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

E-NEWS

EDITOR'S NOTE – February 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
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NEWS/ANNOUNCEMENTS

CUHMS Membership Conference Needs Survey

We are conducting a brief needs assessment survey to aid in development of our next and future scientific meetings. Please take a few minutes to answer the six questions: https://surveys.mcmaster.ca/limesurvey/index.php/397178?lang=en

Call for Presentations – CUHMA ASM 2020

Both thematic lecture and original research abstracts will be considered for oral presentation at the 2020 CUHMA annual scientific meeting to be held October 22-25 in Niagara Falls, ON. Submission deadlines are **February 15** for thematic lectures and **June 15** for original research. Submit abstracts 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+ (thematic lecture abstracts) - 150-250 words, block format (ie, no indenting), overview of proposed presentation; no references, tables or figures. No line breaks between sections.

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

Hyperbaric Safety Director Course 2020

Simon Fraser University, in Burnaby, BC, is offering this 3-day program in collaboration with International ATMO February 07-09. It will provide necessary tools and resources to fulfill the responsibilities of the Hyperbaric Safety Director (as defined by CSA Z275.1). Both classroom instruction and practical exercises are included. Visit: https://www.sfu.ca/science/faculty-support/facilities-services/empu/courses/hyperbaric_safety_director.html.

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

Bosco G, Paganini M, Rizzato A, Martani L, Garetto G, Lion J, Camporesi EM, Moon RE. Arterial blood gases in divers at surface after prolonged breath-hold. Eur J Appl Physiol. 2020 Jan 7. doi: 10.1007/s00421-019-04296-2. [Epub ahead of print]

PURPOSE: Adaptations during voluntary breath-hold diving have been increasingly investigated since these athletes are exposed to critical hypoxia during the ascent. However, only a limited amount of literature explored the pathophysiological mechanisms underlying this phenomenon. This is the first study to measure arterial blood gases immediately before the end of a breath-hold in real conditions. METHODS: Six well-trained breath-hold divers were enrolled for the experiment held at the "Y-40 THE DEEP JOY" pool (Montegrotto Terme, Padova, Italy). Before the experiment, an arterial cannula was inserted in the radial artery of the non-dominant limb. All divers performed: a breath-hold while moving at the surface using a sea-bob; a sled-assisted breath-hold dive to 42 m; and a breath-hold dive to 42 m with fins. Arterial blood samples were obtained in four conditions: one at rest before submersion and one at the end of each breath-hold. RESULTS: No diving-related complications were observed. The arterial partial pressure of oxygen (96.2±7.0 mmHg at rest, mean ± SD) decreased, particularly after the sled-assisted dive (39.8±8.7 mmHg), and especially after the dive with fins (31.6±17.0 mmHg). The arterial partial pressure of CO_2 varied somewhat but after each study was close to normal (38.2±3.0 mmHg at rest; 31.4±3.7 mmHg after the sled-assisted dive; 36.1±5.3 after the dive with fins). CONCLUSION: We confirmed that the arterial partial pressure of oxygen reaches hazardously low values at the end of breath-hold, especially after the dive performed with voluntary effort. Critical hypoxia can occur in breath-hold divers even without symptoms.

Cherouveim ED, Botonis PG, Tsakiris T, Koskolou MD, Geladas ND. The effect of menstrual cycle on maximal breath-hold time. Respir Physiol Neurobiol. 2020 Jan 7:103381. doi: 10.1016/j.resp.2020.103381. [Epub ahead of print]

This study investigated the effect of menstrual cycle phase on breath-hold time (BHT). Twelve healthy females, aged 18-30 yrs, with regular menstrual cycles, without breath-hold (BH) experience, performed a BH protocol which included eight repeated maximal efforts with face immersion in cool water separated by 2-min intervals in two different phases of menstrual cycle; early follicular (EF) phase and midluteal (ML) phase. Respiratory, cardiovascular and hematological responses were studied before, during and after BH efforts. Maximal BHT was significantly higher during ML (115.59±13.95 sec) compared to EF (106.10±12.42 sec) phase of the menstrual cycle. Metabolic rate and build-up of CO2 were higher ($p<0.001$) in EF compared to ML phase. In conclusion, the greater BHT observed at the ML phase of the menstrual cycle may be the result of elevated levels of estrogen and progesterone during midluteal phase affecting both ventilatory response and metabolic rate.

Huang E, Demirel S, Bliss C, Savaser D, Castle JR. Reliability of the Dexcom G6 continuous glucose monitor during hyperbaric oxygen exposure. Diabetes Technol Ther. 2020 Jan 9. doi: 10.1089/dia.2019.0390. [Epub ahead of print]

BACKGROUND: People with diabetes-related ulcers may benefit from hyperbaric oxygen (HBO_2) therapy and from continuous glucose monitoring (CGM). Although blood glucose (BG) meters based on glucose oxidase (GO) report erroneously low values at high PO_2, BG meters based on glucose dehydrogenase (GD) do not. We therefore examined the performance of a GO-based continuous glucose monitoring (CGM) system in comparison to GO-based and GD-based BG systems in normobaric air (NBAir), hyperbaric air (HBAir), and HBO_2 environments. MATERIALS AND METHODS: Twenty-six volunteers without diabetes mellitus (DM) wore Dexcom G6 CGM systems and provided periodic blood samples before, during, and after a standard HBO_2 treatment consisting of three 30-minute intervals of HBO_2 separated by two 5-minute intervals of HBAir. Accuracy of the CGM and GO-based BG meter were assessed by comparisons with the GD-based values. RESULTS: The MARD for the CGM system was 15.96% and for the GO-based meter was 8.52%. Compared to NBAir, HBO_2 exposure resulted in significantly higher CGM values (+3.76 mg/dL, $p<0.001$) and significantly lower GO-based meter values (-10.38 mg/dL, $p<0.001$). Pre-HBO_2 and post-HBO_2 values obtained in NBAir were also significantly different when measured by CGM (+4.13 mg/dL, $p=0.015$) or the GO-based meter (-9.04 mg/dL, $p<0.001$). CONCLUSION: In volunteers without DM, HBO_2 exposure results in statistically significant differences in glucose measurements obtained with GO-based devices, but not a GD-based device. Standard HBO_2 treatment results in statistically significant effects on glucose concentrations. These differences are of unlikely clinical significance.

Löndahl M, Boulton AJM. Hyperbaric oxygen therapy: useless or useful? A battle. Diabetes Metab Res Rev. e3233 2020 Jan 11[Online ahead of print]

The use of hyperbaric oxygen therapy (HBO) in the treatment of certain types of diabetic foot ulcers (DFU) has been the topic of much debate and disagreement over the last several decades. In this review, the evidence for its use is presented and discussed by two experts in DFU management. Whereas some randomized controlled trials suggest that HBO may speed the healing of certain ischaemic or neuroischaemic ulcers after the failure of standard of care, most recent trials have been negative. No RCT is perfect, and the weaknesses of RCTs in this therapeutic area are discussed. It can be concluded that the indications for the use of HBO remain unclear, and that large, rigorously designed and executed RCTs are required to clarify the use of HBO in DFU treatment.

Maffi L, Paganini M, Vezzani G, Soumelis A, Aspati Research Group 1, Camporesi EM, Bosco G. Hyperbaric oxygen treatment for carbon monoxide poisoning in Italy: retrospective validation of a data collection tool for the Italian registry of carbon monoxide poisonings (IRCOP). Int J Environ Res Public Health. 2020; 17(2).

Background: Carbon Monoxide (CO) poisoning is a frequent cause of intoxication. However, CO poisoning incidence is globally underreported, as well as its features, especially in Italy. The aim of this study was to investigate such characteristics of CO intoxication and foster the creation of the Italian Registry of Carbon Monoxide Poisonings. Methods: A data collection tool was developed and organized in five sections: Patient's characteristics; CO intoxication modality; emergency medical service and emergency department; hyperbaric facility; outcomes. The tool was validated through a retrospective analysis, including CO intoxicated patients treated in 14 Italian hyperbaric facilities between 2015 and 2016. Results: A total of 1383 patients were included. The high completion ratio (85%) of the collection tool suggests its feasibility in practical terms. CO intoxications were mostly accidental (93.64%) and caused by solid fuel (48.59%). There was not a uniform application of hyperbaric oxygen treatment protocols, but most of the patients were adequately treated at least at 2.5 ATA for more than 60 min (44.97%). Conclusion: This analysis provided new information that was previously unavailable in this country. Furthermore, this tool proved to be a valid base for future registry aiming to consolidate the body of knowledge about CO intoxications in Italy.

Semadi NI. The role of VEGF and TNF-alpha on epithelialization of diabetic foot ulcers after hyperbaric oxygen therapy. Open Access Maced J Med Sci. 2019; 7(19): 3177-83.

Background: Around 15-25% of diabetes mellitus (DM) patients will develop diabetic foot ulcers (DFUs) with high morbidity, many studies have been proposed to search the most effective healing techniques. Aim: This study was conducted to demonstrate the ability of hyperbaric oxygen therapy (HBOT) as a complementary therapy in DFUs healing through raising vascular endothelial growth factor (VEGF) levels and suppressing tumour necrosis factor-alpha (TNF-α). Methods: All patients received the same treatment including wound debridement and wound care, but the patients in the HBOT group, breathed 100% oxygen at 2.4 ATA for 90 minutes in total of 20 sessions (four weeks). Result: There were 32 diabetic patients with DFUs Wagner 3-4. VEGF levels after four weeks of HBOT was significantly elevated compared to the control group (p=0.013). The effect size of VEGF levels was p=0.005. TNF-α levels after four weeks of therapy were decreased (p=0.01). Faster epithelialization is seen in the HBOT group (p<0.001). We also performed path analysis, HBOT had a significant effect on the epithelialization (p<0.001) and VEGF levels affected the epithelialization process (p=0.042). Conclusion: HBOT administration leads to increased VEGF levels, decreased TNF-α levels, and accelerated wound healing of DFUs patients. HBOT directly aids epithelialization and indirectly through VEGF upsurge and TNF-α downturn.

Siewiera J, Szałański P, Tomaszewski D, Kot J. High-altitude decompression sickness treated with hyperbaric therapy and extracorporeal oxygenation. Aerosp Med Hum Perform. 2020; 91(2):106-9.

BACKGROUND: High-altitude decompression sickness (HADCS) is a rare condition that has been associated with aircraft accidents. To the best of our knowledge, the present paper is the first case report of a patient treated for severe HADCS using recompression therapy and veno-venous extracorporeal oxygenation (VV-ECMO) with a complete recovery. CASE REPORT: After depressurization of a cabin, the 51-yr-old jet pilot was admitted to the Military Institute of Medicine with a life-threatening HADCS approximately 6 h after landing from a high-altitude flight, in a dynamically deteriorating condition, with progressing dyspnea and edema, reporting increasing limb paresthesia, fluctuating consciousness, and right-sided paresis. Hyperbaric oxygen therapy in the intensive care mode was initiated. A therapeutic recompression with US Navy Treatment Table 6 was performed with neurological improvement. Due to cardiovascular collapse, sedation, mechanical ventilation, and significant doses of catecholamines were started, followed by continuous veno-venous hemodialysis. In the face of disturbances in oxygenation, during the second day of treatment the patient was commenced on veno-venous extracorporeal oxygenation. Over the next 6 d, the patient's condition slowly improved. On day 7, VV-ECMO was discontinued. On day 19, the patient was discharged with no neurological deficits. DISCUSSION:

We observed two distinct stages during the acute phase of the disease. During the first stage, signs of hypoperfusion, neurological symptoms, and marbled skin were observed. During the second stage, multiple organ dysfunction dominated, including heart failure, pulmonary edema, acute kidney injury, and fluid overload, all of which can be attributed to extensive endothelial damage.

Tapias LF, Wright CD, Lanuti M, Muniappan A, Deschler D, Mathisen DJ. Hyperbaric oxygen therapy in the prevention and management of tracheal and oesophageal anastomotic complications. Eur J Cardiothorac Surg. 2020 Jan 13[Online ahead of print]

Objectives: Failure of anastomotic healing is a morbid complication after airway or oesophageal surgery. Hyperbaric oxygen therapy (HBOT) has been used extensively in the management of complex wound-healing problems. We demonstrate the use of HBOT to rescue at-risk anastomoses or manage anastomotic failures in thoracic surgery. Methods: Retrospective review of 25 patients who received HBOT as part of the management of tracheal or oesophageal anastomotic problems during 2007-2018. HBOT was delivered at 2 atm with 100% oxygen in 90-min sessions. Results: Twenty-three patients underwent airway resection and reconstruction while 2 patients underwent oesophagectomy. There were 16 (70%) laryngotracheal and 7 (30%) tracheal resections. Necrosis at the airway anastomosis was found in 13 (57%) patients, partial dehiscence in 2 (9%) patients and both in 6 (26%) patients. HBOT was prophylactic in 2 (9%) patients. Patients received a median of 9.5 HBOT sessions (interquartile range 5-19 sessions) over a median course of 8 days. The airway anastomosis healed in 20 of 23 (87%) patients. Overall, a satisfactory long-term airway outcome was achieved in 19 (83%) patients; 4 patients failed and required reoperation (2 tracheostomies and 1 T-tube). HBOT was used in 2 patients after oesophagectomy to manage focal necrosis or ischaemia at the anastomosis, with success in 1 patient. Complications from HBOT were infrequent and mild (e.g. ear discomfort). Conclusions: HBOT should be considered as an adjunct in the management of anastomotic problems after airway surgery. It may also play a role after oesophagectomy. Possible mechanisms of action are rapid granulation, early re-epithelialization and angiogenesis.

Ustrup A, Pedersen SK, Suppli Ulrik C. Assessment of fitness for recreational scuba diving in candidates with asthma: a pilot study. BMJ Open Sport & Exercise Medicine. 2020;6:e000624. doi:10.1136/bmjsem-2019-000624

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.

Vas PR, Papanas N. Editorial and mini-review: topical oxygen therapy for diabetic foot ulcerations - avenue towards new hope? Rev Diabet Stud. 2019;15:71-3.

Diabetic foot complications now represent the 10th leading cause of disease burden and disability. Wound healing is impaired, leading to chronic ulceration. Local high oxygen concentration is required by the metabolically active cells in the wound, which may render the region hypoxic, even in the absence of peripheral arterial disease. Therefore, the contribution of hyperbaric oxygen to improved healing rates has been extensively investigated. More recent developments include products delivering topical oxygen therapy (TOT) directly at the wound site, either by continuous delivery or by pressurized systems. A very recent systematic review has found that TOT increases wound healing rates in chronic, less severe diabetic foot ulcers (DFUs), and it promotes high rates of healing in more severe ulcers. Thus, TOT appears to be

very promising to improve healing in DFUs. We now need more experience regarding its therapeutic place in the algorithm of DFU management and in relation to optimal patient selection.

Wu J, Peng T, Xu Z, Yang X, Zhao L, Yang H, Zhao D. Evaluation of changes in magnetic resonance diffusion tensor imaging after treatment of delayed encephalopathy due to carbon monoxide poisoning. J Integr Neurosci. 2019 Dec 30;18(4):475-479. doi: 10.31083/j.jin.2019.04.160.

Diffusion tensor imaging of the brain tissue microstructure was performed to predict or diagnose the pathophysiological mechanism underlying delayed encephalopathy after carbon monoxide poisoning and the treatment effect was analyzed. The changes in the diffusion parameters (average diffusion coefficient and fractional anisotropy) in adult patients after hyperbaric oxygen therapy of delayed encephalopathy after carbon monoxide poisoning were not significant differences of the two lateral ventricles or anterior or posterior limb of the internal capsule. In the group exposed to hyperbaric oxygen therapy, the fractional anisotropy values of the white matter in the ventricles of the brain and anterior and posterior limbs of the internal capsule were higher than those recorded before therapy, while the average diffusion coefficient values were significantly lower. These finding provide important monitoring indicators for clinicians.

Žarak M, Perović A, Dobrović I, Sandra Goreta S, Dumić J. Galectin-3 and cardiovascular biomarkers reflect adaptation response to scuba diving. Int J Sports Med. 2020 Jan 23[Online ahead of print]

To understand better the adaptation response of the cardiovascular system (CVS) to self-contained underwater breathing apparatus (scuba) diving, Galectin-3 (Gal-3) and specific CVS biomarkers were measured in plasma of 16 male recreational divers before and after (30 min, 3 and 6 h) diving (total time of 30 min at 30 m depth) undertaken a after long non-dive period. The one-time scuba dive caused a significant increase in Gal-3, N-terminal prohormone of brain natriuretic peptide (NT-proBNP), high-sensitivity troponin-I (hs-TnI), and myoglobin immediately after diving. Whereas Gal-3 and myoglobin dropped down to the basal levels during the recovery period, NT-proBNP and hs-TnI concentration continued to increase. An immediate increase of vascular endothelial growth factor, detected immediately after diving, was followed by a significant decrease and return to the basal level, 3 and 6 h after diving, respectively. After a significant initial decrease, endothelin-1 increased during the recovery period, but did not return to the basal level. The observed changes in these biomarkers reflect comprehensive, but transient adaptation of CVS and muscular system to the specific environmental conditions during the scuba dive. Whether the recurrent activation of these adaption mechanisms due to repetitive dives has positive or negative effects on CVS remains to be elucidated.

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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