something like 2/3rd of the match underwater and I would not be at all surprised to see some pretty frightening falls in PaO_2. This would be a fascinating area to look at. Clearly the hypoxic ventilatory response needs looking at because there is very little data on this in breathhold divers. One final point in discussing this area of physiology, I do not think we should mix scuba divers and breath-hold divers into one group because they may be totally different in their behaviour. We need more data on this.

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QUESTIONS

Question:

Does the repeated high $PaCO_2$ of multiple breath hold dives in underwater hockey lead to a reduced CO_2 response or do the good players come from those with a low CO_2 response?

Dr Davis:

That is a question I do not think anyone can answer clearly at this stage. It would appear from dry land studies that the CO_2 response in any individual is probably largely determined by his genetic make up. For instance, if you look at identical twins you have very close correlations in their $C0_2$ responses whether they are sportsmen or not. Secondly, people have looked at the effect of 6 to 8 weeks of intensive physical training on the $C0_2$ response and that sort of intense training programme does not alter the $C0_2$ response in dry land athletes. Now opposed to that, Schaeffer[3] many years ago showed in US Navy submarine escape tower instructors that when they had a break of several weeks from instruction work in the tower their response to 5% $C0_2$ appeared to be increased after the layoff. We have only looked at two of our international subjects after a layoff. It is very difficult to get underwater hockey players to lay off their sport. They are totally addicted to it, just like runners. In these two, at the end of a 6 week layoff, the duplicated CO_2 response had doubled from around 0.5 l per minute per mm Hg CO_2 to somewhere in the order of 1.3 to 1.5 l per minute per mm Hg $C0_2$. So I am not sure how much of it is adaptive and how much is pre-determined. This is another area we could look at taking new players through over a long time period.

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PREVENTING POST-DIVE HYPOTHERMIA

Rob Stephens

My qualifications for being in front of you are few and simple: I have been diving for a very long time, since before World War II in fact, and I have specialised in long distance diving with a small crew, the last two expeditions being from Auckland to the Kermadec Islands. My dive motto is the old Service one “Any fool can be uncomfortable”.

Small boat and small expedition diving requires rather a special form of safety precautions. My most common problem when diving from very small boats, eg. inflatables, has been the cold. A winter dive in a small boat miles from base means that a chilled diver must sit still in an icy blast for maybe a couple of hours during the journey home. Those who take “dry” clothes on such a trip usually find that instead of freezing in foam rubber, they freeze even worse in wet wool. Happily there is a simple answer, the large transparent plastic bag. The illustrations show two adults sitting in their own private greenhouse which maintains its configuration simply by wind pressure. Having got the occupants inside the bag, I usually simply pull one side of the opening over a projection such as the outboard motor, leaving a generous hole about a foot across for the wind to enter and maintain inflation of the bag. Three benefits accrue from this system:

1. Evaporative cooling of the wet diving suit virtually ceases as the air flow within the bag is very slow.

2. Body heat from the occupant(s) is largely retained within the bag’s microclimate.

3. Even only moderate sunshine produces a rapid temperature rise whereupon condensation is evident on the inner wall of the bag.

The illustrations inappropriately show the bag on the foredeck of a launch where need for the bag is obviated because there is a nice warm cabin, dry clothes and hot drinks. However, a chill problem can occur on large boats and frequently returning divers are incapacitated by cold.

On winter dives it is my custom to heat up a large pan containing about 10 litres of water so that each diver on return can have his suit filled with water as hot as he or she can bear it. This seldom seems hot to the person doing the pouring but the diver’s facial expression changes from tense apprehension to bliss and rapture as the water spreads from chin to toes. Some divers claim a bigger ‘buzz’ from the warm-up than from the dive itself!

Follow the external warm-up with a hot drink and within five minutes of return to the ship, your diver is a cheerful and efficient crew member once more. Should it be necessary to remove the suit, it is worth pointing out that a warm suit comes off far more readily than a cold one due to its increased elasticity.

Our oxygen routine management of possible bends differs in only one respect from the orthodox in as much as we carry a closed circuit oxygen diving set (courtesy Italian Navy 1942) as well as oxygen cylinder fitted with a standard diving regulator. A closed circuit system extends the duration of oxygen use

Figure 1. Exterior view of two adults ina large plastic bag on the bow of a boat

Figure 2. Interior of the bag showing the "greenhouse"

should this be required, as well as giving the photographers a bubble free shallow water dive!

In conclusion, whilst plastic bags are universally available you may have a little trouble obtaining very large ones. I get mine from Transpak Industries in Glenfield, Auckland (ISD phone 64-9-4444823 and ask for Frank Richardson) and I should like to take this opportunity of thanking Allan Bloomfield, their Managing Director who kindly supplied bags for both my trips to the Kermadec Islands.

Figure 3. Warming the winter diver by filling the wet suit with heated water.

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THE ZIERING ALPHABET

AN APOLOGY

Owing to a printing error the name of Tony Catley, who drew the illustrations of the Ziering alphabet, was omitted.

HYPERBARIC OXYGEN THERAPY RATIONALE FOR TREATMENT OF DIVING ACCIDENTS

Andrew A Pilmanis

SUMMARY

Use of a hyperbaric chamber with 100 per cent 0_2 by mask is the currently accepted treatment for diving related air embolism and decompression sickness. However, the basic rationale and goals of hyperbaric oxygen therapy are not universally understood by members of the diving community. This lack of understanding often leads to attempts at inadequate and misdirected measures resulting in, at the least, delays to proper treatment and, at the worst, to harmful measures. This paper is an attempt to clarify the currently accepted basic rationale and goals of recompression oxygen therapy for diving accidents.

In 1964, Goodman and Workman[1] introduced the hyperbaric oxygen treatment tables for decompression sickness (DCS) and air embolism. These tables are currently almost universally used for treatment of these ailments. The success of these tables is generally recognized. The treatment method involves the use of 100 per cent 0_2 by mask delivered intermittently inside a hyperbaric chamber at various pressures for various times depending on the severity of the condition.[2,3]

The University of Southern California Catalina Marine Science Center hyperbaric Chamber facility was involved with 554 diving accident incidents between 1974 and 1985 (Table 1). There were 179 decompression sickness patients and 101 air embolism patients treated in the chamber according to the above mentioned treatment procedures.

It was observed that, in general, a number of misconceptions existed in the diving community about the rationale or objectives of these treatment procedures. It is the purpose of this paper to clearly define this rationale as perceived by the author. These are not original concepts, and are not universally presented in this manner. However, the concepts are, in general, accepted by the majority of the hyperbaric medicine field. There is obviously overlap among the five goals of recompression therapy listed. In addition, the order of the listing does not necessarily reflect priority or level of importance.

GOALS OF RECOMPRESSION THERAPY

1. Bubble Size Reduction

Since all divers are taught the basic pressure/ volume/ density relationships defined by Boyle's Law, this goal is the most obvious. Although this aspect has definite beneficial results (especially in the case of air embolism), as is apparent in Figure 1, the Boyle's Law effect is not nearly as dramatic when viewed from the standpoint of the decrease in the diameter of a sphere rather than simply by volume reduction, ie. a bubble in the body. For example, at 50 metres of sea water (msw), 165 feet of sea water (fsw), which is the initial treatment depth for air embolism, the volume in a bubble has been reduced to 1/6. However, the diameter of that bubble has only decreased to 55 per cent. Certainly that 45 per cent reduction is beneficial in permitting blood flow to previously occluded tissues. However, by itself this factor will not cure the problem.