Readers are invited to submit letters for publication in this department. Submit letters online at http://joem.edmgr.com. Choose "Submit New Manuscript." A signed copyright assignment and financial disclosure form must be submitted with the letter. Form available at www.joem.org under Author and Reviewer information.

Yo-Yo Diving and Risk of Decompression Sickness in Trainee Military Divers

To the Editor:

o-yo diving is a common practice in commercial diving (fish farm workers, harvest divers) corresponding to a series of multiple short-duration descents and ascents to the same depth with short surface intervals. This method of diving is traditionally recognized as a dangerous procedure in the medical community, mainly due to the lack of validated decompression tables to guide this type of repetitive dives.^{1,2} However, a study of the Scottish fish farms divers by Wilcock et al³ suggests that there was no evidence that yo-yo diving with an average number of surface excursions less than eight and a maximum depth at 16 msw for a mean time of 41 minutes produce a higher risk of decompression sickness (DCS) than that generally accepted by the diving industry. Furthermore, theoretical studies using mathematical models of decompression to analyze the potential risk of DCS development with this diving pattern in comparison with a single dive of equivalent duration and depth gave conflicting results.^{4,5} Recently, some researchers conducted a field study over 6 years in a cohort of 77 aquaculture divers using Doppler ultrasound to investigate decompression stress (ie, vascular bubble formation) produced from working bouncedive series that were performed with specific dive tables based on nodecompression time limits (DCIEM dive table).⁶ They found that 97% of yo-yo dives profiles with a median number of seven bounces per series were low stress. In addition, none of the divers developed DCS during the study period. From the above findings, we therefore examined the characteristics and incidence of DCS

Source of funding: none.

e336

- The authors report no conflict of interest.
- Address correspondence to: Emmanuel Gempp, MD, French Armed Forces Health Service, BCRM Toulon, Centre médical des armées, cellule école de plongée, 83800 Toulon Cedex 9, France (gempp@netc.fr).
- Copyright © 2016 American College of Occupational and Environmental Medicine
- DOÎ: 10.1097/JOM.00000000000844

in the population of military divers trained to yo-yo diving (Fig. 1) during their course of "ship diver" in the French Navy diving school.

All the medical records and military statutory declaration forms concerning diving parameters, demographic, and clinical characteristics of student divers treated for DCS in the recompression chamber of the French Navy diving school (Saint-Mandrier, France) between January 2003 and September 2015 were retrospectively analyzed. Inclusion criteria were the subjects who presented neurological symptoms or inner ear disorders following scuba air dives including a minimum of three bounces. Suspected cases of cerebral arterial gas embolism and inner ear barotrauma were excluded from the database. The incidence rate (IR) of DCS was calculated using the number of injuries sustained by the trainee divers as the numerator and the total number of yo-yo dives performed during the training program over the study period as the denominator. This number was accurately estimated from the number of divers registered for each course (6 per year) combined with the exact number of yoyos dives performed by each diver to be qualified (ie, 10 series).

The 13-year study period captured 23,400 person-dives with nine DCS cases that occurred after yo-yo diving, yielding an IR of 3.8 per 10,000 dives (0.038%). Detailed analysis of DCS characteristics revealed that mean age of injured divers

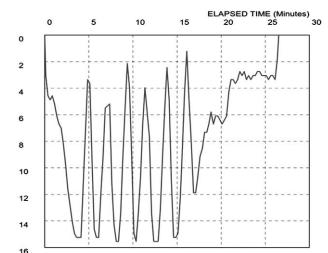
was 27 ± 3 years for a mean depth of $16 \pm 2 \,\text{msw}$ and a mean bottom time of 40 ± 20 minutes followed by mandatory decompression stops of 1-minute at 6 msw and 5-minutes at 3 msw (ascent rate 15 m/minute). Inner ear DCS was considered as the main injury (7/9, 77%) with a median delay of symptoms onset of 30 minutes [IQR, 11-90] after surfacing. All patients underwent hyperbaric oxygen treatment (US Navy 5 or GERS B table) in less than 3 hours $(73 \pm 45 \text{ minutes})$ and none of them exhibited residual deficit. Follow-up assessment of right-to-left shunt with transcranial Doppler examination revealed that 40% of divers had this condition. It is noteworthy that no DCS case was declared in the population of diving instructors using nitrox 40% as breathing gas during the same period.

To conclude, yo-yo diving practiced in the French Navy diving school is a risky procedure for trainee divers if we consider the 0.01% to 0.03% overall DCS incidence range in commercial diving.3,6 Future field studies are needed for the validation of safer diving profiles in this population.

Emmanuel Gempp, MD

French Navy Diving School, BP 311, Toulon, France

Christophe Pény, MD Cephismer, BP 84, Toulon, France



16 DEPTH (M)

FIGURE 1. Yo-yo dive profile routinely performed by trainee military divers in French Navy diving school.

JOEM • Volume 58, Number 9, September 2016

mLfbnk52MFhZp2MjUSo=

on 09/03/2024

REFERENCES

- 1. Douglas JDM, Milne AH. Decompression sickness in fish farm workers: a new occupational hazard. *BMJ*. 1991;302:1244–1245.
- Dunford RG, Mejia EB, Salbador GW, Gerth WA, Hampson NB. Diving methods and decompression sickness incidence in Miskito indian underwater harvesters. *Undersea Hyperb Med*. 2002;29:74–85.
- Wilcock SE, Cattanach S, Duff PM, Shields TG. The incidence of decompression sickness arising from diving and fish farms. In: XVIIIth Annual Meeting of EUBS; 1992. p. 191–195.
- Flook V. Yo-yo diving and the risk of decompression illness. In: UK Health and Safety Executive; 2004. Research Report 214.
- 5. Parker EC, Survanshi SS, Thalmann ED, Weathersby PK. Analysis of the risk of decompression

sickness due to yo-yo diving using the USN probabilistic decompression model. *Undersea Hyperb Med.* 1994;21(suppl):62.

 Smart DR, Van den Broek C, Nishi R, Cooper PD, Eastman D. Field validation of Tasmania's aquaculture industry bounce-diving schedules using Doppler analysis of decompression stress. *Diving Hyperb Med.* 2014;44: 124–136.

© 2016 American College of Occupational and Environmental Medicine