the potential benefits of HBOT after MCAO and cerebral I/R injury. The contrary data are also discussed to verify the effectiveness of HBOT in stroke outcomes.

Utz ER, LaBanc AJ, Nelson MJ, Gaudreau PA, Wise SR. Balloon dilation of the Eustachian tube for baro-challenge-induced otologic symptoms in military divers and aviators: a retrospective analysis. Ear Nose Throat J. 2020 Jul 5;145561320938156. doi: 10.1177/0145561320938156. Online ahead of print.

Objective: To evaluate the effectiveness of balloon dilation (tuboplasty) of the Eustachian tube (BET) in active duty military personnel working in hyper- and hypobaric environments suffering from baro-challenge-

induced ETD using functional outcomes. Methods: Military divers and aviators diagnosed with persistent baro-challenge-induced ETD resulting in disqualification from performing flight and dive duties and who elected for treatment with BET were included for analysis. Posttreatment follow-up assessments were undertaken at 1, 6, and 12 months. Outcome measures included successful hyperbaric chamber testing or return to the hyper- or hypobaric environment without significant baro-challenge-induced ETD symptoms and pre- and postdilation Eustachian Tube Dysfunction Questionnaire (ETDQ-7) scores. Results: Mean pretreatment duration of symptoms was 48 months (range: 3-120 months). Following treatment, 92% (12/13) of patients successfully returned to operational duties with resolution of limiting symptoms. Average return to duty time was 8.5 weeks (range: 6-24 weeks). The ETDQ-7 scores improved from a mean of 4.33 (2.57-6.57) predilation to 2.19 (1.00-4.43) postdilation (Z=2.73, W=70, P=0.0063). Mean duration of follow-up was 38 weeks (range: 13-70 weeks). Conclusion: Eustachian tube balloon dilation appears to be a safe and highly effective treatment option for baro-challenge-induced ETD in affected military divers and aviators who work in hyper- and hypobaric environments. Further study is needed to determine whether similar results can be achieved in more diverse subject populations and to assess long-term effectiveness.

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.

Canadian Undersea and Hyperbaric Medical Association
10 Plumtree Place, Portugal Cove-St. Philips,
Newfoundland and Labrador, A1M 3T1
info@cuhma.ca https://cuhma.ca

Editor: Neal W. Pollock, PhD - neal.pollock@kin.ulaval.ca

CUHMA BOARD OF DIRECTORS

Jay MacDonald	President
Rita Katznelson	President-Elect
Neal Pollock	Secretary
Julie Malone	Treasurer
Debbie Pestell	Past President
Caroline Bain	Director-at-Large
Paul Cervenko	Director-at-Large
George Harpur	Director-at-Large
Ray Janisse	Director-at-Large
Rita Katznelson	Director-at-Large
Ron Linden	Director-at-Large
Anton Marinov	Director-at-Large
Tara Planetta	Director-at-Large
Geoff Zbitnew	Director-at-Large