LETTERS

OXYGEN TOXICITY AND DIVING HEADACHE

Dear Editor:

In their recent review [1], Burkett and Nahas-Geiger addressed the incidence of headache in diving. They related this for the most part to hypercapnia, as well as to decompression sickness, primary headache disorders, and possible diving ascent headache. They cited a study of 201 professional divers, and a definition that diving headache occurred during dives to a depth of more than 10 meters seawater [2]. The Divers Alert Network (DAN) reported a 2% incidence of headache in 374 self-reports from scuba divers [3]. Other analyses of diving headache ascribed head pain not due to personal medical conditions or accidents to CO_2 retention, cold exposure, and exertion [4-7].

We conducted two studies of central nervous system (CNS) oxygen toxicity in closed-circuit oxygen diving. In the first, we documented the symptoms reported by 473 closed-circuit oxygen divers who made a total of 2,527 training dives to a depth of 1-7 meters seawater (most of them at 3 and 5 meters) lasting between 0.5-5 hours [8]. The second investigation documented signs and symptoms from 36 diving accidents, in which divers had to terminate a dive due to severe CNS oxygen toxicity which culminated in convulsions and loss of consciousness [9].

During training for closed-circuit oxygen diving, the mean percentage of dives with headache was 4.5%. This increased linearly from 2.6% within the first hour to 8.5% in the fourth, and then dramatically to 43% in the fifth hour. However, of the 36 dives terminated due to CNS oxygen toxicity, headache was reported in 45%.

Carbon dioxide scrubber function was tested in 18 of the 36 apparatuses involved in the incidents. In 11 of the 18 there was evidence of scrubber failure, headache occurring in four of these 11 divers (36%). The incidence of headache in the dives for which there was no evidence of scrubber malfunction was 29% (2/7). All of the six divers who suffered headache had hyperventilated, but there were other divers who hyperventilated and had no headache. Of the 2,527 training dives reported in the first study, hyperventilation was reported in 2.6% (which may or may not be related to carbon dioxide accumulation). However, a higher percentage (4.5%) suffered headache. Thus, in neither of these two studies can headache be related only to CO2.

We therefore concluded that in closed-circuit oxygen diving, headache is related mainly to oxygen toxicity, suggesting that it may even be considered a mild form of this syndrome. An anecdotal example is a diver who became extra-sensitive to oxygen, suffering from headache immediately on entering the water with closed-circuit oxygen apparatus, quite the opposite of his experience when he breathed air during a dive.

Because oxygen levels in our closed-circuit system are in the region of 90% [10] (unreported measurements), the inspired oxygen tension for the majority of the training dives was 1.17 atmospheres absolute (3 meters) or 1.35 atmospheres absolute (5 meters). The incidence of headache in these dives was 3.1% and 5.5%, respectively. There were fewer dives at other depths between 1 and 7 meters seawater, however not necessarily with less headache. The inspired oxygen tension in regular self-contained underwater breathing apparatus (scuba) and in nitrox diving is close to the values in our training dives with closed-circuit apparatus. Therefore, the effect of oxygen on diving headache cannot be ignored.

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THE ISSUE: 24/7 ACCESS TO HYPERBARIC CARE

Editors note:

The publication of the paper 'Delayed hyperbaric oxygen therapy for severe arterial gas embolism following scuba diving: a case report; UHM 2019, 46(2), 197-202, by Dr. Charlotte Sadler and colleagues and the University of California at San Diego (UCSD) stated that a patient with a severe case of AGE was transferred from the University of Hawaii Hyperbaric Treatment Center (UH HTC) to UCSD due to the lack of 24/7 access to hyperbaric facilities. This prompted the following letter from UH HTC's Dr. Susan Steinemann, who contested this assertion. An answering letter from Dr. Sadler ensued as well as a discussion on the details of the transfer.

After considerable debate in this matter, speaking via email with Dr. Steinemann at UH HTC Hawaii; Drs. Charlotte Sadler and Kaighley Brett at UCSD; and Dr. Jim Chimiak, in consultation with medical specialist Daniel Nord at DAN, a discussion has emerged that highlights the issue of 24/7 access to hyperbaric care.

Despite the apparent lack of agreement in determining the exact steps in the decision tree for the treatment and recovery of this patient with severe AGE, timely care – which is essential in diving emergencies – was provided. As noted by Dr. Jim Chimiak at DAN, both facilities are to be commended for their attentiveness to their patient.

~ The Editors

THE LETTER FROM DR. STEINEMANN

Dear Dr. Camporesi and UHM readers:

I appreciated Dr. Sadler and colleagues' recount of a challenging case of arterial gas embolism ('Delayed hyperbaric oxygen therapy for severe arterial gas embolism following scuba diving: a case report; UHM 2019, 46(2), 197-202), and am grateful for the willingness of the University of California San Diego (my alma mater) to assist in these cases. However, the article inaccurately portrays the state of Hawaii as lacking a 24/7 chamber available to treat critical patients.

The University of Hawaii Hyperbaric Treatment Center (UH HTC) has been providing 24/7 emergency hyperbaric services in a multiplace chamber in Honolulu since 1982. Notwithstanding a recent unanticipated closure (10/19/17 to 1/14/18), the UH HTC has continued to provide treatment for elective and emergency cases, including critically ill and ventilated patients. The UH HTC is unique in that it is not affiliated with a hospital, which makes it substantially more difficult to provide 24/7 critical care availability for these very rare cases. Each critical patient is individually considered based upon patient condition and available resources. The hyperbaric physician who fielded the call for this patient made the (I think correct) decision to have her flown to the mainland, rather than to Oahu, based upon her multiple organ failure, the time lapse (>1 day) before hyperbaric treatment was considered appropriate, and the fact that she was a visitor from the mainland.

I endorse the sentiment iterated by Dr. Sadler and colleagues of the need to maintain emergency hyperbaric services in Hawaii. The ongoing support of the state legislature, health insurers, government entities, and the dive community are essential, as is the ability to continue collaboration with more resource-rich hyperbaric centers on the mainland.

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