LETTER TO THE EDITOR

Helium and Oxygen Mixtures in the Treatment of Compressed-air Illness

The article by Catron et al. (1) confirms the documented observation that when bubbles containing mainly nitrogen are present in the pulmonary microcirculation, a switch to helium and oxygen breathing at 1 ATA may cause a small increase in pulmonary arterial pressure. Although this is likely to be due to the expansion of gas bubbles trapped in the lung, it does predict events after gas switching in the other tissues or the effect of recompression.

Using microscopy, Hyldergaard and Madsen (2) have actually observed the behavior of gas bubbles in adipose tissue under similar conditions to those used by Catron et al. All bubbles seen at 1 ATA, after decompression from a 4-h exposure to compressed air at 3.25–3.3 ATA, always shrank when the animals were switched to breathing a helium and oxygen mixture. This is predicted by the flux data for the two gases in lipid. The bubbles eventually disappeared with continued heliox breathing at 1 ATA. If the breathing gas were changed back to air while the bubbles were still visible, they began to grow again. As the nervous system, and especially the spinal cord, contains a great deal of fat, these data are highly relevant to the treatment of neurologic decompression sickness and are in agreement with clinical experience in the North Sea.

There is also comprehensive experimental evidence, dating from 1954, that, at least for the gut, the flux of helium is less than that of nitrogen. Cross (3) injected 150 ml of room air into a closed loop of bowel in the dog and recorded the reduction in volume with a variety of breathing gases and at various pressures. The results, for a large series of experiments in each instance, are given in Table 1.

It is important to note that in the experiments using compression, the volume of the bowel loops were measured after the animal was decompressed to 1 ATA. At an absolute pressure of 2 ATA, corresponding to recompression therapy, the volume reduction would have been double the values given in the table. If helium had diffused into the bowel more rapidly than the nitrogen was eliminated, the volume of gas would have increased, as, for example, would be the case with the inhalation of nitrous oxide and oxygen mixtures (4). From these data, it would appear that the best treatment for decompression sickness is to adopt the pure oxygen approach, but this neglects the immediate reduction in gas bubble diameter using higher pressures,

TABLE 1

Respired Gas	No. of Experts	Pressure, ATA	Duration, h	Volume Reduction
Air	10	1	6	10.38
Heliox, 80/20	10	1	6	19.90
Heliox, 80/20	22	2	6	28.30
Oxygen	23	1	6	37.50
Oxygen	30	2	6	44.80

which allow the redistribution of the gas. Also, the large unsaturation created by increasing the absolute pressure ensures that separated gas quickly redissolves.

When bubbles are present in flowing blood and a gas switch is made, the transfer of gas is by convection and the sole determinant of growth is the relative solubility of the gases involved in blood, not the product of the diffusion coefficient and the solubility. Under these circumstances a switch to breathing helium with nitrogen bubbles in the circulation will cause a reduction of the size of the bubbles, because helium is less soluble than nitrogen in blood (5). If the opposite switch is made, then the gas phase will expand, so it is dangerous to recompress a diver using air after a helium and oxygen dive.

Despite concerns about the use of helium and oxygen in the therapy of compressed-air decompression sickness, based on the counter-transport of gases (6), there have been no recorded cases of deterioration in commercial experience in the U.K. It has become standard practice to use heliox when deterioration is seen at 2.8 ATA breathing oxygen or to escape from the trap of unresolved symptoms at 6 ATA on compressed air. However it is also the first choice in the treatment of neurologic presentations in the procedures of one diving contractor(7). There are apparently no reports of an adverse response to this method of treatment in the literature but, on the other hand, there have been instances where this change from air to a helium and oxygen mixture with a rapidly deteriorating patient has produced dramatic improvement (8). It can be maintained that the advice given by the U.S. Navy in 1959 (9) to use helium and oxygen in therapy still holds good, and it is notable that it remains an option available to the physicians of that service.

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