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

E-NEWS

EDITORIAL NOTE – June 2019

The E-News is the monthly newsletter of CUHMA used to share news and information. We invite relevant content, including announcements, upcoming conferences, new publication abstracts, job postings, professional perspectives, incident reports, and relevant images of related professional scenes. Feel free to share issues with interested colleagues. All past issues are available at https://cuhma.ca.

Neal W. Pollock, PhD
Université Laval

NEWS/ANNOUNCEMENTS

Gene Editing and Box Jellyfish Anti-Venom

Researchers at the University of Sydney used CRISPR gene editing technology to produce a box jellyfish anti-venom that has shown promise in mice. See Lau et al (here) or visit: https://interestingengineering.com/scientists-discover-anti-venom-for-the-deadly-box-jellyfish?fbclid=IwAR0Tzd0njmBDyayZtvwWOVWbtN7IvNyCU4rzK7r0UM-E--WK3DjHdG_XKH4

New Submersible Depth Record

The submersible Limiting Factor (model Triton 36000/2) made four dives into the Challenger Deep and one into the Sirena Deep of the Mariana Trench from April 28-May 07. The maximum depth achieved was 10,928 m (35,853 ft), surpassing the previous record of 10,911 m (35,797 ft) set on January 23, 1960. For more information, visit:
https://divingalmanac.com/deepest-submersible-dive-ocean/?fbclid=IwAR0jnkPjElQDRuBI6PkDN3YT44yXd-8JdIQy4G6KV21vAFazNbf0PBwNrN8
https://www.cbsnews.com/video/american-sets-new-record-with-deepest-submarine-dive/?fbclid=IwAR1AqUCrP1qXDlK5ds6EuizHPNqoC4pBcH6jucu9cZ43P_wUk_1dQ997jvU

Call for Original Research – CUHMA 2019

Both original research and review session abstracts will be considered for oral presentation at the 2019 CUHMA annual scientific meeting. The submission deadline is June 15. Submit abstracts to neal.pollock@kin.ulaval.ca.
Abstract Submission Guidelines (Word file)
Line 1 - informative title, bold and block capitals.
Line 2 - author(s) (surname followed by initials for each).
Line 3 - professional affiliations for author(s).
Lines 4+ (research abstracts) - maximum 250 words (introduction, methods, results, conclusions, funding acknowledgment), 10 pitch Times New Roman, block format (ie, no indenting), complete data but no references, tables or figures.
Lines 4+ (review session abstracts) - 150-250 words, 10 pitch Times New Roman, block format (ie, no indenting), overview of proposed presentation; no references, tables or figures.

UPCOMING EVENTS

CUHMA Annual Scientific Meeting 2019

The 2019 CUHMA ASM will be held October 03-06 in St. John's, NL, hosted by Memorial University Faculty of Medicine. Two days of pre-conference events will be followed by two days of scientific talks. Pre-conference events include:

- BLS/ACLS course
- Offshore Safety and Survival Centre tour (underwater helicopter escape training facility)
- Hyperbaric procedures simulation course
- 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 registration: https://cuhma.ca.

UMC Introductory Diving Medicine Course

Undersea Medicine Canada is offering a CSA Z275.2-15 Level 1 'Introductory Course in Diving Medicine - Fitness to Dive' October 28-November 01 in Quebec City, QC. Upon successful completion of the course, physicians will qualify as CSA Z275.2-15 Level 1 Diving Medical Examiners and can have their names listed with the Diver Certification Board of Canada (DCBC) to conduct commercial diver medicals in Canada. This 40-h course has been accredited for 35 MAINPRO+ CME credits by the College of Family Physicians of Canada. Contact Dr. Debbie Pestell (drdeb1@ns.sympatico.ca; 902-225-8214) or visit: https://underseamedicine.ca for more information.

UHN Introductory Hyperbaric Medicine Course

The University Health Network, Toronto General Hospital, is offering an Introductory Course in Hyperbaric Medicine

on November 26-30, 2019. The program will provide participants the basic competencies to practice in hyperbaric medicine. Content will include the indications and contraindications for hyperbaric treatments and guidelines on the usage of treatment tables. There will be hands-on clinical practice of skills, opportunities to learn how to manage the chamber and clinical emergencies during hyperbaric treatments, as well as theory and historical background. For more information visit: https://www.uhn.ca/Surgery/PatientsFamilies/Clinics_Tests/Hyperbaric_Medicine_Unit/Pages/Continuing_Education.aspx

RECENT PUBLICATIONS

Bayoumy AB, de Ru JA. The use of hyperbaric oxygen therapy in acute hearing loss: a narrative review. Eur Arch Otorhinolaryngol. 2019 May 20. doi: 10.1007/s00405-019-05469-7. [Epub ahead of print]

INTRODUCTION: Acute hearing loss can have a major impact on a patient's life. This holds true for both acute acoustic trauma (AAT) and idiopathic sudden sensorineural hearing loss (ISSHL), two devastating conditions for which no highly effective treatment options exist. This narrative review provides the rationale and evidence for HBOT in AAT and ISSHL. METHODS: Narrative review of all the literature available on HBOT in acute hearing loss, studies were retrieved from systematic searches on PubMed and by cross referencing. DISCUSSION: First, the etiological mechanisms of acute hearing loss and the mechanism of action of HBOT were discussed. Furthermore, we have provided an overview of 68 studies that clinically investigated the effect of HBOT in the last couple of decades. For future studies, it is recommend to start as early as possible with therapy, preferably within 48 h and to use combination therapy consisting of HBOT and corticosteroids. IMPLICATIONS FOR PRACTICE: HBOT has been used quite extensively for acute hearing loss in the last couple of decades. Based on the amount of studies showing a positive effect, HBOT should be discussed with patients (shared decision making) as optional therapy in case of AAT and ISSHL

Burman F. Low-pressure fabric hyperbaric chambers. S Afr Med J. 2019 Mar 29;109(4):12574. doi: 10.7196/SAMJ.2019.v109i4.13524.

Hyperbaric oxygen therapy is defined as an intervention in which an individual breathes near 100% oxygen while wholly enclosed inside a hyperbaric chamber at a pressure ≥1.4 atmosphere absolute (ATA). The Southern African Underwater and Hyperbaric Medical Association (SAUHMA)-approved indications commence at pressures ≥2 ATA. Low-pressure hyperbaric chambers, at pressures ≤1.4 ATA, are approved for acute mountain sickness only. Mild hyperbaric exposures with air deliver no more oxygen to the body than breathing oxygen by mask at sea level pressure. Exposure to treatment pressures <2.0 ATA while breathing air does not meet the SAUHMA definition of therapeutic hyperbaric oxygen therapy and does not achieve the minimum pressure and oxygen levels required for any SAUHMA-approved indication. All SAUHMA-approved indications require that the patient breathe near 100% oxygen while enclosed in a chamber pressurised to a minimum of 2 ATA. SAUHMA does not recommend the use of mild hyperbaric therapy for any medical purpose other than acute mountain sickness.

Halbach JL, Prieto JM, Wang AW, Hawisher D, Cauvi DM, Reyes T, Okerblom J, Ramirez-Sanchez I, Villarreal F, Patel HH, Bickler SW, Perdrizet GA, De Maio A. Early hyperbaric oxygen therapy improves survival in a model of severe sepsis. Am J Physiol Regul Integr Comp Physiol. 2019 May 15. doi: 10.1152/ajpregu.00083.2019. [Epub ahead of print]

Sepsis is a major clinical challenge with therapy limited to supportive interventions. Therefore, the search for novel remedial approaches is of great importance. We addressed whether hyperbaric oxygen therapy (HBOT) could improve the outcome of sepsis using an acute experimental mouse model. Sepsis was induced in male CD-1 mice by cecal ligation and puncture (CLP) tailored to result in 80-90% mortality within 72 h of the insult. After CLP, mice were randomized into two groups receiving HBOT or not at different times after the initial insult or subjected to multiple HBOT treatments. HBOT conditions were 98% oxygen pressurized to 2.4 atmospheres for one hour. HBOT within 1 h after CLP resulted in 52% survival in comparison with mice that did not receive the treatment (13% survival). Multiple HBOT at 1 and 6h or 1, 6 and 21 h displayed an increase in survival of over 50%, but they were not significantly different than a single treatment after 1 h of CLP. Treatments at 6 h or 21 h after CLP, excluding the first-hour treatment, did not show any protective effect. Early HBO treatment did not modify bacterial counts after CLP, but it was associated with decreased expression of TNF-α, IL-6 and IL-10 expression in the liver within 3 h after CLP. The decrease of cytokine expression was reproduced in cultured macrophages after exposure to HBOT. Early HBOT could be of benefit in the treatment of sepsis and the protective mechanism may be related to a reduction in the systemic inflammatory response.

Kerut CK, Serio JR, Kerut EK. Cutis marmorata in decompression sickness is associated with a patent foramen ovale. Echocardiography. 2019 May 13. doi: 10.1111/echo.14360. [Epub ahead of print]

A 39-year-old male commercial diver developed cutis marmorata after a dive. He had a full recovery after therapy in a hyperbaric oxygen chamber. Transthoracic echocardiography revealed an atrial septal aneurysm and a

large shunt during normal respirations. This form of decompression sickness may progress to type II DCS, thus is important to identify and treat. Cutis marmorata as a result of diving is highly associated with an atrial septal defect or a large patent foramen ovale. It is particularly important to assess these patients for a right-to-left shunt as part of a medical evaluation prior to returning to diving

Körpınar Ş. Could hyperbaric oxygen be a solution in the treatment of spinal infections? Medicina (Kaunas). 2019 May 20;55(5). pii: E164. doi: 10.3390/ medicina55050164.

Background and Objective: Pyogenic spinal infections are rare and potentially devastating, requiring prompt recognition and management. Parallel to the ever-increasing number of invasive spinal procedures, its incidence is on a steady rise, particularly in an expanding elderly population. The aim of this study was to evaluate the efficacy of hyperbaric oxygen (HBO_2) therapy in the treatment of this heterogeneous group of disorders. Materials and Methods: Nineteen patients who were referred to our center for HBO_2 with a clinical diagnosis of spinal infections (vertebral osteomyelitis, pyogenic spondylitis, spondylodiscitis, surgical site infection following spine surgery, epidural abscess) were retrospectively reviewed. Results: Infection resolution was adequately achieved in 12 of 13 patients (92.3%) on magnetic resonance imaging at the end of HBO_2 treatment or during the first month of follow-up. The mean follow-up period was 11 months (range 1 month to 3 years). Conclusions: This study suggests that HBO_2 therapy is efficacious in patients with pyogenic spinal infections complicated by primary therapy failure or by medical comorbidities that may impede the eradication of microbial infection and delay wound healing. HBO_2 therapy may be useful for reducing long hospital stays, repeated surgeries, and morbidities.

Lau MT, Manion J, Littleboy JB, Oyston L, Khuong TM, Wang QP, Nguyen DT, Hesselson D, Seymour JE, Neely GG. Molecular dissection of box jellyfish venom cytotoxicity highlights an effective venom antidote. Nat Commun. 2019 Apr 30;10(1):1655. doi: 10.1038/s41467-019-09681-1.

The box jellyfish *Chironex fleckeri* is extremely venomous, and envenoming causes tissue necrosis, extreme pain and death within minutes after severe exposure. Despite rapid and potent venom action, basic mechanistic insight is lacking. Here we perform molecular dissection of a jellyfish venom-induced cell death pathway by screening for host components required for venom exposure-induced cell death using genome-scale lenti-CRISPR mutagenesis. We identify the peripheral membrane protein ATP2B1, a calcium transporting ATPase, as one host factor required for venom cytotoxicity. Targeting ATP2B1 prevents venom action and confers long lasting protection. Informatics analysis of host genes required for venom cytotoxicity reveal pathways not previously implicated in cell death. We also discover a venom antidote that functions up to 15 minutes after exposure and suppresses tissue necrosis and pain in mice. These results highlight the power of whole genome CRISPR screening to investigate venom mechanisms of action and to rapidly identify new medicines.

Moir ME, Klassen SA, Al-Khazraji BK, Woehrle E, Smith SO, Matushewski BJ, Kozić D, Dujić Ž, Barak OF, Shoemaker JK. Impaired dynamic cerebral autoregulation in trained breath-hold divers. J Appl Physiol (1985). 2019 May 9. doi: 10.1152/ japplphysiol.00210.2019. [Epub ahead of print]

Breath-hold divers (BHD) experience repeated bouts of severe hypoxia and hypercapnia with large increases in blood pressure. However, the impact of long-term breath-hold diving on cerebrovascular control remains poorly understood. The ability of cerebral blood vessels to respond rapidly to changes in blood pressure represent the property of dynamic autoregulation. The current investigation tested the hypothesis that breath-hold diving impairs dynamic autoregulation to a transient hypotensive stimulus. Seventeen BHD (3 females, 11±9 years diving) and 15 healthy controls (2 females) completed two or three repeated sit-to-stand trials during spontaneous breathing and poikilocapnic conditions. Heart rate (HR), finger arterial blood pressure (BP), and cerebral blood flow velocity (BFV) from the right middle cerebral artery were measured continuously with three-lead electrocardiography, finger photoplethysmography, and transcranial Doppler ultrasonography, respectively. End-tidal carbon dioxide partial pressure was measured with a gas analyzer. Offline, an index of cerebrovascular resistance (CVRi) was calculated as the quotient of mean BP and BFV. The rate of the drop in CVRi relative to the change in BP provided the rate of regulation (RoR; $[\Delta CVRi/\Delta T]/\Delta BP$). The BHD demonstrated slower RoR than controls ($P \leq 0.001$, $d=1.4$). Underlying the reduced RoR in BHD was a longer time to reach nadir CVRi compared with controls ($P=0.004$, $d=1.1$). In concert with the longer CVRi response, the time to reach peak BFV following standing was longer in BHD than controls ($P=0.01$, $d=0.9$). The data suggest impaired dynamic autoregulatory mechanisms to hypotension in BHD.

Risberg J, Phillips S. Rescue of a submerged convulsing diver. Undersea Hyperb Med. 2019;46:153-7.

In 2018, the Medical Panel of the NATO Underwater Diving Working Group (UDWG) discussed the question of the rescue and management of a submerged unresponsive compressed-gas diver. The Panel reviewed the 2012 recommendation by the UHMS Diving Committee with respect to the specific recommendation in a convulsing diver using a half-face mask and separate

mouthpiece, to delay surfacing until the clonic phase had subsided if the mouthpiece was in place. There is a paucity of scientific, epidemiological, experimental and observational human studies to substantiate this guidance. Experimental animal studies suggest that the likelihood of a complete airway obstruction during an ongoing seizure is low and that there is a high likelihood of surviving pulmonary barotrauma caused by complete airway closure. Airway management and control is an essential step in the management of the unresponsive diver and would be challenging to achieve in the underwater environment. Even in the military setting, it will be difficult to provide sufficient training to enable divers to handle such a situation. In this very rare scenario it is considered that emergency guidelines should be clear, concise and easy to follow. The UDWG therefore recommends that all unconscious military divers in this situation should be rescued to surface without waiting for clonic seizures to subside. Training organizations for recreational and occupational divers should consider whether this guidance should be applied for civilian divers as well.

Tanaka T, Minami A, Uchida J, Nakatani T. Potential of hyperbaric oxygen in urological diseases. Int J Urol. 2019 May 13. doi: 10.1111/iju.14015. [Epub ahead of print]

Hyperbaric oxygen therapy is a promising medical technology that delivers oxygen to targeted tissues at high pressure to increase the amount of dissolved oxygen in the blood. Over the past three decades, hyperbaric oxygen has been used in a variety of conditions, including radiation-induced tissue injuries, non-healing states with ischemia and malignant neoplasms. In the field of urology, hyperbaric oxygen has also been applied to some pathological conditions (eg, radiation-induced hemorrhagic cystitis, Fournier gangrene, interstitial cystitis, male infertility, acute kidney injury and urological cancers). In normal and injured tissues, hyperoxia from hyperbaric oxygen therapy contributes to anti-inflammation, angiogenesis through endothelial proliferation, enhanced fibroblastic activity, increased lymphocyte and macrophage activity, and bactericidal effects with the aim of wound repair. In cancerous tissues, the enhanced supply of oxygen into the hypoxic cancer cells can exert inhibitory effects on factors that contribute to their aggressiveness (eg, cell survival, escape from apoptosis, epithelial-to-mesenchymal transition and tumor immunotolerance), and sensitize the tumor to radiation therapy and chemotherapy. However, further research, including multicenter clinical studies, is essential for determining the role of hyperbaric oxygen therapy in refractory urological diseases that are resistant to conventional therapies.

Tillmans F, Sharghi R, Noy T, Kähler W, Klapa S, Sartisohn S, Sebens S, Koch A. Effect of hyperoxia on the immune status of oxygen divers and endurance athletes. Free Radic Res. 2019 May 23:1-13. doi: 10.1080/10715762.2019.1612890. [Epub ahead of print]

Physical activity, particularly that, exerted by endurance athletes, impacts the immune status of the human body. Prolonged duration and high-intensity endurance training lead to increased production of reactive oxygen species (ROS) and thereby to oxidative stress. Military combat swimmers (O_2-divers) are regularly exposed to hyperbaric hyperoxia (HBO) in addition to intensive endurance training intervals. They are, therefore, exposed to extreme levels of oxidative stress. Several studies support that the intensity of oxidative stress essentially determines the effect on immune status. The aim of this study was to comparatively characterise peripheral blood mononuclear cells (PBMCs) of O_2-divers (military combat swimmers), endurance athletes (amateur triathletes), and healthy control volunteers with respect to DNA fragmentation, immune status and signs of inflammation. Furthermore, it was investigated how PBMCs from these groups responded acutely to exposure to HBO. We showed that DNA fragmentation was comparable in PBMCs of all three groups under basal conditions directly after HBO exposure. However, significantly higher DNA fragmentation was observed in O_2-divers 18 hours after HBO, possibly indicating a slower recovery. O_2-divers also exhibited a proinflammatory immune status exemplified by an elevated number of CD4+CD25+ T cells, elevated expression of proinflammatory cytokine IL-12, and diminished expression of anti-inflammatory TGF-β1 compared to controls. Supported by a decreased basal gene expression and prolonged upregulation of anti-oxidative HO-1, these data suggest that higher oxidative stress levels, as present under intermitted hyperbaric hyperoxia, e.g. through oxygen diving, promote a higher inflammatory immune status than oxidative stress through endurance training alone.

Wingelaar TT, Brinkman P, van Ooij PJAM, Hoencamp R, Maitland-van der Zee AH, Hollmann MW, van Hulst RA.Markers of pulmonary oxygen toxicity in hyperbaric oxygen therapy using exhaled breath analysis. Front Physiol. 2019 Apr 24;10:475. doi: 10.3389/fphys. 2019.00475. eCollection 2019.

INTRODUCTION: Although hyperbaric oxygen therapy (HBOT) has beneficial effects, some patients experience fatigue and pulmonary complaints after several sessions. The current limits of hyperbaric oxygen exposure to prevent pulmonary oxygen toxicity (POT) are based on pulmonary function tests (PFT), but the limitations of PFT are recognized worldwide. However, no newer modalities to detect POT have been established. Exhaled breath analysis in divers have shown volatile organic compounds (VOCs) of inflammation and methyl alkanes. This study

hypothesized that similar VOCs might be detected after HBOT. METHODS: Ten healthy volunteers of the Royal Netherlands Navy underwent six HBOT sessions (95 min at 253 kPa, including three 5-min "air breaks"), ie, on five consecutive days followed by another session after 2 days of rest. At 30 min before the dive, and at 30 min, 2 and 4 h post-dive, exhaled breath was collected and followed by PFT. Exhaled breath samples were analyzed using gas chromatography-mass spectrometry (GC-MS). After univariate tests and correlation of retention times, ion fragments could be identified using a reference database. Using these fragments VOCs could be reconstructed, which were clustered using principal component analysis. These clusters were tested longitudinally with ANOVA. RESULTS: After GC-MS analysis, eleven relevant VOCs were identified which could be clustered into two principal components (PC). PC1 consisted of VOCs associated with inflammation and showed no significant change over time. The intensities of PC2, consisting of methyl alkanes, showed a significant decrease (p=0.001) after the first HBOT session to 50.8%, remained decreased during the subsequent days (mean 82%), and decreased even further after 2 days of rest to 58% (compared to baseline). PFT remained virtually unchanged. DISCUSSION: Although similar VOCs were found when compared to diving, the decrease of methyl alkanes (PC2) is in contrast to the increase seen in divers. It is unknown why emission of methyl alkanes (which could originate from the phosphatidylcholine membrane in the alveoli) are reduced after HBOT. This suggests that HBOT might not be as damaging to the pulmonary tract as previously assumed. Future research on POT should focus on the identified VOCs (inflammation and methyl alkanes).

Xu Y, Wang Q, Qu Z, Yang J, Zhang X, Zhao Y. Protective effect of hyperbaric oxygen therapy on cognitive function in patients with vascular dementia. Cell Transplant. 2019 May 28:963689719853540. doi: 10.1177/0963689719853540. [Epub ahead of print]

Recent studies have shown that hyperbaric oxygen (HBO) has a therapeutic effect on vascular dementia (VD); however, the exact mechanism remains unclear. This article aims to reveal the protective effects and underlying mechanisms of HBO on VD. A total of 158 patients with VD were prospectively included in the study and were randomly divided into control group and HBO group. The control group was given conventional treatment and the HBO group was treated with HBO in addition to conventional treatment. The following HBO protocol was practiced: 5 days per week, 60 min each, 100% oxygen at 2 standard atmospheric pressures for 12 weeks. The Mini-Mental State Examination (MMSE) scores and serum Humanin levels were detected before and after treatments in both groups. The baseline characteristics were not different dramatically between groups ($p>0.05$). There was no significant difference in MMSE scores and serum Humanin levels between the two groups before treatment ($p>0.05$). After treatment, compared with the control group, the MMSE scores and serum Humanin levels in the HBO group were significantly increased ($p<0.05$). Spearman correlation analysis showed that the serum Humanin levels were positively correlated with MMSE scores ($r=0.409$, $p<0.05$) and this correlation was independent of baseline characteristics ($\beta=0.312$, $p<0.05$). HBO therapy can improve cognitive function in patients with VD, and its mechanism may be related to elevated serum Humanin levels.

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