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

E-NEWS

EDITORIAL NOTE – April 2018

The E-News is the monthly newsletter of CUHMA used to share news items and links. We invite your comments and content, including new publication abstracts, news, announcements, job postings, and images of underwater work. Please submit items by the 25th of each month for inclusion in the next release. Past issues of E-News will be available online at https://cuhma.ca, serving an ongoing role as an information repository.

Neal W. Pollock

NEWS/ANNOUNCEMENTS

Call for Abstracts – CUHMA 2018

Both research and review session abstracts will be considered for the 2018 CUHMA annual scientific meeting. The submission deadline is June 15, 2018. Decisions will be returned to corresponding authors by July 15. Proposals and abstracts can be brief, with appropriate titles and 100-150-word descriptions.

UPCOMING EVENTS

TEKDiveUSA

TekDiveUSA will be held April 27-28, 2018 in Orlando, FL. This is a biennial advanced and technical diving conference that will draw over 35 USA and overseas specialist companies and offer a wide range of talks and workshops focused on advanced and technical diving, including operational diving, physiology, safety and imaging. For more details, visit: https://tekdiveusa.com.

UMC Diving and Hyperbaric Medicine Course

The 3rd Undersea Medicine Canada Introductory Course in Diving Medicine - Fitness to Dive program will be held May 07-11, 2018 in Quebec City and Lévis, 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 from the College of Family Physicians of Canada. For more information, contact Debbie Pestell (drdeb1@ns.sympatico.ca; 902-225-8214) or visit: https://underseamedicine.ca. A room block in available at the Sepia Hotel ($130 single / $145 double [plus taxes] including breakfast, parking and wifi; http://www.hotelsepia.ca).

Hyperbaric Medicine Technologist Course

The Environmental Medicine and Physiology Unit at Simon Fraser University is offering a HMT course May 14-26, 2018. Visit: http://www.sfu.ca/science/faculty-support/facilities-services/empu/courses/hyperbaric-medical-technologist.html.

UHMS Annual Scientific Meeting

The 2018 Undersea and Hyperbaric Medical Society annual scientific meeting will be held June 28-30 in Orlando, FL. Visit: https://www.uhms.org. Note: CUHMA members are eligible to receive a 50% discount on UHMS annual membership dues.

Second Tricontinental Scientific Conference on Diving and Hyperbaric Medicine

The second Tricontinental Scientific Conference will be held in Durban, KwaZulu Natal, South Africa, September 23-29, 2018. The week will combine scientific meetings, diving workshops, and social events. The joint organizing committee includes EUBS, SPUMS, SAUHMA and the Scott Haldane Foundation, working with local Durban Hyperbaric Centre staff and a South Africa event management bureau. The weather in September is ideal with temperatures in the low 20s for both land and sea and little chance of rain. For more information, visit: www.tricon2018.org.

WMS Diving and Environmental Medicine CME

The Wilderness Medical Society is offering a continuing medical education course October 06-13 on Cayman Brac. The six-day program includes four hours of interactive lectures each morning and two boat dives each afternoon. Presentations focus on diving medicine and safety for both typical and extreme diving activities. Primarily designed for physicians, this program will benefit professionals interested in optimizing diving health and safety. For more information, see https://wms.org/conferences/cayman18 or contact course director Neal Pollock (neal.pollock@kin.ulaval.ca).

AAUS Diving for Science Symposium 2018

The 2018 American Academy of Underwater Sciences Diving for Science Symposium will be held October 09-13 in Tahoe City, CA. The University of California Berkeley and the University of California Davis will serve as hosts. This meeting is relevant to diving scientists, students, diving safety officers, and anyone with an interest in diving science. For more information: www.aaus.org/annual_symposium.

CUHMA Annual Scientific Meeting 2018

The 2018 CUHMA ASM will be held in Quebec, QC November 01-04, hosted by Université Laval and Hôtel-Dieu de Lévis. Two days of workshops will be followed by two days of science talks. Additional events include board and business meetings, and networking sessions. Tentatively planned workshops include:

- Hyperbaric emergency training simulation (HETS)
- Transcutaneous oxygen monitoring (TCOM)
- Problem wound management

An evening reception will be held on November 02 and a banquet on November 03. Visit our website for updates and future registration: https://cuhma.ca.

STUDENT OPPORTUNITIES

Doctoral Studies in Diving Research

Active recruitment is underway at Université Laval for qualified students wanting to pursue doctoral studies in environmental physiology. 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. Current efforts are funded by the Canadian Institutes of Health Research, Reseau Quebec Maritime, and the Canadian Space Agency. This opportunity is open to highly motivated individuals wanting to dedicate their educational efforts to environmental physiology. 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.

RECENT PUBLICATIONS

Blake DF, Young DA, Brown LH. Transcutaneous oximetry: variability in normal values for the upper and lower limb. Diving Hyperb Med. 2018;48(1):2-9.

INTRODUCTION: Published normal transcutaneous oxygen partial pressures ($PtcO_2$) for the chest and lower limb have defined tissue hypoxia as a value of <40 mmHg (< 30 mmHg in some patients, < 50 mmHg in others). AIM: To determine 'normal' $PtcO_2$ for the upper and lower limb in healthy, non-smoking adults using the Radiometer® TCM400 with tc Sensor E5250. METHOD: Thirty-two volunteers had transcutaneous oxygen measurements (TCOM) performed on the chest, upper and lower limbs breathing air, with leg then arm elevated and whilst breathing 100% oxygen. RESULTS: Room-air $PtcO_2$ (mmHg, mean (95% confidence interval)) were: chest: 53.6 (48.7-58.5); upper arm: 60.0 (56.1-64.0); forearm: 52.3 (44.8-55.8); dorsum of hand: 50.2 (46.1-54.3); thenar eminence: 70.8 (67.7-73.8); hypothenar eminence: 77.9 (75.1-80.7); lateral leg: 50.2 (46.2-54.2); lateral malleolus: 50.5 (46.6-54.3); medial malleolus: 48.9 (45.6-52.1); dorsum, between first and second toe: 53.1 (49.2-57.0); dorsum, proximal to fifth toe: 58.5 (55.0 - -62.0); plantar, 1st MTP: 73.7 (70.3-77.1). Nineteen subjects had at least one room-air $PtcO_2$ below 40 mmHg (nine upper limb, 13 lower limb, four chest). Approximately 10% lower limb $PtcO_2$ were <100 mmHg on normobaric oxygen. Only one subject at one site had an upper limb $PtcO_2$ <100 mmHg breathing oxygen. CONCLUSION: The broad dispersion in $PtcO_2$ in our healthy cohort reflects the inherent biologic variability in dermal perfusion and oxygen delivery, making it difficult to define narrow, rigid 'normal' values. Thus, we cannot recommend a single $PtcO_2$ value as 'normal' for the upper or lower limb. A thorough patient assessment is essential to establish appropriateness for hyperbaric oxygen therapy, with TCOM used as an aid to guide this decision and not as an absolute.

Castagna O, de Maistre S, Schmid B, Caudal D, Regnard J. Immersion pulmonary oedema in a healthy diver not exposed to cold or strenuous exercise. Diving Hyperb Med. 2018;48(1):40-4.

In healthy divers, the occurrence of immersion pulmonary oedema (IPE) is commonly caused by contributory factors including strenuous exercise, cold water and negative-pressure breathing. Contrary to this established paradigm, this case reports on a 26-year-old, well-trained combat swimmer who succumbed to acute IPE during static immersion in temperate (21°C) water, while using a front-mounted counterlung rebreather. The incident occurred during repeated depth-controlled ascent practice at the French military diving school. It was discovered that the diver had attempted to stop any gas leakage into the system by over-tightening the automatic diluent valve (ADV) (25th notch of 27) during the dive, thus causing a high resistance to inspiratory flow. The ventilatory constraints imposed by this ADV setting were assessed as a 3.2 Joules·L^{-1} inspiratory work of breathing and -5 kPa (-50 mbar) transpulmonary pressure. This report confirms the key role of negative pressure breathing in the development of interstitial pulmonary oedema. Such a breathing pattern can cause a lowering of thoracic, airway and interstitial lung pressure, leading to high capillary pressure during each inspiration. Repetition of the diving drills resulted in

an accumulation of interstitial lung water extravasation, causing pathological decompensation and proven symptoms.

Kawecki M, Pasek J, Cieślar G, Sieroń A, Knefel G, Nowak M, Glik J. Computerized planimetry evaluation of hyperbaric oxygen therapy in the treatment of diabetic foot. Adv Clin Exp Med. 2018 Jan;27(1):39-44.

BACKGROUND: Diabetic foot ulcer is one of the major complications of diabetes mellitus in adults. OBJECTIVES: The aim of the study was to conduct a planimetry evaluation of the effectiveness of hyperbaric oxygen therapy (HBOT) in the treatment of patients with vascular disorders caused by diabetic foot. METHODS: The study included 94 patients, 30 females (32%) and 64 males (68%), aged 33-76 years, with diabetes lasting 1.5-32 years, who underwent HBOT due to diabetic foot. All patients from that group underwent vascular procedures prior to HBOT. In qualifying patients for hyperbaric oxygen therapy, transcutaneous oximetry method was applied (30-60 exposures in hyperbaric oxygen at pressure of 2.5 ATA). Progress in wound healing was evaluated by computerized planimetry system IRIS 4. RESULTS: In 26 patients the wounds were completely closed and in 37 patients the topical state was significantly improved - the wound surface decreased by 34% in average. During the treatment, in 11 patients amputation of fingers and metatarsal necrotic bones was performed, while in 9 patients amputation was prevented. CONCLUSIONS: A planimetry evaluation showed that the application of HBOT in the treatment of diabetic foot enhances foot ulcer healing, reduces tissue damage, contributes to the reduction of complications related to soft tissue and bone infections.

Mazur A, Guernec A, Lautridou J, Dupas J, Dugrenot E, Belhomme M, Theron M, Guerrero F. Angiotensin converting enzyme inhibitor has a protective effect on decompression sickness in rats. Front Physiol. 2018 Mar 1;9:64.

Introduction: Commercial divers, high altitude pilots, and astronauts are exposed to some inherent risk of decompression sickness (DCS), though the mechanisms that trigger are still unclear. It has been previously showed that diving may induce increased levels of serum angiotensin converting enzyme. The renin angiotensin aldosterone system (RAAS) is one of the most important regulators of blood pressure and fluid volume. The purpose of the present study was to control the influence of angiotensin II on the appearance of DCS. Methods: Sprague Dawley rats have been pre-treated with inhibitor of angiotensin II receptor type 1 (losartan; 10 mg/kg), angiotensin-converting enzyme (ACE) inhibitor (enalapril; 10 mg/kg), and calcium-entry blocker (nifedipine; 20 mg/kg). The experimental groups were treated for 4 weeks before exposure to hyperbaric pressure while controls were not treated. Seventy-five rats were subjected to a simulated dive at 1000 kPa absolute pressure for 45 min before starting decompression. Clinical assessment took place over a period of 60 min after surfacing. Blood samples were collected for measurements of TBARS, interleukin 6 (IL-6), angiotensin II (ANG II) and ACE. Results: The diving protocol induced 60% DCS in non-treated animals. This ratio was significantly decreased after treatment with enalapril, but not other vasoactive drugs. Enalapril did not change ANG II or ACE concentration, while losartant decreased post dive level of ACE but not ANG II. None of the treatment modified the effect of diving on TBARS and IL-6 values. Conclusion: Results suggests that the rennin angiotensin system is involved in a process of triggering DCS but this has to be further investigated. However, a vasorelaxation mediated process, which potentially could increase the load of inert gas during hyperbaric exposure, and antioxidant properties were excluded by our results.

McDermott JH, Reynard C, Perry J, Dear JW, Child F, Jenner R. Acute carbon monoxide toxicity in a paediatric cohort: analysis of 10 boys poisoned during a scuba diving lesson. Clin Toxicol (Phila). 2018 Mar 8:1-4.

BACKGROUND: Recent public health strategies have contributed towards a significant reduction in the incidence of carbon monoxide (CO) poisonings. When events do occur, symptoms can vary dramatically depending on the carboxyhaemoglobin level and individual factors. Most reports to date focus on individual cases or larger retrospective reviews of diverse cohorts. There are very few reports of CO exposure related to scuba diving activities. METHODS: We describe the clinical sequelae experienced by 10 children who were exposed to CO during a scuba diving lesson. We collate patient data in the context of a severely affected individual and employ exponential decay calculations to estimate half-life. RESULTS: Six of the patients exposed to CO were symptomatic. The most severely affected individual suffered multi-organ effects, including myocardial damage, and required intensive care unit admission. The remaining cohort demonstrated notable clinical variability. The half-life of carboxyhaemoglobin on high flow oxygen in this cohort was ~75 min, in line with previous estimates. CONCLUSION: This work described an uncommon clinical presentation, representing the largest single cohort of its kind. This work exemplifies the variable symptomatology of CO toxicity, of which clinicians should be alert to if patients fall ill after scuba diving.

Mitchell SJ, Bennett MH, Bryson P, Butler FK, Doolette DJ, Holm JR, Kot J, Lafère P. Pre-hospital management of decompression illness: expert review of key principles and controversies. Diving Hyperb Med. 2018;48(1):45-55.

Guidelines for the pre-hospital management of decompression illness (DCI) had not been formally revised since the 2004 Divers Alert Network/Undersea and Hyperbaric Medical Society workshop held in Sydney, entitled "Management of mild or marginal decompression illness in remote locations". A contemporary review was initiated by the Diver's Alert Network and undertaken by a multinational committee with members from Australasia, the USA and Europe. The process began with literature reviews by designated committee members on: the diagnosis of DCI; first aid strategies for DCI; remote triage of possible DCI victims by diving medicine experts; evacuation of DCI victims; effect of delay to recompression in DCI; pitfalls in management when DCI victims present at hospitals without diving medicine expertise and in-water recompression. This was followed by presentation of those reviews at a dedicated workshop at the 2017 UHMS Annual Meeting, discussion by registrants at that workshop and finally several committee meetings to formulate statements addressing points considered of prime importance to the management of DCI in the field. The committee placed particular emphasis on resolving controversies around the definition of "mild DCI" arising over 12 years of practical application of the 2004 workshop's findings, and on the controversial issue of in-water recompression. The guideline statements are promulgated in this paper. The full workshop proceedings are in preparation for publication.

Noh Y, Posada-Quintero HF, Bai Y, White J, Florian JP, Brink PR, Chon KH. Effect of shallow and deep scuba dives on heart rate variability. Front Physiol. 2018 Feb 27;9:110.

Prolonged and high-pressure diving may lead to various physiological changes including significant alterations of autonomic nervous system (ANS) activity that may be associated with altered physical performance, decompression sickness, or central nervous system oxygen toxicity. Ideally, researchers could elucidate ANS function before, during, and after dives that are most associated with altered function and adverse outcomes. However, we have a limited understanding of the activities of the ANS especially during deeper prolonged scuba diving because there has never been a convenient way to collect physiological data during deep dives. This work is one of the first studies which was able to collect electrocardiogram (ECG) data from scuba divers at various depths (33, 66, 99, 150, and 200 ftsw; equivalent to 10.05, 20.10, 30.17, 45.72, and 60.96 m of salt water, respectively) breathing different gas mixtures (air, nitrox and trimix). The aim of this study was to shed light on cardiac ANS behavior during dives, including deep dives. With the aid of dry suits, a Holter monitor that could handle the pressure of a 200 ft. dive, and a novel algorithm that can provide a useful assessment of the ANS from the ECG signal, we investigated the effects of scuba dives with different time durations, depths and gas mixtures on the ANS. Principal dynamic mode (PDM) analysis of the ECG, which has been shown to provide accurate separation of the sympathetic and parasympathetic dynamics, was employed to assess the difference of ANS behavior between baseline and diving conditions of varying depths and gas mixtures consisting of air, nitrox and trimix. For all depths and gas mixtures, we found consistent dominance in the parasympathetic activity and a concomitant increase of the parasympathetic dynamics with increasing diving duration and depth. For 33 and 66 ft. dives, we consistently found significant decreases in heart rates (HR) and concomitant increases in parasympathetic activities as estimated via the PDM and root mean square of successive differences (RMSSD) for all time intervals (from the first 5 min to the last 30 min) at the bottom depth when compared to the baseline depth at sea level. The sympathetic dynamics did not change with dive duration or gas mixtures, but at the 150 and 200 ft. dives, we found a significant increase in the sympathetic dynamics in addition to the elevated parasympathetic dynamics when compared to baseline. The power spectral density (PSD) measures such as the low frequency (LF), high frequency (HF) and its ratio, and approximate entropy (ApEn) indices were not as consistent when compared to PDM-derived parasympathetic dynamics and RMSSD index.

Reid RL, Lorenzo M. Scuba diving in pregnancy. J Obstet Gynaecol Can. 2018 Mar 1. pii: S1701-2163(17)30967-2.

OBJECTIVE: Obstetrical care providers may occasionally encounter women with questions about the safety of self-contained underwater breathing apparatus (scuba) diving in pregnancy. This article provides an overview of safety issues associated with basic scuba diving and offers guidance to practitioners about how to evaluate and counsel pregnant women about the associated maternal and fetal risks. Basic diving physiology is reviewed and the implications of scuba diving during pregnancy are discussed. A literature review examined available animal and human data about the potential adverse effects of the physiological changes of pregnancy on divers, the impact of pressure changes during diving, and possible consequences of hyperbaric gas exposure and rapid decompression on mother and fetus. DATA SOURCES: Studies were found by searching the terms "scuba diving," "pregnancy," "fetus," "decompression illness," "hyperbaric medicine," and "animal studies" in the databases Medline, Pubmed, and Embase. Reference lists from existing articles

and reports from identified diving magazines were also reviewed. Studies were limited to the English language and included publications until 2016. STUDY SELECTION: All relevant human studies were selected. Five retrospective studies and one prospective study assessing the antenatal and postnatal outcomes of women who participated in scuba diving while pregnant were reviewed. DATA SYNTHESIS: Published data was limited in both quantity and quality. The authors' experience with scuba diving together with a background in obstetrics allowed themes to be explored and recommendations developed. CONCLUSIONS: In addition to established risks of scuba diving, pregnant women are at increased risk due to changes in body habitus (affecting equipment fitting and balance). Animal data suggest possible adverse fetal effects due to fetal decompression illness (DCI) and hyperbaric oxygen exposure. Human data, though generally reassuring, are of poor quality and thus do not completely exclude adverse outcomes. In general, women should be cautioned to avoid diving during pregnancy, but inadvertent exposure to recreational diving in early pregnancy is not a reason for pregnancy termination.

Sames C, Gorman DF, Mitchell SJ, Zhou L. Long-term changes in spirometry in occupational divers: a 10-25-year audit. Diving Hyperb Med. 2018;48(1):10-6.

AIM: To determine whether long-term engagement in occupational diving causes significant changes in spirometric measurements. METHOD: All divers with adequate spirometric records spanning at least 10 years were identified from the New Zealand occupational diver database. Changes in lung function over time were compared with normative values derived using published prediction equations. Any significant changes were tested for correlation with age, duration of occupational diving, gender, smoking history and body mass index (BMI). RESULTS: Spirometry data spanning periods of 10 to 25 years were analysed for 232 divers. Forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) declined with increasing duration of diving, but slightly less than predicted with increasing age, while peak expiratory flow (PEF) declined more than expected for age in longer-term divers. The changes in PEF were statistically significant, and correlated with duration of diving exposure, initial age and final BMI. Nevertheless, the changes were small and probably clinically insignificant. CONCLUSION: We compared changes in spirometric parameters over long periods of occupational diving with normative data and found no clinically significant differences that could be attributed to diving. We found no justification for routine spirometry in asymptomatic divers.

Wingelaar TT, Clarijs P, van Ooij PA, Koch DA, van Hulst RA. Modern assessment of pulmonary function in divers cannot rely on old reference values. Diving Hyperb Med. 2018;48(1):17-22.

INTRODUCTION: Pulmonary function testing (PFT) is an important part of dive medical examinations. Depending on the standard used to assess fitness to dive, different reference sets and fixed cut-off points are used. Reference values are part of an ongoing debate regarding the validity and accuracy related to different age groups, sex and ethnic backgrounds. The Global Lung Initiative (GLI) has provided an all-age reference set which corrects for sex and ethnicity (GLI-2012); this has had substantial impact on pulmonary medicine. METHOD: We present an algorithm that can be used to standardise analysis of PFT in divers using the GLI-2012 reference set. Differences in the analysis of PFT between the ECSC/ERS-1993 and the GLI-2012 reference values are illustrated by means of three case reports. CONCLUSION: Using a valid database of reference values increases accuracy and might prevent additional medical investigations and/or incorrect assessment of fitness to dive. Although our algorithm needs further evaluation to ensure its validity, the preliminary results are promising. Whatever algorithm is used, we urge dive medical physicians to consider using valid reference sets when analysing PFT for assessment of fitness to dive.

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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