on experienced divers who had recovered from spinal DCS showed a tremendous number of lesions in the spinal cord.

4. Rehydration

There are a number of sources of dehydration associated with diving:

a) Immersion diuresis*

b) Breathing dry air

c) Exercise

d) Cold

e) Decompression sickness or air embolism

* In Latin urinare means "to dive" and, in the past, divers have been referred to as "urinators".

It is beneficial to give fluids to patients with air embolism or decompression sickness either by mouth or intravenously. Diuretics such as alcohol or caffeine-containing fluids should be avoided.

THE VICIOUS CYCLES OF DECOMPRESSION SICKNESS

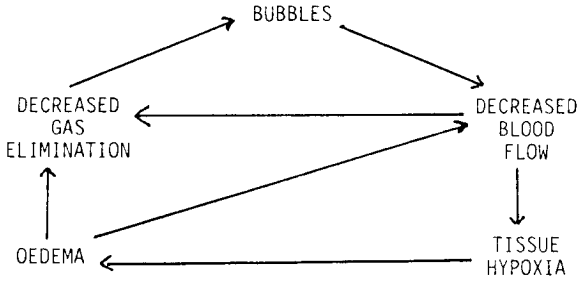

FIGURE 3. Oedema problems in delayed diving accidents.

5. Reduction of Neurological Oedema (Figure 3)

Tissue hypoxia from any source leads to swelling or oedema. Of particular concern in decompression and air embolism are the neurological tissues, ie. the brain and the spinal cord. Bubbles in these regions obstruct blood flow and result in oedema. This oedema is difficult to reverse and treat. The longer the delay to treatment, the worse this situation becomes. Currently, two methods are used to reduce neurological oedema related to diving problems:

a) Hyperbaric oxygen has been shown to reduce oedema through vasoconstriction.

b) Steroids, specifically dexamethasone (Decadron), are given in high dosage to reduce oedema.

CONCLUSIONS

1. Do not take a diver with decompression sickness or air embolism back underwater for treatment.
2. Administer 100% oxygen by mask and give fluids to the patient during transport.
3. Transport as rapidly as possible to a properly equipped and staffed double-lock multiplace hyperbaric chamber facility.
4. Treat the patient in such a chamber with pressure and 100 per cent oxygen by mask according to standard oxygen treatment tables.

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SCOPODERM AND DIVER PERFORMANCE

Mike Davis

I was very lucky in my first few years of diving as an undergraduate, in the early 1960's, to be involved in most of the field projects undertaken by Alan Baddeley, who is now Director of the Medical Research Council (MRC) Applied Psychology Unit in Cambridge. Alan, in those days, was just beginning to look at some of the effects of diving on diver performance, in particular, nitrogen narcosis. So I learnt a bit, albeit rather superficially, about the problems of applied psychology experiments in the field, problems which are pretty considerable. The overall concept of 'diver performance', that it was not just nitrogen narcosis we were worried about, but that there were a whole variety of components that contributed, became increasingly understood by a number of groups around the world at that time. One of the problems about diver performance, probably the biggest, is how to assess it under field conditions. For many years there were really two main schools of thought on how to approach this, either to use an array of simple tasks which define different areas of performance, for instance, manipulative and various cognitive and reasoning tasks, or to go for the analysis of complex tasks like assembling an oil well head. A common feature of all these studies has been how much greater is the effect seen in open water compared to simulated chamber dives.

When I arrived in Christchurch in the late 1970's to find myself running a recompression chamber with some other enthusiasts, I looked at one or two small areas of research that we might tackle. One was to go back to what I had been involved with a decade earlier,

hoping that things had not advanced too much and our rather simplistic approach to applied psychology problems might enable us to look at the effects of drugs on diver performance in the chamber. We felt that the appropriate thing to do was to look at those agents with which divers commonly self medicate, such as nasal decongestants and anti-motion sickness agents. So a few years ago a diving medical friend of mine, Graham McGeoch, and I looked at cyclizine and pseudoephedrine. That was our first mistake, trying to study two drugs at once, which resulted in a complicated study design which neither we nor Undersea Biomedical Research felt we fulfilled adequately. Nevertheless, from this preliminary project we learnt a great deal about design and methodology; We also saw some drug-related effects on performance.

In recent years there have been some major developments in the evaluation of tasks for use in diver performance studies. The major contribution has been from the US Navy and their biodynamics division in New Orleans. In a study of 112 different tasks they assessed the validity of each for repetitive measures applications, that is, the sort of situation where you wish to repeat a particular test on an individual on a number of different occasions and perhaps in different environmental circumstances. They found that some two-thirds of the tests assessed were invalid as performance measures for various reasons. About 40 tests, however, were applicable to repeated measures situations. Two of those happen to be tests that Alan Baddeley was very much involved in developing and which we have used for many years. The other important thing about repeated measures tests is that as well as being stable, minimal or no practice effects should be present. If significant learning effects do occur as in the case, for instance, with manual tasks, it is important that these effects are linear. Any study of performance must take all these factors into consideration in the experimental design.

In late 1985, we undertook a simple performance study of trans-dermal scopolamine (Scopoderm). Scopolamine or hyoscine, which is used widely in anaesthetic practice as a drying agent, is also probably the most effective anti-motion sickness agent there is. Unfortunately scopolamine given orally or parenterally has quite profound CNS side effects, drowsiness, difficulty concentrating and so on which makes it a dangerous agent, like many of the anti-motion sickness agents, in association with diving. The trans-dermal patch is a special multi-layer preparation on an adhesive waterproof backing which has contained within it a known dose of scopolamine. The drug is absorbed through the skin in a two phase manner rather like that of a two phase infusion to achieve steady state drug levels in the serum, thus avoiding the peak levels that produce side effects. This preparation has been shown to be an effective anti-motion sickness agent. Two studies suggest that Scopoderm does not have effects on performance at normal ambient pressure. The study undertaken is summarised below. A full report for publication is being prepared.

The effects of trans-dermal scopolamine on three measures of performance were studied in 24 divers during simulated air dives to 5m and 36m in a recompression chamber. A placebo-controlled randomised double-blind experimental design was used. Small but significant decrements in manual dexterity and in a grammatical reasoning task were seen at 36m compared with 5m, but no change in simple arithmetic skills. No additional decrement of performance was seen either at 5m or 36m with trans-dermal scopolamine compared with placebo nor any interaction or drug and depth on performance. Subjective side effects such as tiredness and blurring of vision were more common with scopolamine than placebo. Though there appeared to be no adverse effects of trans-dermal scopolamine on performance at depth in a dry recompression chamber, caution is needed in extrapolating the findings to open water diving conditions. In addition, we need to know whether pressure and/or open water diving, have an effect on the rate of drug uptake from the trans-dermal patch as this could alter its efficacy.

QUESTIONS

Question:
How long does it take for an effective blood level to occur after a person has put on the patch?

Dr Davis:
Six hours is what is recommended in the Ciba Geigy literature. The kinetics of drug uptake from the patch have not been extensively studied since no reliable plasma assay is available. The subjects put the patch on at 2200 hours the night before each dive. Each subject did their dive at the same time the following day in the late afternoon, so they all had the patch on for a minimum of 16 hours by which time we knew that all subjects were to the point where they would have a stable plasma level.

Question:
Did you know the preparation is not available on the Australian market as yet?

Dr Davis:
We tend to get most drugs earlier in New Zealand than in Australia. Our country is a fertile ground for the pharmaceutical industry for phase 1 and phase 2 clinical studies. For instance, in anaesthesia we have three or four drugs in our armamentarium that you do not. I think the same applies to Scopoderm. Federal Registration has been applied for, I believe, and it is probably 9 months to a year away from release in Australia. One thing I should say is that I do not think you can on the basis of this study advocate that it is safe to use this patch when diving.

Question:
Does it make any difference what sort of blood flow area you put the patch on?

Dr Davis:
The important thing is that it must go on a hairless part of the skin and the most convenient one is on the mastoid process behind the ear. That is where we recommend it be put on.

Question:
Did you get any pupillary dilation with these people because that would explain problems with vision?

Dr Davis:
Some of our subjects complained of visual problems but the number of complaints was identical in the two groups.

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