

## ランチョンセミナーLS2-2 RECOMPRESSION TREATMENT FOR DECOMPRESSION SICKNESS

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### INTRODUCTION

Recompression and breathing of hyperbaric oxygen (HBOT) is generally accepted treatment for decompression sickness (DCS), but the administration of it may vary.<sup>1)</sup>

<sup>2)</sup> In the absence of the clinical trial type of evidence, the guidance for the treatment of DCS is based on a consensus of experts represented in professional associations.<sup>3)</sup> In preparation for the DAN/UHMS 2019 workshop that will review current practice worldwide, we surveyed hyperbaric and diving medicine specialists to explore how they comply with the guidelines provided by the Undersea and Hyperbaric Medical Association (UHMS).

Decompression sickness is caused by a quick decrease of the environmental pressure and liberation of gas from supersaturated tissues. Liberated gas may cause local injuries or distant embolization. Recompression instantaneously reduces the volume of free gas and mitigates further mechanical tissue injury.<sup>1)</sup> Administration of oxygen at increased environmental pressure (hyperbaric oxygen treatment - HBOT) may improve oxygen supply to ischemic tissues and help healing by reducing inflammation and other pathological processes involved.<sup>4)</sup> If the recompression is not immediately available, the first aid should include replacing oxygen for air as breathing gas at normal pressure (normobaric oxygen - NBO)<sup>5)~7)</sup> There is a consensus among experts that HBOT is the standard treatment for DCI, but the modalities of treatment pressure, duration and breathing gas administration may vary. The Undersea and Hyperbaric Medical Society (UHMS) recommends the US Navy Treatment Table 6 (USNTT6) or an equivalent as a standard protocol.<sup>8)</sup> This protocol prescribes maximum pressure of 2.8 bars (equivalent depth 60 ft, 18 m). The total duration is 278 minutes, and most of the time is spent at 18 and 9 m. The breathing gas is pure oxygen with scheduled air breaks to mitigate the effects of oxygen toxicity. In case that there is no relief of symptoms within the first 20-minute breathing period at 18 m, the pressure could be increased. If the resolution is not complete, the HBOT session can be extended for up to two 30 minute periods of breathing oxygen.<sup>9)</sup>

The success rate of the USNTT6 is high, but there are still cases that do not respond to it and end up with a severe disability.<sup>10) ~12)</sup> Protocols with higher pressure or longer duration are sometimes used in severe cases, but there is no evidence of their superiority to standard treatment. On the other hand, in mild cases, protocols at lesser pressures or of shorter duration are sometimes used.<sup>13)14)</sup>

The major hurdles to establishing the comparative efficacy of various treatment modalities for this rare disease are the variability of DCS presentation, its spontaneous evolution, and varying time to treatment.

Management of persistent or residual symptoms, recommendation how long to wait before flying after treatment and treatment of symptoms that occur during or after flying post-dive may also vary.

The best practice based on available evidence as described in a Cochran Review<sup>1)</sup> is summarized by the author below:

- Recovery without recompression can be slow and incomplete.
- Recompression is applied while breathing 100% oxygen or heliox.
- Recompression with 100% oxygen has become universally accepted as the appropriate therapy despite the lack of high-quality clinical evidence of effectiveness.
- Heliox recompression and non-steroidal anti-inflammatory drug (NSAID) may shorten the course of recompression required.
- There is little evidence for using one recompression strategy over another in the treatment of decompression illness.
- More research is needed.

### THE SURVEY

The survey consisted of the eight groups of questions addressing areas of practice variance.:

- Could normobaric oxygen replace standard treatment?
- What is the optimal time for treatment (golden hour)?
- Is it ever late to recompress?
- Could DCI be treated in monoplace with < 2.8 bar?
- Is there benefit with a higher (>2.8bar) treatment pressure?
- How long to treat residual symptoms?
- How long to wait before flying after treatment?
- What to do with recurrent or new symptoms during or after the flight?

The survey was administered online using the Survey Monkey platform. The invitation to participate was sent to diving and hyperbaric medicine physicians on the UHMS mailing list. The reminder was sent out twice. We provided a link to survey to other diving and hyperbaric medicine associations affiliated with UHMS.

### RESULTS

Within a month, 134 respondents from 23 countries took the survey. Most respondents were from the USA.

**Normobaric oxygen.** While it is given that NBO may be the only treatment for mild DCS in remote locations when the HBOT is not available, most participants believe that regardless of NBOT outcome, even divers with a mild DCS should receive the HBOT when it is available. However, if an injured diver has been symptom-free for a prolonged time after the NBOT and before the admission, the answers vary. In case of the mild DCS that has been symptom-free for at least six hours, 55% would probably not consider HBOT, while 45% of the respondent would treat regardless. In a serious case of DCS, most respondents (62%) would not hesitate to treat even if the diver may have been symptom-free for more than six hours.

**The optimal time to treatment.** The opinion about the optimal time to treatment varied from one hour to 24 hours. Most respondents think that symptomatic divers should be treated even if they admit to treatment days

after the injury.

**Short or shallow treatment protocols.** Most respondents adhere to USNTT6 or equivalent as a standard treatment and do not accept shorter or shallower protocols as an initial treatment (72%). However, when standard treatment is not available, shorter and shallower HBO protocols like Comex 12, Kindwall, USN T9, and similar, if administered by trained personnel, are acceptable to 87% of respondents.

**Recompression deeper than 60ft/18m,** for selected cases was not disapproved by most respondents (77%). Instead, they would consider it for DCS in technical diving and for severe DCS cases with a short delay to treatment (if the recompression to 18 m does not provide a relief).

**Follow-up treatment** if the initial recompression did not achieve a complete relief, varies in practice. While most respondents believe that there is a limit to the number of recompression treatments (59%), majority approves it: a) for mild cases up to two standard HBO treatments, and b) for severe cases two standard recompression protocols and after that daily standard HBO sessions for as long as there is a post-treatment improvement.

**Waiting time to fly after treatment** recommendations vary from one day to at least one week. Most agree that the waiting time should be 72 hours. If the patient is symptom-free after treatment, forty percent would recommend waiting for 24 hours. To wait at least for a week before flying would recommend 11% of respondents.

Recurrence of symptoms during the flight should be treated with HBOT if the symptoms resolve spontaneously after landing, is the opinion supported by 61% of respondents. The symptoms that recur within 24 hours after landing would be treated by 81% of respondents.

## DISCUSSION

It is important to recognize that this survey was not intended to replace any of the existing guidelines for the treatment of DCS and no practice change should be based on the result of this survey. The results of our survey confirm that the treatment of DCS varies in current clinical practice. Most variances occur in the treatment of very mild and severe cases of DCS. In the case of mild DCS, despite no evidence of incomplete resolution if not treated with HBOT, physicians prescribe HBOT whenever it is available, even to patients that have been asymptomatic before admission. In severe cases, physicians retain the option to administer the higher pressure if the resolution is not achieved with the standard treatment. The recommendations for how long to wait after the HBOT before flying vary greatly and may be very costly to divers despite the lack of evidence that shorter waiting period causes adverse health effects.

In general, the variance in treatment practices is expected whenever the evidence for clinical decision making is not available. Our findings indicate that more research is needed to establish optimal treatment protocols for DCS.

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