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

E-NEWS

EDITOR'S NOTE – March 2020

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

Neal W. Pollock, PhD
Université Laval

NEWS/ANNOUNCEMENTS

Obituary - Bruce R. Wienke, PhD

Bruce Wienke, credited for his work developing and promoting the reduced gradient bubble model (RGBM) used in many dive computers, died February 15.

Peer Review Oversight

Peer review is an imperfect but vital tool in the dissemination of new research information. Awareness of the problems with predatory journals is growing, but there are others issues of concern. Publishers are developing tools to identify patterns of inappropriate self-citation that can serve as one more check. For one example of action: https://www.nature.com/articles/d41586-020-00335-7

Call for Abstracts – CUHMA ASM 2020

The deadline for original research abstracts to be considered for oral presentation at the 2020 CUHMA annual scientific meeting is **June 15**. Submit to neal.pollock@kin.ulaval.ca.
Abstract Submission Guidelines (Word file; all text 10 pitch New Times Roman)
Line 1 - informative title, bold and block capitals.
Line 2 - author(s) (surname followed by initials for each; affiliation numbers superscripted after initials).
Line 3 - professional affiliations, starting with superscripted number and separated by a semi-colon.
Lines 4+ (research abstracts) - maximum 250 words (introduction, methods, results, conclusions, funding acknowledgment [optional]), block format (ie, no indenting), complete data but no references, tables or figures. No line breaks between sections but section headers bold. Funding acknowledgment limited to one line.

UPCOMING EVENTS

UHN Introductory Hyperbaric Medicine Course

The University Health Network, Toronto General Hospital, is offering this course twice in 2020: March 31-April 04 and 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

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' September 28-October 02 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.

CUHMA Annual Scientific Meeting 2020

The 2020 CUHMA ASM will be held October 22-25 in Niagara Falls, ON. McMaster University CPD will provide accreditation and meeting support. Two days of pre-conference events will be followed by two days of scientific talks. 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.

International Congress on Hyperbaric Medicine

The 20th ICHM will be held November 11-15, 2020 at the Rio Othon Palace Hotel, in Copacabana, Rio de Janeiro, Brazil. The conference is held every three years, and is unusual in not being linked to any single institution. The scientific program will include oral and poster research presentations and invited lectures by renowned national and international speakers. CUHMA members are being offered 10% off the registration price. Visit www.ichm2020.rio.br.

RECENT PUBLICATIONS

Batinac T, Sotošek V, Valković T, Gorup L, Franolić M, Barković I. Hyperbaric oxygen treatment: a complementary treatment modality of modic changes? Med Hypotheses. 2020; 138: 109617 2020 Feb 10[Online ahead of print]

Modic changes (MCs) have attracted great interest in recent years. The complex process of MC development and progression seems to involve interplay between mechanical, infective, inflammatory, and degenerative processes that cannot be clearly differentiated. Based on signal intensity on T1- and T2-weighted MRI scans, MCs can be divided three types: Type 1, Type 2, and Type 3. Predominantly Type 1 MCs are commonly associated with chronic low back pain that is unresponsive to classic treatment options. Infection with low-virulent anaerobic microorganisms, most commonly Propionibacterium acnes, has been implicated in MC development following a disc herniation when a tear enables bacteria to enter the disc. Recent studies in patients with chronic low back pain following a lumbar disc herniation associated with Type 1 MCs have reported promising results following prolonged systemic antibiotic treatment with amoxicillin-clavulanate. Hyperbaric oxygen therapy, as primary or adjuvant treatment in association combination with systemic antibiotics or anti-inflammatory therapy, could offer important advantages in treating patients with suspected low-virulent disc infections due to anaerobic microorganisms associated with Type 1 MCs. We believe that hyperbaric oxygenation could contribute to faster resolution of Type 1 MCs and associated pain through multiple effects-including direct antimicrobial effects through formation of reactive oxygen species (ROS), altering the favorable low oxygen tension milieu such that it becomes unfavorable for bacterial growth and survival, and anti-biofilm effects. Additionally, hyperbaric oxygenation could contribute to faster pain resolution via direct and indirect anti-inflammatory effects. As an adjuvant treatment administered in combination with systemic antibiotics, HBOT could increase the sensitivity of Propionibacterium acnes to antimicrobial drugs under hyperoxic conditions, resulting in faster MC resolution. Overall, the faster infection resolution, diminished bacterial load, and anti-inflammatory effects due to reduced cytokine expression and levels of infectious by-products could lead to faster pain resolution following HBOT, and a significant improvement of quality of life in these patients.

Brouwer RJ, Lalieu RC, Hoencamp R, van Hulst RA, Ubbink DT. A systematic review and meta-analysis of hyperbaric oxygen therapy for diabetic foot ulcers with arterial insufficiency. J Vasc Surg. 2020; 71(2):682-92.

Background: Diabetic foot ulcers (DFUs) are frequently associated with peripheral arterial occlusive disease (PAOD) and may ultimately lead to amputations of the lower extremity. Adjuvant hyperbaric oxygen treatment (HBOT) might foster better wound healing and lower amputation rates in patients with DFU and PAOD. A systematic review was conducted to assess the effects of HBOT as an adjunctive therapy to standard treatment for patients with DFUs with PAOD. Methods: Systematic review using the MEDLINE, EMBASE, and Cochrane CENTRAL databases (from inception to October 2018). All original, comparative studies on the effect of HBOT on DFUs with PAOD were eligible. The primary outcome measures were amputation rate, amputation-free survival, complete ulcer healing, and mortality. Results: Eleven studies, totaling 729 patients, were included for analysis, including 7 randomized clinical trials, 2 controlled clinical trials, and 2 retrospective cohorts. Four were used for quantitative synthesis. Meta-analysis showed a significantly fewer major amputations in the HBOT group (10.7% vs 26.0%; risk difference, -15%; 95% confidence interval [CI], -25 to -6; P=0.002; number needed to treat, 7; 95% CI, 4-20). No difference was found for minor amputations (risk difference, 8%; 95% CI, -13 to 30; P=0.46). Three studies reporting on complete wound healing showed contrasting results. No significant difference was found for mortality or amputation-free survival. Conclusions: Current evidence shows that adjuvant HBOT improves major amputation rate, but not wound healing, in patients with DFUs and PAOD. Given the wide range of patients included in the trials, better patient selection may help define which patients with DFUs and PAOD benefit most from HBOT as standard adjunctive treatment.

Choi Y, Choi HY, Jeong AY, Kang WS, Park HJ, Chung JW, Ahn JH.Hyperbaric oxygen (HBO) therapy as an effective approach to the treatment of patients with severe idiopathic sudden sensorineural hearing loss. Acta Otolaryngol. 2020; 1-4 Feb 12 [Online ahead of print]

Background: The potential etiology of idiopathic sudden sensorineural hearing loss (ISSNHL) is cochlear ischemia, therefore, hyperbaric oxygen (HBO) therapy is a promising treatment, particularly in patients with severe hearing loss (≥70 dB).Aims/objectives: To evaluate the efficacy of HBO therapy.Material and methods: The medical records of patients diagnosed with ISSNHL were retrospectively reviewed (≥70 dB). Patients received HBO therapy 14 times in addition to systemic and intratympanic steroid therapy (HBO group), or systemic and intratympanic steroid therapy only (control group).Results: Data from a total of 82 patients (83 ears) were included in the analysis; 37 (38 ears) in the HBO group and 45 (45 ears) in the control group. After 2 weeks' treatment, hearing was significantly improved in the HBO group versus controls (weighted four-frequency average 28.1±26.9 dB versus 14.8±13.5 dB, respectively; $p<0.05$),

particularly in the low frequency groups (0.5 kHz, 1 kHz, 2 kHz; p<0.05).Conclusion and significance: These data demonstrate that HBO therapy is an effective initial treatment option for patients with ISSNHL suffering from severe hearing loss.

Demoulin R, Poyet R, Castagna O, Gempp E, Druelle A, Schmitt P, Capilla E, Rohel G, Pons F, Jégo C, Brocq FX, Cellarier GR. Epidemiological, clinical, and echocardiographic features of twenty 'Takotsubo-like' reversible myocardial dysfunction cases with normal coronarography following immersion pulmonary oedema. Acta Cardiol. 2020; 1-7 2020 Feb 24[Online ahead of print]

Background: Pulmonary immersion oedema is a frequent diving accident. Although its outcome is generally favourable within 72 h, it can nonetheless lead to heart failure or sudden death. Cases of transient myocardial dysfunction have been reported in the literature. This phenomenon is similar to Takotsubo syndrome in many ways. It is characterised by transient myocardial hypokinesia, without associated coronary lesions. Methods: We report on 20 cases of patients who showed transient alteration of left ventricular kinetics with normal coronary angiography over the course of an immersion pulmonary oedema. Results: The echocardiographic localisation of the myocardial damage was generally focal and not centred on the apex with an average left ventricular ejection fraction of 45%. The main anomalies in the electrocardiographic repolarisation were T wave inversion with corrected QT interval prolongation. We also observed a moderate increase in troponin levels, with discordance between the enzymatic peak and the severity of the left ventricle segmental dysfunction. Conclusion: These cases suggest the incidence of a clinical entity strongly reminiscent of Takotsubo phenomenon of atypical topography as a consequence of diving accidents.

Denk MA, Fahlman A, Dennison-Gibby S, Song Z, Moore M. Hyperbaric tracheobronchial compression in cetaceans and pinnipeds. J Exp Biol. 2020 Feb 10[Online ahead of print] PMID: 32041809 DOI: 10.1242/jeb.217885

Assessment of the compressibility of marine mammal airways at depth is crucial to understanding vital physiologic processes such as gas exchange during diving. Very few studies have directly assessed changes in cetacean and pinniped trachea-bronchial shape, and none have quantified changes in volume with increasing pressure. A freshly deceased harbor seal, grey seal, harp seal, harbor porpoise, and common dolphin were imaged post mortem via CT in a radiolucent hyperbaric chamber as previously described in Moore et al (2011). Volume reconstructions were performed of segments of the trachea and bronchi of the pinnipeds and bronchi of the cetaceans for each pressure treatment. All specimens examined demonstrated significant decreases in volume with increasing pressure, with the harbor seal and common dolphin nearing complete collapse at the highest pressures. The common dolphin bronchi demonstrated distinctly different compression dynamics between 50% and 100% lung inflation treatments, indicating the importance of air in maintaining patent airways, and collapse occurred caudally to cranially in the 50% treatment. Dynamics of the harbor seal and grey seal airways indicated that the trachea was less compliant than the bronchi. These findings indicate potential species-specific variability in airway compliance, and cessation of gas exchange may occur at greater depths than those predicted in models assuming rigid airways. This may potentially increase the likelihood of decompression sickness in these animals during diving

Dinç ASK, Çayönü M, Boynueğri S, Tuna EU, Eryılmaz A. Is salvage hyperbaric oxygen therapy effective for sudden sensorineural hearing loss in patients with non-response to corticostreoid treatment? Cureus. 2020; 12(1):e6560.

Purpose: The aim of this study was to evaluate the efficacy of salvage hyperbaric oxygen therapy (HBOT) for sudden sensorineural hearing loss (SSNHL); HBOT is performed after three weeks of the onset of the disease. Methods: This retrospective clinical study included patients with unilateral idiopathic SSNHL. All patients admitted to the hospital with the diagnosis of SSNHL were given standard steroid treatment within the 14 days of the onset of the SSNHL. We compared the two study groups - Group A: patients receiving steroid treatment within the first 14 days; Group B: patients receiving corticosteroid treatment within the first 14 days, but unresponsive to this treatment, and began to receive HBOT after three weeks of the onset of SSNHL for the purpose of salvage therapy. Results: A total of 50 patients were included in the study. The mean age of the patients was 50.6±14.1 years. There was not a significant difference in the degree of hearing loss between the groups based on the findings from audiometric examinations performed at the time of diagnosis. It was observed that salvage HBOT was not effective when the initial and post-treatment audiometric tests were compared. Conclusion: According to our results, salvage HBOT was not efficient when performed three weeks after the onset of the SSNHL for patients who did not respond to corticosteroid treatment.

Gardin C, Bosco G, Ferroni L, Quartesan S, Rizzato A, Tatullo M, Zavan B. Hyperbaric oxygen therapy improves the osteogenic and vasculogenic properties of mesenchymal stem cells in the presence of inflammation in vitro. Int J Mol Sci. 2020; 21(4): 2020 Feb 20.

Hyperbaric oxygen (HBO) therapy has been reported to be beneficial for treating many conditions of inflammation-

associated bone loss. The aim of this work was to in vitro investigate the effect of HBO in the course of osteogenesis of human mesenchymal stem cells (MSCs) grown in a simulated pro-inflammatory environment. Cells were cultured with osteogenic differentiation factors in the presence or not of the pro-inflammatory cytokine tumor necrosis factor-α (TNF-α), and simultaneously exposed daily for 60 min, and up to 21 days, at 2.4 atmosphere absolute (ATA) and 100% O_2. To elucidate osteogenic differentiation-dependent effects, cells were additionally pre-committed prior to treatments. Cell metabolic activity was evaluated by means of the MTT assay and DNA content quantification, whereas osteogenic and vasculogenic differentiation was assessed by quantification of extracellular calcium deposition and gene expression analysis. Metabolic activity and osteogenic properties of cells did not differ between HBO, high pressure (HB) alone, or high oxygen (HO) alone and control if cells were pre-differentiated to the osteogenic lineage. In contrast, when treatments started contextually to the osteogenic differentiation of the cells, a significant reduction in cell metabolic activity first, and in mineral deposition at later time points, were observed in the HBO-treated group. Interestingly, TNF-α supplementation determined a significant improvement in the osteogenic capacity of cells subjected to HBO, which was not observed in TNF-α-treated cells exposed to HB or HO alone. This study suggests that exposure of osteogenic-differentiating MSCs to HBO under in vitro simulated inflammatory conditions enhances differentiation towards the osteogenic phenotype, providing evidence of the potential application of HBO in all those processes requiring bone regeneration.

Lundell RV, Räisänen-Sokolowski AK, Wuorimaa TK, Ojanen T, Parkkola KI. Diving in the Arctic: cold water immersion's effects on heart rate variability in Navy divers. Front Physiol. 2020; 10, 1600 2020 Jan 31 eCollection

Introduction: Diving close to the Arctic circle means diving in cold water regardless of the time of year. The human body reacts to cold through autonomous nervous system (ANS)-mediated thermoregulatory mechanisms. Diving also induces ANS responses as a result of the diving reflex. Materials and methods: In order to study ANS responses during diving in Arctic water temperatures, we retrospectively analyzed repeated 5-min heart rate variability (HRV) measures and the mean body temperature from dives at regular intervals using naval diving equipment measurement tests in 0°C water. Three divers performed seven dives without physical activity (81-91 min), and two divers performed four dives with physical activity after 10 min of diving (0-10 min HRV recordings were included in the study). Results: Our study showed a significant increase in parasympathetic activity (PNS) at the beginning of the dives, after which PNS activity decreased significantly (measure 5-10 min). Subsequent measurements (15-20 min and onward) showed a significant increase in PNS activity over time. Conclusion: Our results suggest that the first PNS responses of the human diving reflex decrease quickly. Adverse effects of PNS activity should be considered on long and cold dives. To avoid concurrent sympathetic (SNS) and PNS activity at the beginning of dives, which in turn may increase the risk of arrhythmia in cold water, we suggest a short adaptation phase before physical activity. Moreover, we suggest it is prudent to give special attention to cardiovascular risk factors during pre-dive examinations for cold water divers.

Ustrup A, Pedersen SK, Ulrik CS. Assessment of fitness for recreational scuba diving in candidates with asthma: a pilot study. BMJ Open Sport Exerc Med. 2020; 6(1): e000624 2020 Jan 15 eCollection 2020

Background: Asthma may be regarded as a contraindication to scuba diving. Purpose: A clinical algorithm to assess fitness to dive among individuals with asthma was developed and tested prospectively in clinical practice. Study design: Cohort study. Methods: All patients with possible asthma referred to Hvidovre Hospital, Denmark, for assessment of fitness to dive over a 5-year period (2013-2017) were included. Fitness to dive was assessed by case history, spirometry and mannitol challenge test. All patients with ≥10% decline in forced expiratory volume in 1 s (FEV_1) (at any point during the challenge test) were offered step-up asthma therapy and rechallenge after at least 3 months. Patients with <10% decline in FEV_1 after administration of a maximum dose of mannitol at the latest challenge were classified as having no medical contraindications to scuba diving. Results: The study cohort comprised 41 patients (24 men; mean age 33 years), of whom 71% and 63% of men and women, respectively, were treated with rescue bronchodilator and inhaled corticosteroid. After the first mannitol challenge test, 21 patients were classified as having no medical contraindications to scuba diving, of whom 16 were currently prescribed asthma medication. After step-up asthma therapy and rechallenge test, an additional seven patients were classified as having no medical contraindications to scuba diving. Overall, using this clinical algorithm, 28 (68%) of the referred patients were finally assessed as having no medical contraindications to scuba diving. Conclusion: Using a clinical algorithm with mannitol challenge to assess fitness to dive among patients with possible asthma and allowing a rechallenge test after step-up asthma therapy increased the proportion of individuals classified as having no medical contraindications to scuba diving. However, as this algorithm has so far not been evaluated against actual scuba diving safety, further studies are clearly needed before it can be implemented with confidence for use in clinical practice. Clinical relevance: An algorithm to

assess fitness for scuba diving among individuals with possible asthma using bronchial challenge test, with the option of step-up asthma therapy and rechallenge for reassessment, has been developed for clinical use.

Yamamoto N, Oyaizu T, Enomoto M, Horie M, Yuasa M, Okawa A, Yagishita K. VEGF and bFGF induction by nitric oxide is associated with hyperbaric oxygen-induced angiogenesis and muscle regeneration. Sci Rep. 2020; 10(1): 2744 2020 Feb 17

Hyperbaric oxygen (HBO) treatment promotes early recovery from muscle injury. Reactive oxygen species (ROS) upregulation is a key mechanism of HBO, which produces high O_2 content in tissues through increased dissolution of oxygen at high pressure. Nitric oxide (NO), a type of ROS, generally stabilizes hypoxia-inducible factor (HIF) 1α and stimulates secretion of vascular endothelial growth factor (VEGF) and basic fibroblast growth factor (bFGF) from endothelial cells and macrophages, which then induces angiogenesis. The purpose of the present study was to investigate whether HBO could promote angiogenesis via induction of NO and induce muscle regeneration in contused rat skeletal muscles. The HBO protocol consisted of 2.5 atmospheres absolute (ATA) 100% oxygen for 120 minutes, once a day for 5 consecutive days. We also evaluated the effects of a ROS inhibitor (NAC) or NOS-specific inhibitor (L-NAME) on HBO. HBO significantly increased NO3-, VEGF, and bFGF levels and stabilized HIF1α within 1 day. HBO promoted blood vessel formation at 3-7 days and muscle healing at 5-7 days after contusion. Administration of both NAC and L-NAME before HBO suppressed angiogenesis and muscle regeneration even after HBO. HBO thus promoted angiogenesis and muscle regeneration mainly through generation of NO in the early phase after muscle contusion injury.

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

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