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

E-NEWS

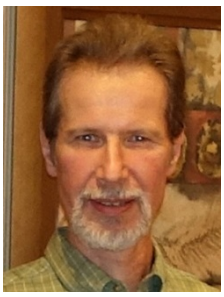
EDITORIAL NOTE – March 2019

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

Neal W. Pollock, PhD
Université Laval

NEWS/ANNOUNCEMENTS

Obituary - Richard M. Johnson



Richard Johnson (RN, CHT) died unexpectedly on February 09, 2019 while vacationing in Costa Rica. Richard was a stalwart of the Canadian hyperbaric community throughout most of his career. After graduating from Ryerson University in 1989, he worked as an ICU nurse at Toronto Western Hospital. He completed his CHT training in 1992 and worked as a registered nurse and Controller for the Hyperbaric Medicine Unit, staff nurse at Toronto General Hospital, and as a CHT at the Judy Dan and Rouge Valley Medical Centres until his professional retirement in 2017. Richard served as an educator from 2002, teaching the patient care components of NBDHMT courses for CHTs and CHRNs, and of UHMS courses for MDs in Toronto and Ottawa. He was also very active as a volunteer, serving as a member of the CSA Committee on Standards for Hyperbaric Facilities (Z275.1), and in multiple capacities in the governance of diving and hyperbaric medical organizations in Canada. He was a member of the UHMS Great Lakes Chapter (GLC) since 1996, and served on the board as a member from 2001-03, Vice-President from 2003-05 and 2008-09, and Secretary-Treasurer from 2009-10. His efforts in the last role were critical in the final accounting of GLC. When the GLC was disbanded and the Canadian Chapter of the UHMS was formed in 2010, Richard served on the Board of Directors in several capacities, including Treasurer and webmaster. He continued on as Treasurer of CUHMA when it was founded in 2015, retiring from that position in late 2018. Outside of work, Richard loved nature and the outdoors. He was an avid beekeeper, and he and his wife Joyce enjoyed running, cycling, hiking, yoga, travel, and scuba diving. He will be deeply missed by all who knew him.

Educational Video Clips from CUHMA 2018 ASM

We are extending the reach of CUHMA scientific meetings with video clips of presentation highlights and workshops. These are freely available through the CUHMA website for educational purposes. There are clips in English and French, ranging from 5-13 minutes in duration. To review: https://www.youtube.com/playlist?list=PLHJt-7L92RI42TEfb79-lf5b1LPt9aUcm

Call for Original Research – CUHMA 2019

Both original research and review session abstracts will be considered for oral presentation at the 2019 CUHMA annual scientific meeting in St. John's, NL October 03-06. The submission deadline is June 15, 2019, with decisions returned to corresponding authors by July 15. Submit abstracts to neal.pollock@kin.ulaval.ca.

Abstract Submission Guidelines (Word file)
Line 1 - informative title, bold and block capitals.
Line 2 - author(s) (surname followed by initials for each).
Line 3 - professional affiliations for author(s).
Lines 4+ (research abstracts) - maximum 250 words (introduction, methods, results, conclusions, funding acknowledgment), 10 pitch Times New Roman, block format (ie, no indenting), complete data but no references, tables or figures.
Lines 4+ (review session abstracts) - 150-250 words, 10 pitch Times New Roman, block format (ie, no indenting), overview of proposed presentation but no references, tables or figures.

Doctoral Studies in Diving Research

Active recruitment is underway at Université Laval for qualified and motivated students wanting to pursue doctoral studies in environmental physiology related to diving. The research focus is health and safety in extreme environments, with concentration in decompression stress, monitoring technology, and diver safety. Students will also gain experience with a variety of studies in hyperbaric medicine. Contact Dr. Neal Pollock (neal.pollock@kin.ulaval.ca) for more information. Inquiries would best include concise CVs and a description of key interests and goals.

UPCOMING EVENTS

UHN Introductory Course in Hyperbaric Medicine

The University Health Network-Toronto General Hospital, Hyperbaric Medicine Unit is offering an introductory course in hyperbaric medicine April 01-05. The course is suitable for physicians, physician assistants, respiratory therapists, military medical personnel, paramedic/emergency medical technicians, licensed practical nurses, and nurse practitioners. The program is accredited by the Undersea and Hyperbaric Medical Society (40 CME credits) and the National Board of Diving and Hyperbaric Medical Technology (40 CME credits and as a pre-course for CHT certification). For details and online registration, see: https://www.uhn.ca/Surgery/PatientsFamilies/Clinics_Tests/Hyperbaric_Medicine_Unit/Pages/Continuing_Education.aspx

UMC Level 2 Advanced Diving Medicine Course

Undersea Medicine Canada is offering a CSA Z275 Level 2 'Advanced Course in Diving Medicine: Diagnosis and Treatment'. This 6-day course will be held May 06-11 at the Canadian Museum of Immigration, Pier 21 in Halifax, NS. Augmenting classroom instruction and case-based learning, site visits will allow observation of commercial diver training and diving operations, as well as training at the Hyperbaric Medicine Unit at the QEII Health Sciences Centre in Halifax. A CSA Z275.2-15 Level 1 course or equivalent training is a prerequisite for this 45-h program. You can register at https://underseamedicine.ca or contact Dr. Debbie Pestell at drdeb1@ns.sympatico.ca or 902-225-8214 for more information.

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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 Level 1 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.

RECENT PUBLICATIONS

Atzeni F, Casale R, Alciati A, Masala IF, Batticciotto A, Talotta R, Gerardi MC, Salaffi F, Sarzi-Puttini P. Hyperbaric oxygen treatment of fibromyalgia: a prospective observational clinical study. Clin Exp Rheumatol. 2019;37 Suppl 116(1):63-9.

OBJECTIVES: Fibromyalgia (FM) is a syndrome of unknown aetiology that is characterised by widespread musculoskeletal pain, fatigue and disordered sleep, and often associated with neuropsychiatric and cognitive symptoms. Current treatment options are only partially effective, but hyperbaric oxygen therapy (HBOT) seems to be capable of relieving some of the symptoms. The aim of this study was to evaluate the efficacy and safety of HBOT after fewer sessions than generally used, chosen on the basis of pre-clinical and clinical data showing its rapid and sustained antinociceptive effect. METHODS: Patients with FM underwent HBOT (100% oxygen at 2.5 ata with air breaks) administered on three days per week for a total of twenty 90-minute sessions. Pain, fatigue, the quality of sleep, symptoms of anxiety and depression, and the patients' health-related quality of life were prospectively assessed before and after ten and twenty sessions. RESULTS: Twenty-eight of the 32 study patients completed the 20 HBOT sessions. Pain scores and the symptoms of anxiety (but not those of depression) significantly improved after both 10 and 20 sessions, whereas fatigue and FM symptom severity scores significantly improved only after 20 sessions. There was no significant change in the quality of sleep. The adverse effects were limited. CONCLUSIONS: These findings support the view that HBOT is an effective, rapid and safe means of treating various symptoms of FM.

Bralow LM, Piehl M. Barotrauma and arterial gas embolism: a diving emergencies simulation case for emergency medicine residents. MedEdPORTAL. 2018 Dec 21;14:10788. doi: 10.15766/mep_2374-8265.10788.

INTRODUCTION: Arterial gas embolism (AGE) is a rare but severe complication of scuba diving. While AGE is most commonly encountered in coastal areas with high volumes of recreational divers, at-risk populations exist throughout the United States, making basic knowledge of the disease important for all emergency medicine (EM) physicians. METHODS: We used a hypothetical simulation case to train EM residents on diagnosis and management of AGE. A 32-year-old male presented with

shortness of breath and unilateral neurologic deficits immediately after scuba diving. Residents were challenged to emergently diagnose and treat tension pneumothorax followed by diagnosis and treatment of AGE. A resident, attending, and simulation technician ran the case for four separate simulation teams in the simulation center with the addition of chest tube supplies to the basic resuscitation bay setup. Teams were allowed to use the internet in real time as a reference tool. RESULTS: Most teams arrived at the correct diagnosis using real-time internet searches, but none found the Divers Alert Network Emergency Hotline. Learners were debriefed both immediately and in a formal lecture. A follow-up survey showed good retention of knowledge. DISCUSSION: This case fills a significant knowledge and training gap for many EM physicians. AGE is a rare but highly morbid complication of diving, and EM residents should have knowledge of the disease and available consultation resources. Most EM residents will not have the opportunity to treat a diver during training, and the simulation environment provides a means to teach and practice this skill set

Bush N, Snodgrass W. Hyperbaric oxygen therapy improves oral graft take in hypospadias stag reoperations. J Urol. 2019 Feb 7. doi: 10.1097/ JU.0000000000000145. [Epub ahead of print]

PURPOSE: Increased complications following failed hypospadias repairs suggest impaired wound healing is a contributing factor. We used perioperative hyperbaric oxygen therapy (HBOT) to promote wound healing determined by graft take in staged tubularized autograft (STAG) reoperations using oral graft. METHODS: HBOT was recommended in patients having 3 or more failed hypospadias repairs, comprising 20 preoperative and 10 postoperative sessions. All underwent reoperative STAG repair using oral mucosa. Graft length and widths were measured at the time of grafting and again at the 2 stage, from which graft area was calculated. The primary outcomes were percent graft contracture, and graft failure, defined as contracture ≥50%. HBOT patients were compared to other reoperative STAG patients who did not receive therapy. RESULTS: There were 57 patients, 32 receiving HBOT and 25 who had <3 prior repairs or were not able to have treatment due to insurance or lack of local availability. Grafts were healthier with HBOT, having significantly less percent area contracture (9% vs 26%, p=0.04) and graft failure (6% vs 28%, p=0.03) as compared to those not receiving therapy, even though treated patients had significantly more prior failed hypospadias repairs. CONCLUSIONS: HBOT improved graft take in hypospadias reoperations. This observation also calls attention to wound healing as another variable to consider in hypospadias surgery.

Cha SG, Byun YS, Jeon MJ, Sakong J. Diving patterns and decompression sickness among South Korean fishery divers. J Occup Health. 2019;61(1):143-53.

OBJECTIVES: We aimed to report the characteristics of diving practice and the incidence of decompression sickness (DCS) among South Korean fishery divers. METHODS: We sent out questionnaires to 215 registered boat owners, and 196 of the fishery divers responded. The questionnaire was comprised of demographical characteristics, diving-related characteristics, and experiences with DCS. DCS was classified into types I and II based on the symptoms. RESULTS: Their average length of career in fishery diving was 18.1±8.5 years. They were working for 10.8±1.9 months per year. The average bottom time was 74.7±23.3 minutes, the average depth was 23.6±6.8 m, and the average surface interval time was 20.7±12.5 minutes. The incidence of DCS symptoms among the total participants was 84.7%. The incidence increased as working days per month and dives per day increased (P<0.05). An increased average working depth and a short surface interval time tended to reflect an elevated incidence in the DCS symptoms (P<0.01). Logistic regression analysis revealed working days per month, dives per day, average bottom time, and rapid ascent as risk factors (P<0.05). CONCLUSIONS: South Korean fishery divers were shown to be susceptible to DCS because of their repetitive dives for financial reasons. However, they are often beyond the scope of the law. The results of this study suggested that it is necessary to establish the registries of fishery divers.

Guggino G, Schinocca C, Lo Pizzo M, Di Liberto D, Garbo D, Raimondo S, Alessandro R, Brighina F, Ruscitti P, Giacomelli R, Sireci G, Triolo G, Casale R, Sarzi-Puttini P, Dieli F. T helper 1 response is correlated with widespread pain, fatigue, sleeping disorders and the quality of life in patients with fibromyalgia and is modulated by hyperbaric oxygen therapy. Clin Exp Rheumatol. 2019;37 Suppl 116(1):81-9.

OBJECTIVES: Hyperbaric oxygen therapy (HBOT) has been used as treatment for different clinical conditions, including fibromyalgia (FM). HBOT modulates brain activity, ameliorates chronic pain and modifies the ratio of immune cells. Clinical studies have provided evidence that FM is associated with immune system dysregulation. In the present study we aimed to evaluate the effect of HBOT on immune system and on the quality of life-style of FM patients. METHODS: Patients with primary FM and controls were treated with HBOT. Physical, emotional and social assessment, quality of sleep, tender points, intensity score, WPI and symptom severity were evaluated before and after HBOT. Furthermore, a characterisation of CD4 T lymphocytes and their cytokine production was performed by flow cytometry. The expression of TNF-α, IFN-γ, IL-17, IL-9 and IL-22 was also assessed by RT-PCR. Finally, the serum levels of serotonin were evaluated

by ELISA. RESULTS: Our results confirm the participation of immune system in the pathogenesis of FM and highlight the impact of HBOT treatment, with particular regard to the changes on proinflammatory cytokines production by CD4 T cells subsets. CONCLUSIONS: FM patients show a Th1 signature and the activation of this subset is modulated by HBOT.

Imbert JP, Balestra C, Kiboub FZ, Loennechen Ø, Eftedal I. Commercial divers' subjective evaluation of saturation. Front Psychol. 2019 Jan 11;9:2774.

Commercial saturation diving involves divers living and working in an enclosed atmosphere with elevated partial pressure of oxygen (ppO2) for weeks. The divers must acclimatize to these conditions during compression, and for up to 28 days until decompression is completed. During decompression, the ppO2 and ambient pressure are gradually decreased; then the divers must acclimatize again to breathing normal air in atmospheric pressure when they arrive at surface. We investigated 51 saturation divers' subjective evaluation of the saturation and post-decompression phase via questionnaires and individual interviews. The questions were about decompression headaches and fatigue; and time before recovering to a pre-saturation state. Twenty-two (44%) of the divers who responded declared having headaches; near surface (44%) or after surfacing (56%). 71% reported post-saturation fatigue after their last saturation, 82% of them described it as typical and systematic after each saturation. Recovery was reported to normally take from 1 to 10 days. The fatigue and headaches observed are compatible with divers' acclimatization to the changes in ppO2 levels during saturation and decompression. They appear to be reversible post- decompression.

Jendle J, Adolfsson P. Continuous glucose monitoring diving and diabetes: an update of the Swedish recommendations. J Diabetes Sci Technol. 2019 Feb 2:1932296819826584. doi: 10.1177/1932296819826584. [Epub ahead of print]

Divers travel to different countries to explore various diving sites worldwide. In 2005, the Divers Alert Network (DAN) published their guidelines for recreational diving and diabetes mellitus. However, although years have passed, there is still no consensus in the form of international guidelines on diabetes and diving. Large differences are noted with regard to the regulations in different countries. Furthermore, the diabetes technology has evolved rapidly and is not reflected in current international guidelines. This is potentially both a medical and an insurance problem for a diver with diabetes. We present a short summary of the recently updated Swedish recommendations for recreational divers with type 1 diabetes mellitus, focusing on the use of continuous glucose monitoring and continuous subcutaneous insulin infusion during such circumstances

Nakajima M, Aso S, Matsui H, Fushimi K, Yasunaga H. Hyperbaric oxygen therapy and mortality from carbon monoxide poisoning: A nationwide observational study. Am J Emerg Med. 2019 Feb 10. pii: S0735-6757(19)30087-7. doi: 10.1016/j.ajem.2019.02.009. [Epub ahead of print]

BACKGROUND: The effects of hyperbaric oxygen therapy (HBOT) on mortality or morbidity in patients with carbon monoxide (CO) poisoning remain unknown. We examined the effects of HBOT on CO poisoning and further strived to delineate its inherent effects on specific subgroups of patients using a nationwide inpatient database. METHODS: We identified adult patients with CO poisoning who were registered in the Japanese Diagnosis Procedure Combination inpatient database from 2010 to 2016. Propensity score-matching was performed to compare patients who received HBOT within 1 day of admission (HBOT group) with those who did not receive HBOT (control group). The primary outcome was in-hospital mortality. The secondary outcomes were a depressed mental status and reduced activities of daily living (ADL) at discharge. We also performed subgroup analyses divided according to severity of CO poisoning. RESULTS: Eligible patients were categorized into the HBOT group (n = 2034) or the control group (n = 4701). One-to-one propensity score-matching created 2034 pairs. In-hospital mortality was not significantly different between the HBOT and control groups (0.8% vs. 1.2%, risk difference: -0.4%, 95% confidence interval: -1.0 to 0.2). Patients in the HBOT group had significantly lower proportions of a depressed mental status and reduced ADL at discharge than did those in the control group. Similar associations were shown in the non-severe poisoning subgroup. CONCLUSIONS: Although HBOT was not significantly associated with reduced mortality, it was significantly associated with a favorable consciousness level and ADL in patients with CO poisoning. HBOT may be beneficial even for patients with non-severe CO poisoning.

Schipke JD, Lemaitre F, Cleveland S, Tetzlaff K. Effects of breath-hold deep diving on the pulmonary system. Respiration. 2019 Feb 15:1-8. doi: 10.1159/000495757. [Epub ahead of print]

This short review focuses on pulmonary injury in breath-hold (BH) divers. When practicing their extreme leisure sport, they are exposed to increased pressure on pulmonary gas volumes, hypoxia, and increased partial gas pressures. Increasing ambient pressures do present a serious problem to BH deep divers, because the semi-rigid thorax prevents the deformation required by the Boyle-Mariotte law. As a result, a negative-pressure barotrauma (lung squeeze) with acute hemoptysis is not uncommon. Respiratory maneuvers such as glossopharyngeal insufflation (GI) and glossopharyngeal exsufflation (GE) are practiced to prevent lung squeeze and to permit

equalizing the paranasal sinuses and the middle ear. GI not only impairs venous return, thereby provoking hypotension and even fainting, but also produces intrathoracic pressures likely to induce pulmonary barotrauma that is speculated to induce long-term injury. GE, in turn, further increases the already negative intrapulmonary pressure, thereby favoring alveolar collapse (atelectasis). Finally, hypoxia seemingly not only induces brain injury but initiates the opening of intrapulmonary shunts. These pathways are large enough to permit transpulmonary passage of venous N2 bubbles, making stroke-like phenomena in deep BH divers possible.

Steinberg F, Doppelmayr M. Neurocognitive markers during prolonged breath-holding in freedivers: an event-related EEG study. Front Physiol. 2019 Feb 6;10:69. doi: 10.3389/fphys.2019.00069. eCollection 2019.

Since little is known concerning the psychological, cognitive, and neurophysiological factors that are involved in and important for phases of prolonged breath-holding (pBH) in freedivers, the present study uses electroencephalography (EEG) to investigate event-related neurocognitive markers during pBH of experienced freedivers that regularly train pBH. The purpose was to determine whether the well-known neurophysiological modulations elicited by hypoxic and hypercapnic conditions can also be detected during pBH induced hypoxic hypercapnia. Ten experienced freedivers (all male, aged 35.10±7.89 years) were asked to hold their breath twice for 4 min per instance. During the first pBH, a checker board reversal task was presented and in the second four-min pBH phase a classical visual oddball paradigm was performed. A visual evoked potential (VEP) as an index of early visual processing (i.e., latencies and amplitudes of N75, P100, and N145) and the latency and amplitude of a P300 component (visual oddball paradigm) as an index of cognitive processing were investigated. In a counter-balanced cross-over design, all tasks were once performed during normal breathing (B), and once during pBH. All components were then compared between an early pBH (0-2 min) and a later pBH stage (2-4 min) and with the same time phases without pBH (ie, during normal breathing). Statistical analyses using analyses of variance (ANOVA) revealed that comparisons between B and pBH yielded no significant changes either in the amplitude and latency of the VEP or in the P300. This indicates that neurocognitive markers, whether in an early visual processing stream or at a later cognitive processing stage, were not affected by pBH in experienced freedivers.

Thom SR, Bhopale VM, Yang M. Microparticle-induced vascular injury in mice following decompression is inhibited by hyperbaric oxygen: Effects on microparticles and interleukin-1β. J Appl Physiol (1985). 2019 Feb 14. doi: 10.1152/japplphysiol.01109.2018. [Epub ahead of print]

Hyperbaric oxygen (HBO_2) became a mainstay for treating decompression sickness (DCS) because bubbles are associated with the disorder. Inflammatory processes including production of circulating microparticles (MPs) have now been shown to occur with DCS, leading to questions regarding pathophysiology and the role for HBO2. We investigated effects of HBO2 on mice exposed to 790 kPa air pressure for 2 hours, which triggers elevations of MPs ladened with interleukin (IL)-1β that cause diffuse vascular injuries. Exposure to 283 kPa O_2 (HBO2) inhibited MPs elevations at 2 hours post-decompression by 50% when applied either prophylactically or as treatment after decompression; and MPs number remained suppressed for 13 hours in the prophylactic group. Particle content of IL-1β at 2 hours post-decompression was 139.3+16.2 (mean + SE, n=11, $p<0.05$) pg/million MPs, versus 8.2+1.0 (n=15) in control mice; whereas it was 31.5+6.1 (n=6, not significant vs control [NS]) in mice exposed to HBO_2 prophylactically, and 16.6+6.3 (n=7, NS) when HBO_2 was administered post-decompression. IL-1β content in MPs was similar in HBO_2-exposed mice at 13 hours post decompression. HBO_2 also inhibited decompression-associated neutrophil activation and diffuse vascular leak. Immunoprecipitation studies demonstrated that HBO_2 inhibits high pressure-mediated neutrophil NLRP3 inflammasome oligomerization. Further, MPs isolated from decompressed mice cause vascular injuries when injected into naïve mice, but if decompressed mice were exposed to HBO_2 before MPs harvest, vascular injuries are inhibited. We conclude that HBO_2 impedes high pressure/ decompression-mediated inflammatory events by inhibiting inflammasome formation and IL-1β production.

Toroslu T, Erdoğan H, Çağlar Ö, Güçlü O, Dereköy FS. Comparison of different treatment methods for idiopathic sudden sensorineural hearing loss. Turk Arch Otorhinolaryngol. 2018;56(4):226-32.

OBJECTIVE: To evaluate the effectiveness of different therapies for idiopathic sudden sensorineural hearing loss and prognostic factors, and determine the most successful treatment according to the audiogram type and time from onset to treatment. METHODS: A total of 90 cases from February 2009 to January 2015 were classified under Group I oral treatment (methylprednisolone, acyclovir, betahistine-dihydrochloride, and vitamin B12); Group II oral treatment + intratympanic steroids (ITS); Group III oral treatment + hyperbaric oxygen; and Group IV only ITS. A pure tone average (PTA) improvement of less than 10 dB was assessed as "no improvement," a PTA of 10 dB or more or a 10% or more increase in the speech discrimination score (SDS) as "partial improvement," and a hearing threshold within 10 dB and SDS within 5%-10% of the unaffected ear as "full improvement." RESULTS:

Overall, 32.2% patients showed full and 28.9% showed partial improvement, whereas 38.9% showed no improvement. There was no significant difference in terms of mean hearing gain between the different treatment methods. As the degree of hearing loss and time from onset to treatment increased, improvement worsened ($p<0.05$). Descending audiogram had lower mean hearing gains compared to other groups ($p=0.014$). There was no significant effect of age, sex, tinnitus and/or vertigo, and systemic disease on treatment success ($p>0.05$). CONCLUSION: The most important factors affecting prognosis were the time from onset to treatment, hearing loss severity, and audiogram type. Only ITS avoided side effects and reduced hospitalization. ITS in the first two weeks, followed by hyperbaric oxygen were considered as the treatment priority.

Wingelaar TT, van Ooij PAM, Brinkman P, van Hulst RA. Pulmonary oxygen toxicity in Navy divers: a crossover study using exhaled breath analysis after a one-hour air or oxygen dive at nine meters of sea water. Front Physiol. 2019 Jan 25;10:10. doi: 10.3389/fphys.2019.00010. eCollection 2019.

Introduction: Exposure to hyperbaric hyperoxic conditions can lead to pulmonary oxygen toxicity. Although a decrease in vital capacity has long been the gold standard, newer diagnostic modalities may be more accurate. In pulmonary medicine, much research has focussed on volatile organic compounds (VOCs) associated with inflammation in exhaled breath. In previous small studies after hyperbaric hyperoxic exposure several methyl alkanes were identified. This study aims to identify which VOCs mark the development of pulmonary oxygen toxicity. Methods: In this randomized crossover study, 12 divers of the Royal Netherlands Navy made two dives of one hour to 192.5 kPa (comparable to a depth of 9 msw) either with 100% oxygen or compressed air. At 30 min before the dive, and at 30 min and 1, 2, 3, and 4 h post-dive, exhaled breath was collected and followed by pulmonary function tests (PFT). Exhaled breath samples were analyzed using gas chromatography-mass spectrometry (GC-MS). After univariate tests and correlation of retention times, ion fragments could be identified using a standard reference database [National Institute of Standards and Technology (NIST)]. Using these fragments VOCs could be reconstructed, which were then tested longitudinally with analysis of variance. Results: After GC-MS analysis, seven relevant VOCs (generally methyl alkanes) were identified. Decane and decanal showed a significant increase after an oxygen dive ($p=0.020$ and $p=0.013$, respectively). The combined intensity of all VOCs showed a significant increase after oxygen diving ($p=0.040$), which was at its peak (+35%) 3 h post-dive. Diffusion capacity of nitric oxide and alveolar membrane capacity showed a significant reduction after both dives, whereas no other differences in PFT were significant. Discussion: This study is the largest analysis of exhaled breath after in water oxygen dives to date and the first to longitudinally measure VOCs. The longitudinal setup showed an increase and subsequent decrease of exhaled components. The VOCs identified suggest that exposure to a one-hour dive with a partial pressure of oxygen of 192.5 kPa damages the phosphatidylcholine membrane in the alveoli, while the spirometry and diffusion capacity show little change. This suggests that exhaled breath analysis is a more accurate method to measure pulmonary oxygen toxicity.

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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