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

E-NEWS

EDITORIAL NOTE – August 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

COMMUNITY IMAGES

Neal Pollock preparing to dive on the wreck of the Rose Castle, in Conception Bay, NL (47°36'N, 52°58'W) on July 16, 2019. The 139 m cargo vessel was one of four sunk by German action in WWII. The bottom was at 46 m in 2°C water. Navy operations, visible in the background, were being conducted to remove ordnance from the wrecks. Photo by Lorie Laroche. (https://www.thetelegram.com/news/local/divers-remove-82-unexploded-ordnance-from-wrecks-off-bell-island-336577/).

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

Balestra C, Germonpré P, Rocco M, Biancofiore G, Kot J. Diving physiopathology: the end of certainties? Food for thought. Minerva Anestesiol. 2019 Jun 20. doi: 10.23736/S0375-9393.19.13618-8. [Epub ahead of print]

Our understanding of decompression physiopathology has slowly improved during this last decade and some uncertainties have disappeared. A better understanding of anatomy and functional aspects of patent foramen ovale (PFO) have slowly resulted in a more liberal approach toward the medical fitness to dive for those bearing a PFO. Circulating vascular gas emboli (VGE) are considered the key actors in development of decompression sickness and can be considered as markers of decompression stress indicating induction of pathophysiological processes not

necessarily leading to occurrence of disease symptoms. During the last decade, it has appeared possible to influence post-dive VGE by a so-called "preconditioning" as a pre-dive denitrogenation, exercise or some pharmacological agents. In the text we have deeply examined all the scientific evidence about this complicated but challenging theme. Finally, the role of the "normobaric oxygen paradox" has been clarified and it is not surprising that it could be involved in neuroprotection and cardioprotection. However, the best level of inspired oxygen and the exact time frame to achieve optimal effect is still not known. The aim of this paper is to reflect upon the most actual uncertainties and distil out of them a coherent, balanced advice towards the researchers involved in gas-bubbles-related pathologies.

Bennett MH, Mitchell SJ. Emerging indications for hyperbaric oxygen. Curr Opin Anaesthesiol. 2019 Jul 22. doi: 10.1097/ACO.0000000000000773. [Epub ahead of print]

PURPOSE OF REVIEW: To identify and discuss emerging trends in the therapeutic use of hyperbaric oxygen. RECENT FINDINGS: There has been a maturing of the clinical evidence to support the treatment of sudden hearing loss, a wide range of problematic chronic wound states and the prevention and treatment of end-organ damage associated with diabetes mellitus. On the other hand, the controversy continues concerning the use of hyperbaric oxygen therapy (HBOT) to treat sequelae of mild traumatic brain injury. HBOT remains poorly understood by many medical practitioners despite more than 50 years of clinical practice. Pharmacological actions arise from increased pressures of oxygen in the blood and tissues. Most therapeutic mechanisms identified are not the simple result of the reoxygenation of hypoxic tissue, but specific effects on immunological and metabolic pathways by this highly reactive element. HBOT remains controversial despite biological plausibility and a solid clinical evidence base in several disease states. SUMMARY: Multiple proposals for new indications for HBOT continue to emerge. Although many of these will likely prove of limited clinical importance, some show significant promise. Responsible practitioners remain acutely aware of the need for high-quality clinical evidence before introducing emerging indications into routine practice.

Honěk J, Šrámek M, Šefc L, Januška J, Fiedler J, Horváth M, Tomek A, Novotný Š, Honěk T, Veselka J. High-grade patent foramen ovale is a risk factor of unprovoked decompression sickness in recreational divers. J Cardiol. 2019 Jun 26. pii: S0914-5087(19) 30144-3.

BACKGROUND: Patent foramen ovale (PFO), male sex, age, and body mass index (BMI) were all identified as potential risk factors of decompression sickness (DCS). It has been debated whether PFO might cause unprovoked DCS (i.e., without violation of decompression procedure) due to paradoxical embolization of venous gas emboli. To date, there are no data on the incidence or risk factors of unprovoked DCS. This study sought to evaluate the risk factors of unprovoked DCS in recreational divers. METHODS: A total of 489 consecutive divers were screened for PFO between January 2006 and January 2014 by means of transcranial Doppler. All patients were prospectively included in the study registry. Survival analysis techniques were used to assess for risk factors for unprovoked DCS. Age, sex, BMI, PFO presence, and grade were analyzed. The total sum of dives was used as a measure of time. RESULTS: The group performed a total of 169,411 dives (mean 346±636). Thirty-six (7%) of the divers suffered from an unprovoked DCS. The frequency of PFO was 97.2% in divers with a history of unprovoked DCS and 35.5% in controls ($p<0.001$). There was no difference in sex, age, BMI, or total number of dives between the respective groups. In the adjusted Cox proportional hazards model, PFO grade 3 was a major risk factor for unprovoked DCS; there was a slight protective effect of increasing age. CONCLUSIONS: We demonstrated that a high-grade PFO was a major risk factor for unprovoked DCS in recreational scuba divers.

G KV, Komala J, Mohsin AH, Ahmed MA, Sairam G, Sheethi KV. A study to evaluate the effect of hyperbaric oxygen on osseointegration of root-form endosseous titanium dental implants: an in vivo study. J Contemp Dent Pract. 2019;20(4):460-5.

AIM: To evaluate the effect of hyperbaric oxygen (HBO) therapy on the osseointegration of dental implants by resonance frequency analysis. MATERIALS AND METHODS: Six rabbits of age 2 to 2.5 years, weight approximately 2 kg were selected and tagged 1-6. For all the animals' right femur was selected as a control group (R) and left femur as test group (L). Initially, implants of dimensions 3.75×8 mm (Adin Touareg) were placed in the right femur. Implant stability quotient (ISQ) values were recorded using OSSTELL ISQ at the time of surgery (R0), after one month (R1), and the end of the second month (R2). After two months of uneventful healing, implants were placed on the left femur of all the six rabbits and three were grouped as 2S (subjected to 2 HBO sessions at the weekly interval) and other three as 4S (subjected to 4 HBO sessions at weekly interval for a month). At the time of surgery (L0), end of one month (L1) and two months (L2), ISQ values were recorded and subjected to statistical analysis. The total duration of the study was 4 months from 3 March 2013 to 03 July 2013. RESULTS: The data were statistically analyzed using t-test and analysis of variance (ANOVA) F. On the comparison between the control group (R) and test groups (2S and 4S) ISQ values for test groups were more which was highly statistically significant ($p<0.001$). Among the two test groups 4S

group has more ISQ values compared to 2S ($p<0.001$). CONCLUSION: This study indicated that HBO therapy has a promotive effect on the rate of osseointegration of dental implants. CLINICAL SIGNIFICANCE: Study opens new scope for further in vivo research in utilizing hyperbaric oxygen therapy (HBOT) in implant surgeries, maxillofacial trauma cases and irradiated patients to hasten or improve osseointegration.

Looney DP, Long ET, Potter AW, Xu X, Friedl KE, Hoyt RW, Chalmers CR, Buller MJ, Florian JP. Divers risk accelerated fatigue and core temperature rise during fully-immersed exercise in warmer water temperature extremes. Temperature (Austin). 2019;6(2):150-7.

Physiological responses to work in cold water have been well studied but little is known about the effects of exercise in warm water; an overlooked but critical issue for certain military, scientific, recreational, and professional diving operations. This investigation examined core temperature responses to fatiguing, fully-immersed exercise in extremely warm waters. Twenty-one male US Navy divers (body mass, 87.3±12.3 kg) were monitored during rest and fatiguing exercise while fully-immersed in four different water temperatures (Tw): 34.4, 35.8, 37.2, and 38.6°C ($Tw_{34.4}$, $Tw_{35.8}$, $Tw_{37.2}$, and $Tw_{38.6}$ respectively). Participants exercised on an underwater cycle ergometer until volitional fatigue or core temperature limits were reached. Core body temperature and heart rate were monitored continuously. Trial performance time decreased significantly as water temperature increased ($Tw_{34.4}$, 174±12 min; $Tw_{35.8}$, 115 ± 13 min; $Tw_{37.2}$, 50±13 min; $Tw_{38.6}$, 34±14 min). Peak core body temperature during work was significantly lower in $Tw_{34.4}$ water (38.31±0.49°C) than in warmer temperatures ($Tw_{35.8}$, 38.60±0.55°C; $Tw_{37.2}$, 38.82±0.76°C; $Tw_{38.6}$, 38.97±0.65°C). Core body temperature rate of change increased significantly with warmer water temperature ($Tw_{34.4}$, 0.39±0.28°C·h^{-1}; $Tw_{35.8}$, 0.80±0.19°C·h^{-1}; $Tw_{37.2}$, 2.02±0.31°C·h^{-1}; $Tw_{38.6}$, 3.54±0.41°C·h^{-1}). Physically active divers risk severe hyperthermia in warmer waters. Increases in water temperature drastically increase the rate of core body temperature rise during work in warm water. New predictive models for core temperature based on workload and duration of warm water exposure are needed to ensure warm water diving safety.

Masters TC, Westgard BC, Hendriksen SM, Decanini A, Abel AS, Logue CJ, Walter JW, Linduska J, Engel KC. Case series of hyperbaric oxygen therapy for central retinal artery occlusion. Retin Cases Brief Rep. 2019 Jul 10. doi: 10.1097/ICB.0000000000000895. [Epub ahead of print]

PURPOSE: To retrospectively report the outcomes of patients presenting to our facility with central retinal artery occlusion and receiving therapy with hyperbaric oxygen (HBO). METHODS: This was a retrospective, chart review at a single hospital center. Patients with diagnosed central retinal artery occlusion were treated with HBO twice daily for 5 days during their inpatient stay for a total of 10 HBO treatments. Main outcome was change from the documented presenting best-corrected visual acuity to discharge best-corrected visual acuity. Thirty-nine patients with central retinal artery occlusion were included in the analysis during a 30-month period. RESULTS: Twenty-eight of 39 patients (72%) had some improvement in acuity. There was a mean of 5.05 lines of improvement using a modified Snellen chart after completing their HBO treatment course. Patients treated within 12 hours of symptom onset showed the greatest improvement in their visual acuity (6.11 mean lines of improvement). Complications of therapy included middle ear barotrauma (10/39) and confinement anxiety (1/39) and did not interfere with the therapy regimen or hospital course. CONCLUSION: This retrospective case series supports the use of emergent HBO therapy as a viable treatment option for patients with central retinal artery occlusion. Hyperbaric oxygen therapy was safely administered and well tolerated.

Resanović I, Gluvić Z, Zarić B, Sudar-Milovanović E, Vučić V, Arsić A, Nedić O, Šunderić M, Gligorijević N, Milačić D, Isenović ER. Effect of Hyperbaric Oxygen therapy on fatty acid composition and insulin-like growth factor binding protein 1 in adult insulin-dependent diabetes mellitus patients: a pilot study. Can J Diabetes. 2019 May 8. pii: S1499-2671(19)30023-1. doi: 10.1016/j.jcjd.2019.04.018. [Epub ahead of print]

OBJECTIVE: Metabolic changes in insulin-dependent diabetes mellitus (IDDM) impair vasodilation, and this leads to tissue hypoxia and microvascular pathology. Hyperbaric oxygen therapy (HBOT) can significantly improve the outcome of ischemic conditions in IDDM patients and reduce vascular complications. The aim of our study was to assess the effects of HBOT on plasma fatty acid (FA) composition, and expression of insulin-like growth factor binding protein 1 (IGFBP-1) in IDDM patients. METHODS: Our study included 24 adult IDDM patients diagnosed with peripheral vascular complications. The patients were exposed to 10 sessions of 100% oxygen inhalation at 2.4 atmosphere absolute for 1 hour. Blood samples were collected at admission and after HBOT for measurement of metabolic parameters, FA composition and IGFBP-1. Measurement of plasma FA composition was determined by gas chromatography. Expression of IGFBP-1 in the serum was estimated by Western blot analysis. RESULTS: HBOT decreased blood levels of total cholesterol ($p<0.05$), triglycerides ($p<0.05$) and low-density lipoprotein ($p<0.05$). HBOT increased plasma levels of individual FAs: palmitic acid ($p<0.05$), palmitoleic acid ($p<0.05$), docosapentaenoic acid ($p<0.05$) and docosahexaenoic acid ($p<0.01$), and decreased levels

of stearic acid ($p<0.05$), alpha linolenic acid ($p<0.05$) and linoleic acid ($p<0.01$). Expression of IGFBP-1 ($p<0.01$) was increased, whereas the level of insulin ($p<0.001$) was decreased in the serum after HBOT. CONCLUSIONS: Our results indicate that HBOT exerts beneficial effects in IDDM patients by improving the lipid profile and altering FA composition.

Sankaran R, Radhakrishnan K, Sundaram KR. Hyperbaric oxygen therapy in patients with hypoxic ischemic encephalopathy. Neurol India. 2019;67(3):728-31.

BACKGROUND AND AIM: To assess the efficacy of hyperbaric oxygen therapy (HBOT) in patients with hypoxic ischemic encephalopathy (HIE). DESIGN: Non-randomized case-control observational study. SETTING: Tertiary level neurorehabilitation unit. POPULATION: Twenty-five patients with HIE seen between 1 to 12 months after the injury and having a coma recovery scale-revised (CRS-R) score less than 7 at entry were recruited. METHODS: Out of the patients who received HBOT, 20 received 20 sessions of HBOT at two absolute atmosphere pressure (ATA), and two received 60 sessions at 2 ATA over three different treatment intervals. We compared the outcomes between cases (who received HBOT) and controls (who did not receive HBOT).Cases and controls were allocated to three groups based on the time interval after injury following which they were recruited to the study: 1-3 months (9 cases and 16 controls), 4-8 months (9 cases and 9 controls) and 9-12 months (8 cases and 3 controls). OUTCOME MEASURES: CRS-R, Karnofsky performance scale, and change in disorder of consciousness (DOC) at admission and discharge were assessed. RESULTS: We observed a significant difference in CRS-R favoring the HBOT group at time intervals of 1-3 and 4-8 months. More patients in the HBOT group improved in DOC than the control group. CONCLUSIONS: HBOT given in the first nine months post-HIE can result in a better recovery and functional outcome

Tejada S, Batle JM, Ferrer MD, Busquets-Cortés C, Monserrat M, Nabavi SM, Del Mar Bibiloni M, Pons A, Sureda A. Therapeutic effects of hyperbaric oxygen in the process of wound healing. Curr Pharm Des. 2019 Jul 3. doi: 10.2174/1381612825666190703162648. [Epub ahead of print]

Chronic and non-healing wounds, especially diabetic foot ulcers and radiation injuries, imply a remarkable morbidity with a significant effect on the quality of life and a high sanitary cost. The management of these wounds requires complex actions such as surgical debris, antibiotic treatment, dressings and even revascularization. These wounds are characterized by poor oxygen supply resulting in inadequate oxygenation of the affected tissue. The adjuvant treatment with hyperbaric oxygen therapy (HBOT) may increase tissue oxygenation favoring the healing of wounds which do not respond to the usual clinical care. The increase in partial pressure of oxygen contributes to cover the energy demands necessary for the healing process and reduces the incidence of infections. Moreover, the increase in oxygen leads to the production of reactive species with hormetic activity, acting on signaling pathways that modulate the synthesis of inflammation mediators, antioxidants and growth factors which can contribute to the healing process. Studies performed with cell cultures and in animal models seem to demonstrate the beneficial effects of HBOT. However, clinical trials do not show such conclusive results; thus, additional randomized placebo-controlled studies are necessary to determine the real efficacy of HBOT and the mechanism of action for various types of wounds.

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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