

EDITOR'S NOTE – December 2020

The E-News is the monthly newsletter of CUHMA, the primary outlet to share news and information. It was developed to deliver a range of relevant content, including news, announcements, upcoming events, new publication abstracts, job postings, professional perspectives, incident reports, and images of relevant professional scenes. The CUHMA Board of Directors would like to thank Neal Pollock for the last three years as editor. Past issues are available at <https://cuhma.ca>.

The Board of Directors for CUHMA would like to wish you peace, health and happiness in the new year and hope you all find time this holiday season to slow down for a moment, connect with friends and family and find gratitude in a time when things are ever changing, fast paced and stressful.

Sherri Ferguson, MSc.
Simon Fraser University

PRESIDENTS MESSAGE

Dear CUHMA members,
It is with great pleasure last month to have met with the new Board of Directors that you the members voted for. I look forward to the next couple years as your president in leading the organization through these challenging times. The Board and I have many ideas that we are working towards in order to fulfill our association's goals, vision and mission, while honouring our values of excellence, leadership, collaboration, communication and integrity. Thank you for your interest and support of CUHMA despite these difficult times triggered by the COVID-19 pandemic. I wish you and your loved ones a very happy holiday season and a New Year full of love and light!

Sincerely,
Rita Katznelson, MD FRCPC
CUHMA President.

NEWS/ANNOUNCEMENTS

Recall and Safety Alert

Health Canada is advising Canadians that soft-shelled hyperbaric chambers are unlicensed medical devices and may pose serious health risks. Since first warning Canadians about the risks of using unlicensed soft-shelled hyperbaric chambers in October of 2019 the Department has continued to take action to remove these products from the market and respond to complaints. It is illegal to advertise for sale, import for sale, or sell medical devices without appropriate licensing. For more information or to report a concern:

<https://healthycanadians.gc.ca/recall-alert-rappel-avis/hc-sc/2020/74275a-eng.php#:~:text=Health%20Canada%20is%20advising%20Canadians,may%20pose%20serious%20health%20risks>.

UPCOMING EVENTS

SFU Fundamentals of Hyperbaric Medicine. Simon Fraser University Introductory Hyperbaric Medicine course will run February 13-28 in a live stream online format on weekends and evenings. The program is suitable for physicians and other health professionals looking to become CHT certified or obtain knowledge towards supervising hyperbaric treatments. 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: www.sfu.ca/empu

Call for Abstracts UHMS Annual Scientific Meeting: 2021 ASM will be held June 10-12 at the Astor Crowne Plaza French Quarter, New Orleans, LA. Deadline for submissions Sunday, February 7th Midnight ET.
<https://www.uhms.org/meetings/annual-scientific-meeting/uhms-annual-scientific-meeting-information/2-uncategorised/23-call-for-abstracts-submission.html>

RECENT PUBLICATIONS

Hyperbaric oxygen therapy increases telomere length and decreases immunosenescence in isolated blood cells : a prospective trial. Aging 2020 Oct 26;182(44):V06200463. Yafit Hachmo , Amir Hadanny , Ramzia Abu Hamed, Malka Daniel-Kotovsky, Merav Catalogna, Gregory Fishlev, Erez Lang, Nir Polak, Keren Doenyas, Mony Friedman, Yonatan Zemel, Yair Bechor, Shai Efrati.

Introduction: Aging is characterized by the progressive loss of physiological capacity. At the cellular level, two key hallmarks of the aging process include telomere length (TL) shortening and cellular senescence. Repeated intermittent hyperoxic exposures, using certain hyperbaric oxygen therapy (HBOT) protocols, can induce regenerative effects which normally occur during hypoxia. The aim of the current study was to evaluate whether HBOT affects TL and senescent cell concentrations in a normal, non-pathological, aging adult population. **Methods:** Thirty-five healthy independently living adults, aged 64 and older, were enrolled to receive 60 daily HBOT exposures. Whole blood samples were collected at baseline, at the 30th and 60th session, and 1-2 weeks following the last HBOT session. Peripheral blood mononuclear cells (PBMCs) telomeres length and senescence were assessed. **Results:** Telomeres length of T helper, T cytotoxic, natural killer and B cells increased significantly by over 20% following HBOT. The most significant change was noticed in B cells which increased at the 30th session, 60th session and post HBOT by 25.68%±40.42 (p=0.007), 29.39%±23.39 (p=0.0001) and 37.63%±52.73 (p=0.007), respectively. There was a significant decrease in the number of senescent T helpers by -37.30%±33.04 post-HBOT (P<0.0001). T-cytotoxic senescent cell percentages decreased significantly by -10.96%±12.59 (p=0.0004) post-HBOT. In conclusion, the study indicates that HBOT may induce significant senolytic effects including significantly increasing telomere length

and clearance of senescent cells in the aging populations.

Hyperbaric Oxygen Therapy in Chronic Inflammatory Conditions of the Pouch. World Neurosurg. 2020 Sep 2;S1878-8750(20)31842-8. Badar Hasan, Yunjoo Yim , Mamoon Ur Rashid, Rumman A Khalid , Deepika Sarvepalli , Daniel Castaneda, Asad Ur Rahman, Nicole Palekar, Roger Charles, Fernando J Castro, Bo Shen

Background: Pouchitis can be a chronic complication of ileal pouch-anal anastomosis. We aimed to determine the efficacy and safety of hyperbaric oxygen therapy (HBOT) for chronic antibiotic-refractory pouchitis (CARP) and other inflammatory conditions of the pouch.

Methods: This was a retrospective case series of adults with inflammatory bowel disease (IBD) who underwent ileal pouch-anal anastomosis and then developed CARP and received HBOT between January 2015 and October 2019. A modified Pouchitis Disease Activity Index (mPDAI) score was used to quantify subjective symptoms (0-6) and endoscopic findings (0-6) before and after HBOT. **Results:** A total of 46 patients were included, with 23 (50.0%) being males with a mean age of 43.6 ± 12.9 years. The median number of HBOT sessions was 30 (range 10-60). There was a significant reduction in the mean mPDAI symptom subscore from 3.19 to 1.91 after HBOT (P < 0.05). The pre- and post-HBOT mean mPDAI endoscopy subscores for the afferent limb were 2.31 ± 1.84 and 0.85 ± 1.28 (P = 0.006); for the pouch body, 2.34 ± 1.37 and 1.29 ± 1.38 (P < 0.001); and for the cuff, 1.93 ± 1.11 and 0.63 ± 1.12 (P < 0.001), respectively. Transient side effects included ear barotrauma in 5 patients (10.9%) and hyperbaric myopic vision changes in 5 patients (10.9%).

Conclusions: Despite minor adverse events, HBOT was well tolerated in patients with CARP and significantly improved symptoms and endoscopic parameters.

Hyperbaric oxygen and focused rehabilitation program: a feasibility study in improving upper limb motor function after stroke. *Dermatol Ther.* 2020 Nov 20;e14565. S Schiavo, D Richardson, D Santa Mina, S Buryk-Iggers, J Uehling, J Carroll, H Clarke, C Djaiani, M Gershinsky, R Katznelson

Neuroplasticity and recovery after stroke can be enhanced by a rehabilitation program pertinent to upper limb motor function exercise and mental imagery (EMI) as well as hyperbaric oxygen therapy (HBOT). We assessed feasibility and safety of the combined approach utilizing both HBOT and EMI, and to derive preliminary estimates of its efficacy. In this randomized controlled trial, 27 patients with upper extremity hemiparesis at 3-48 months after stroke were randomized to receive either a complementary rehabilitation program of HBOT-EMI (intervention group), or EMI alone (control group). Feasibility and safety were assessed as total session attendance, duration of sessions, attrition rates, missing data, and intervention-related adverse events. Secondary clinical outcomes were assessed with both objective tools and self-reported measures at baseline, 8 weeks (end of treatment), and 12-weeks follow-up. Session attendance, duration, and attrition rate did not differ between the groups; there were no serious adverse events. Compared with baseline, there were significant sustained improvements of objective and subjective outcomes' measures in the intervention group, and a single improvement in an objective measure in the control group. Between-group outcome comparisons were not statistically significant. This study demonstrated that the combination HBOT-EMI was a safe and feasible approach in patients recovering from chronic stroke. There were also trends for improved motor function of the affected upper limb after the treatments. ClinicalTrials.gov registration no.: [NCT02666469](https://clinicaltrials.gov/ct2/show/study/NCT02666469). **Novelty** HBOT combined with an upper limb exercise and mental imagery rehabilitation program is feasible and safe in chronic stroke patients. This combined approach showed trends for improved functional recovery.

Avascular necrosis of the femoral head: Evaluation of hyperbaric oxygen therapy and quality of life. *Graefes Arch Clin Exp Ophthalmol.* 2020 Feb;258(2):303-310. Angeliki Chandrinou, Anna Korompeli, Eirini Grammatopoulou, Konstantina Gaitanou, Konstantinos Tsoumakas, George Fildissis

Introduction: The treatment of avascular necrosis of the femoral head (AVNFB) is based on invasive (e.g., core decompression) and non-invasive methods (e.g., hyperbaric oxygen therapy - HBO2). The purpose of the present study is to evaluate the effect of HBO2 on the quality of life (QoL) of patients with AVNFB. **Methods:** This was a prospective observational non-controlled study of patients with AVNFB treated by HBO2. It was conducted, with the use of Steinberg scale, on 73 patients with AVNFB Stage I or II who were treated with HBO2. Patients' QoL was assessed with EuroQol-5D-5L (EQ), Harris Hip Score (mHHS), MAHORN (MHOT), and VAS, in three different phases: before HBO2; after the completion of the first phase (20 HBO2 sessions, up to two months); and after the completion of the second phase (20 HBO2 sessions, up to two months after the first phase). A reassessment was made on the completion of each phase. Ratings were also made after the completion of each phase, over the first five months of follow-up. **Results:** All 73 patients (67.1% males, 32.9% females, mean age: 40.34, SD \pm 9.99) participated in the study. Steinberg scale, mean EQ (F (1, 57) = 25.18, η^2 = .306 and F (1, 43) = 43.402, η^2 = .502); mHHS (F (1, 61) = 67.13, η^2 = .524) and F (1, 43) = 31.84, η^2 = .425); MHOT (F (1, 61) = 11.68, η^2 = .161) and F (1, 43) = 98.01, η^2 = .695); and VAS (F (1, 53) = 24.11, η^2 = .313) and F (1, 39) = 45.61, η^2 = .539), improved between the first and second measurements and between the second and third measurement accordingly (p < .01). **Conclusion:** HBO2 treatment does not induce alteration of quality of life and is well tolerated and accepted by patients.

Development of visual acuity under hyperbaric oxygen treatment (HBO) in non arteritic retinal branch artery occlusion. Brain Res. 2020 Dec 1;1748:147097. Ilka Schmidt, Peter Walter, Ullrich Siekmann, Niklas Plange, Antonis Koutsonas, Babac Ebrahim Mazinani, David Kuerten

Purpose: Nonperfusion of retinal tissue due to arterial occlusion leads inevitably to mostly irreversible retinal damage. Until today no evidence-based treatment exists. Inhalation of 100% oxygen at high atmospheric pressure causes an increased solubility of oxygen in the blood that helps the retinal tissue to survive through diffusion in case of an artery occlusion till vascular recanalization occurs. Hence the purpose of this study is to compare the visual outcome in patients with retinal branch artery obstruction treated with hyperbaric oxygen versus patients treated with hemodilution only. Methods: Non-randomized, monocentric, retrospective study. Patients with diagnosis of non-arteritic retinal branch artery occlusion (BRAO) treated with hyperbaric oxygen therapy between 1997 and 2017. Exclusion criteria were central retinal artery occlusion, presence of a cilioretinal artery and arteritic cases. The control group was matched based on visual acuity (VA) at admission, age, and delay between symptoms and beginning of clinical care. Results: The control group and the matching oxygen group contained 14 patients each. Initial VA in the matched HBO group was 0.18 ± 0.19 and 0.23 ± 0.19 in the control group ($p = 0.57$). Final VA at discharge was 0.69 ± 0.29 in the matched oxygen group and 0.32 ± 0.23 in the control group ($p = 0.0009$). HBO-treated patients had a significant visual increase compared with the control group. The most common comorbidities were arterial hypertension and vascular sclerosis. Conclusion: HBO treatment appears to have a beneficial effect on visual outcome in patients with retinal branch artery occlusion. HBO treatment could be a rescue therapy at an early stage of BRAO, especially to bridge the time of a potential reperfusion. However, further, prospective, randomized clinical trials are required to verify this assumption.

Effects of repetitive hyperbaric oxygen therapy on neuroprotection in middle cerebral artery occlusion rats. Cell Mol Neurobiol. 2020 Nov;40(8):1253-1269. Heng-Chih Chang, Yea-Ru Yang, Ray-Yau Wang

Hyperbaric oxygen (HBO) has been suggested as a possible therapy for brain injury. However, the effects of HBO after transient brain ischemia are inconsistent and the underlying mechanisms are not fully known. The present study aimed to investigate the effects of repetitive HBO intervention in a transient middle cerebral artery occlusion (MCAO) animal model. Seventy-two Sprague-Dawley rats received MCAO and were randomly assigned to normal air control or HBO intervention groups. Each group was divided into 3 subgroups according to the intervention time period (7, 14, and 21 days). HBO was started 24 h post-MCAO for 1 h/day at 3.0 ATA with no-air breaks. After the final intervention, half of the rats in each subgroup were sacrificed and the right motor cortex was removed to examine levels of Akt phosphorylation and glutathione (GSH), as well as glutathione peroxidase (GPx) and reductase (GR) activity. The other half of the rats were used to examine infarct volume. At 24 h post-MCAO and the end of the final intervention, rats underwent tests to examine motor performance. We noted that 14- and 21-day HBO interventions significantly reduced infarct volume and increased Akt phosphorylation and GSH levels and GPx and GR activity. Motor performance was also significantly improved after 14- and 21-day interventions. No significant differences were observed between the controls and 7-day intervention groups. Repetitive HBO intervention starting 24 h post-MCAO and applied for at least 14 days, provided neuroprotective effects through modulating the cell survival pathway and antioxidative defense system.

Hyperbaric oxygen therapy for COVID-19 patients with respiratory distress: treated cases versus propensity-matched controls. Undersea Hyperb Med. 2020 Third-Quarter;47(3):405-413. Scott A Gorenstein, Michael L

Castellano Eric S Slone , Brian Gillette , Helen Liu , Cindy Alsamarraie Ala , M Jacobson , Stephen P Wall , Samrachana Adhikari , Jordan L Swartz , Jenica J S McMullen , Marcela Osorio , Christian A Koziatek , David C Lee.

Objective: Given the high mortality and prolonged duration of mechanical ventilation of COVID-19 patients, we evaluated the safety and efficacy of hyperbaric oxygen for COVID-19 patients with respiratory distress. **Methods:** This is a single-center clinical trial of COVID-19 patients at NYU Winthrop Hospital from March 31 to April 28, 2020. Patients in this trial received hyperbaric oxygen therapy at 2.0 atmospheres of pressure in monoplace hyperbaric chambers for 90 minutes daily for a maximum of five total treatments. Controls were identified using propensity score matching among COVID-19 patients admitted during the same time period. Using competing-risks survival regression, we analyzed our primary outcome of inpatient mortality and secondary outcome of mechanical ventilation. **Results:** We treated 20 COVID-19 patients with hyperbaric oxygen. Ages ranged from 30 to 79 years with an oxygen requirement ranging from 2 to 15 liters on hospital days 0 to 14. Of these 20 patients, two (10%) were intubated and died, and none remain hospitalized. Among 60 propensity-matched controls based on age, sex, body mass index, coronary artery disease, troponin, D-dimer, hospital day, and oxygen requirement, 18 (30%) were intubated, 13 (22%) have died, and three (5%) remain hospitalized (with one still requiring mechanical ventilation). Assuming no further deaths among controls, we estimate that the adjusted subdistribution hazard ratios were 0.37 for inpatient mortality ($p=0.14$) and 0.26 for mechanical ventilation ($p=0.046$).

Conclusion: Though limited by its study design, our results demonstrate the safety of hyperbaric oxygen among COVID-19 patients and strongly suggests the need for a well-designed, multicenter randomized control trial.

Hyperbaric oxygen therapy in the prevention and management of tracheal and oesophageal anastomotic complications. Eur J Cardiothorac Surg 2020 Jun 1;57(6):1203-1209. Luis F Tapias , Cameron D Wright , Michael Lanuti , Ashok Muniappan , Daniel Deschler , Douglas J Mathisen

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.

Imaging-based predictors for hyperbaric oxygen therapy outcome in post-stroke patients. Med Hypothesis. 2020 Mar;136:109510. Haim Golan, Boris Makogon, Olga Volkov, Yuri Smolyakov, Amir Hadanny, Shai Efrati

We tested the hypothesis that if SPECT/CT-detected volumes of active and inactive parts of brain tissue present correlation with the results of hyperbaric oxygen therapy (HBOT) of ischemic stroke, SPECT imaging may serve as a selective tool for post-stroke patients to indicate cases that may significantly benefit from HBOT. A retrospective analysis was conducted on 62 consecutive patients administered for HBOT after the ischemic stroke episode. All patients received 60 daily hyperbaric sessions consisting of 90 min of exposure to 100% oxygen at a pressure of 0.2 MPa. The results of the treatment were assessed in correlation with SPECT/CT-detected changes of volumes of the penumbra area around the stroke zone. Patients who significantly benefitted from HBOT (n = 24) by an improvement of their clinical neurologic status and quality of life had the large penumbra zone (363 ± 20.5 ml) that was significantly diminished during HBOT. Patients who did not benefit from HBOT (n = 20) had a relatively small volume of the penumbra zone (148 ± 29.3 ml) and its further diminishing during HBOT was insignificant. The HBOT results were unclear in 18 patients with penumbra volumes between these values. These findings support our hypothesis that the large volume of the penumbra area around the stroke zone can serve as a significant predictor for positive clinical outcome following HBOT in post-stroke patients. The SPECT/CT-based assessment procedure of the volume of the penumbra may serve as an effective selecting tool when HBOT is administered for patients with ischemic stroke.

Severe Decompression Sickness Associated with Shock and Acute Respiratory Failure. Case Reports in Critical Care 2020, 2020: 8855060. Abdullah Arjomand, James R Holm, Anthony J Gerbino.

Decompression sickness (DCS) is a well-recognized complication of diving but rarely results in shock or respiratory failure. We report a case of severe DCS in a diver associated with shock and respiratory failure requiring mechanical ventilation. A healthy 50-year-old male diver dove to a depth of 218 feet for 43 minutes while breathing air but omitted 6.5 hours of air decompression due to diver error. The clinical presentation was remarkable for loss of consciousness, hypotension, cutis marmorata, peripheral edema, and severe hypoxia requiring mechanical ventilation with diffuse lung opacities on chest radiograph. Laboratories were significant for polycythemia and hypoalbuminemia. A single hyperbaric oxygen treatment was provided on the day of admission during which shock worsened requiring aggressive volume resuscitation and three vasopressors. In the first 37 hours of hospitalization, 22 liters of crystalloid and multiple albumin boluses were administered for refractory hypotension by which time all vasopressors had been discontinued and blood pressure had normalized. He required 10 days of mechanical ventilation and was discharged on day 21 with mild DCS-related neurologic deficits. This clinical course is characteristic of DCS-related shock wherein bubble-endothelial interactions cause a transient capillary leak syndrome associated with plasma extravasation, hemoconcentration, and hypovolemia. The pathophysiology and typical clinical course of DCS-related shock suggest the need for aggressive but time-limited administration of crystalloid and albumin. Because hyperbaric oxygen is the primary treatment for DCS, treatment with hyperbaric oxygen should be strongly considered even in the face of extreme critical illness.

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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

For submissions to the E-News please send to the editor by the 10th of the month. Please include the doi and/or PMID with published abstracts for consideration.

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