

A REPETITIVE DIVE SYNDROME: STRESS AT DEPTH

K Jerome Dierks

During the northern autumn of 1978 while doing follow-on work to an earlier study¹ we experienced unexpected compression/decompression stress during and following the second of two "safe" dives performed 24 hours apart. The manifestations were explicit, and subsequent similar experiences indicated that they were repeatable and, to a degree, predictable (Table 1). The phenomenon is somewhat extraordinary in that initial onset of stress begins at depth during the second dive, and a period of non-diving "deacclimatization" preceding the first dive is required to elicit the stress response. It is our purpose here to briefly document and describe the phenomenon in order to stimulate the interest of others better qualified and better equipped to examine it further.

The standard compression/decompression exposure routine was a dive in open water to 30.5m (100 feet) depth for 25 min duration at various water temperatures and repeated 24 hours later. Ascent and descent rates were nominally 18 m/min (60 ft/min) and time on bottom was spent swimming a stretched line between anchor points or a depth contour. Air consumption was nominally 19 l/min per diver, referred to surface pressure. The tabulated water temperatures were those at depth; water surface temperature was nominally 27°C for all tabulated dives, which may have mitigated the "safety" of the exposures.

The manifestations of stress that occurred during and following the second dive were: headache, and sometimes nausea, beginning during the latter half of the dive, ie. at depth, and exacerbated by surfacing; nausea, and sometimes vomiting, at surfacing; dyspnoea, at surfacing; and anorexia. Generally, all manifestations, excepting the headache, resolved within 15-30 min after surfacing, with no after effects. Headaches often persisted for several hours post-dive.

Although it cannot be stated absolutely that gas poisoning did not cause or contribute to the phenomenon, it can be said with some certainty that it probably did not. The air compressor is an in-house unit in use, at that time, almost daily. There were no reports of "bad air" or of stress of any nature prior to the 1978 experience. Following the latter the air remaining in the divers' tanks was tested for CO and CO₂ and tested "clean". Semi annual tests by an outside agency both preceding and following the dive periods indicated in the table have all reported air purity exceeding US Navy standards.

Regarding the requirement for a period of deacclimatization preceding the two repeated dives, during our earlier study (1) there were frequent exposures to up to 5 daily repeated dives with no stress manifested. However, during the period of that study (approximately 8 months) the *maximum* inter-exposure interval was only 5 days (mean interval 3.3 days; standard deviation 1.3 days). In fact, the 21 day non-diving interval shown for the 1978 exposure (Exposure 1 in the table) was imposed because it was felt that the divers had acclimated to a rather intense

compression/decompression regimen. The consequence of that hiatus was totally unexpected. The divers associated with the first 1979 event (Exposure 2 in the table) were performed for a reason unrelated to the present "study", the non-diving intervals tabulated were therefore happenstance. The other non-diving intervals (Exposures 3, 4, and 5 in the table) were, however, imposed.

Exposure (3) was two repeated dives to a shallower depth, 27.4 m (90 feet), for the same 25 min duration, which now was 5 min less than the US Navy no-decompression time limit for that depth. As the onset of stress at depth during the second dive generally occurred about mid-duration a slight diminution in depth seemed a more expedient perturbation than a major reduction in duration. This exposure was uneventful. Thus, a strict interpretation of the "data" would indicate that a non-diving interval of about 10-14 days followed by repeated dives to the US Navy no-decompression time limit at intervals as long as 24 hours may be unsafe. The generality of this conclusion with regard to other depths is of course unknown.

Gait et al (2) reported entrapment of microbubbles in the peripheral vasculature following a severe compression/decompression exposure, with subsequent release into the central circulation following recompression. The interdiving interval in their study was measured in minutes whereas it is hours in the present work. But could the same mechanism be acting to effect the results described here? At this laboratory, and quite likely at many other facilities, dives to the no-decompression time limit repeated on a daily basis is not an unusual exposure regimen. Therefore the question is not a trivial one. Although the present evidence is perhaps tenuous, it is felt that the syndrome could be elicited ad lib, however the divers are understandably reluctant to do so. It is a phenomenon which appears amenable to investigation using an animal model, and it is hoped that a laboratory equipped to do so will examine it further. At best, it is disconcerting to the diver to anticipate possible stress following a "safe" compression/decompression exposure.

REFERENCES

1. Dierks KJ and Eisman PT. Hematologic changes after daily asymptomatic dives. Undersea Biomed. Res. 1977; 4(4): 325-331.
2. Gait D, Miller KW, Paton DM, Smith EB and Welch B. The redistribution of vascular bubbles in multiple dives. Undersea Biomed. Res. 1975; 2(1): 42-50.

DATE	DIVE PROFILE	DIVERS	PRECEDING NONDIVING INTERVAL	EXPOSURE	DIVE 1: SYMPTOMS, ONSET, RESOLUTION	DIVE 2: SYMPTOMS, ONSET, RESOLUTION
WATER TEMP.	SCHEDULE					
11-12 OCTOBER 1978 24°C	30.5 m/25 min Repeat 24 hr later	A,B	21 DAYS	1	A. SURFACED WITH MILD SINUS HEAD- ACHE B. BEGAN WITH MILD SINUS HEADACHE. SURFACED WITH SEVERE ("SICK") HEADACHE	A,B. ONSET OF "POUNDING" HEADACHE 15-20 min INTO DIVE; EXACERBATED BY SURFACING; NAUSEA (10-15 min); DYSPNOEA (10-15 min); ANOREXIA (30 min, AFTER WHICH ATE HEARTILY) A. 5-6 RETCHES ON SURFACING B. HEADACHE PERSISTED UNABATED THROUGH FOLLOWING DAY: 1h O ₂ BY ORONASAL MASK 10/13/78 PROVIDED MILD RELIEF
11-12 AUGUST 1979 14°C	30.5 m/25 min Repeat 24 hr later	A,C,D	A: 9 DAYS B:25 DAYS D:48 DAYS	2	UNEVENTFUL, D REPORTED SOME DISORIENTATION AT DEPTH (HAD NO PREVIOUS EXPERIENCE AT 30.5 m, 14°C WATER, OR LOW VISIBILITY)	A,C,D. ONSET OF HEADACHE 15-20 min INTO DIVE; EXACERBATED BY SURFACING A. SEVERE ("POUNDING") HEADACHE (20-30 min); ANOREXIA (20-30 min) MILD DYSPNOEA (10 min) C. SEVERE HEADACHE (6-8h) D. SEVERE ("POUNDING") HEADACHE (30-40 min); NAUSEA AND VOMITING (10-15 min); ANOREXIA (30-60min)
25-26 AUGUST 1979 19°C	27.4 m/25 min Repeat 24 hr later	A,C,D	13 DAYS	3	ALL DIVERS PRESENTED WITH MILD HEADACHES (10-15 min)	UNEVENTFUL
6-7 OCTOBER 1979 19°C	30.5 m/25 min Repeat 24 hr later	A,C,D	A: 9 DAYS C:17 DAYS D:14 DAYS	4	A,C. SURFACED WITH MILD HEADACHE	A,C. ONSET OF HEADACHE 15-20 min INTO DIVE, LOCALIZED TEMPORALLY/ CERVICALLY (6-12h) A. ONSET OF MILD NAUSEA 21 min INTO DIVE; MILD NAUSEA AND ANOREXIA AFTER SURFACING (10 min) C. SEVERELY DISORIENTED MID-DIVE: DISORIENTED AFTER SURFACING (10 min); ANOREXIA (10 min) D. NO ADVERSE AFFECTS
11-12 DECEMBER 1979 16°C	30.5 m/25 min Repeat 24 hr later	A,C	14 DAYS	5	A. MILD SINUS HEADACHE	A. MILD NAUSEA AT BEGINNING OF ASCENT (10-15 min); ONSET OF HEADACHE AT BEGINNING OF ASCENT (30-60min) C. ONSET OF HEADACHE DURING ASCENT (30-60min); MILD NAUSEA AFTER SURFACING (10min)