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To promote and facilitate the study of all aspects of underwater and hyperbaric medicine.
To provide information on underwater and hyperbaric medicine.
To publish a journal.
To convene members of the Society annually at a scientific conference.

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References

The Journal reference style is the "Vancouver" style, printed in the Medical Journal of Australia, February 15, 1988; 148: 189-194. In this references appear in the text as superscript numbers.[1-2] The references are numbered in order of quoting. Index Medicus abbreviations for journal names are to be used. Examples of the format for quoting journals and books are given below.

1 Anderson T. RAN medical officers' training in underwater medicine. *SPUMS J* 1985; 15 (2): 19-22
2 Lippmann J and Bugg S. *The diving emergency handbook*. Melbourne: J.L.Publications, 1985: 17-23

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PROJECT STICKYBEAK

This project is an ongoing investigation seeking to document all types and severities of diving- related accidents. Information, all of which is treated as being **CONFIDENTIAL** in regards to identifying details, is utilised in reports and case reports on non-fatal cases. Such reports can be freely used by any interested person or organisation to increase diving safety through better awareness of critical factors.

Information may be sent (in confidence) to:
Dr D. Walker
P.O. Box 120, Narrabeen, N.S.W. 2101.

EDITORIAL

The first issue for 1991 continues discussion of the subject of the leading article in the last issue for 1990 with a survey from the Diver Emergency Service (DES) based at the Royal Adelaide Hospital covering the recorded calls from its inception. Inspite of their best endeavours there were times when staff shortages and other pressing matters in the Intensive Care Unit made keeping accurate records impossible. The records which were kept show quite clearly what a useful, and indeed essential service, has been provided by DES to the divers of Australia and overseas. The sugestion that international co-operation is really underway with a meeting of those responsible for the various national services is a good omen for the future. There is a great opportunity for a large and relaible data base to be built up about diving accidents and their causes and the most effective treatments. Thankfully very few units, if any, see enough divers with serious problems to build up a statistically valid data base. International multi-centre co-operation will allow the building of such a data base.

The third instalment completes a study of 100 scuba diving fatalities in Australia and New Zealand. This time it is the contribution of equipment faults, not misuse, that is studied. One can only agree with their conclusion that “more attention should be given to diving training and to training in the use of diving equipment."

The dangers of diving, even to shallow depths, in dark, dirty and very cold water are clearly displayed in the price of Tasmanian scallops. Good advice, and clear pictures, about the usefulness of post mortem CT scans is provided. Once again there is need of better diving training to avoid such needless and avoidable tragedies.

The investigation of Queensland scuba divers’ habits is continued in the paper from Wilks and O’Hagan about their investigation into divers ability to perform simple repetitive dive calculations. The results bear out the recommendations of Edmonds and Walker that. training needs to be improved. But given the commercial imperative to spend as little time as possible on training new divers, for otherwise the dive shop goes out of business, the only way that training can be improved, which means more time is spent training, is to raise the price of diving courses. In an industry which has too many shops, for the potential market to support in a way that allows a reasonable return on the capital invested, higher prices for diving courses will put many shops out of business. The question is will it be the cowboys who operate on the smell of an oiled rag or will it be the safety conscious operators who go to the wall ?

Those members who do “fit to dive medicals” are unlikely to agree entirely with the views of Gatehouse and Wodak. Should remote possibilities of harm and the necessary expensive investigations be discussed with every potential diver ? Will the community really be better off ? Will the dive shops be better off ? Opinions from diving cardiologists are obviously needed to inform the debate. There is no doubt that the lawyers will be involved more often in the investigation of diving fatalities and will perhaps be assiduous in shifting the blame, if any, away from their clients. Whether this will be an advance in the understanding of the causes of diving accidents and deaths is, at the very least, debatable. We hope to publish a commentary on the recent Victorian inquest into four diving deaths in a later issue.

More about the problems of new decompression tables and of teaching trainee scuba divers how to use their tables and how to recognise and avoid decompression sickness are contributions from the 1990 Annual Scientific Meeting. Those of us who only occasionally carry tanks will be glad of the information provided by Dr Barr and her colleagues. The message seems to be to get someone else to carry your tank ! And if you cannot manage that use a sling. Never use the commonest grip that is seen around every diving boat. It is the one which causes the problems. And we will all hope that we never suffer from the physiological alterations outlined by Gorman and Helps. While it may protect the diver from the effects of air embolism in the brain to be aleukaemic, it is hardly likely to be a precaution that will catch on.

The recommendations from the 1990 UHMS workshop on diving accidents make interesting reading as do the collected statistics, published in NAUI News, of the Australasian DES hyperbaric centres work load provided by divers between 1980 and 1990. Another awaful warning about the dangers of bolting for the surface completes our reprinting from the literature.

The programme for the 1991 Annual Scientific Meeting to be held in the Maldives is an interesting one and, now that the Gulf war is over, it is time to make arrangements to attend, as there are still places available.

The Annual General Meeting is to be asked to approve some changes to the Rules of theSociety to bring the Rules in line with the actuality of the Society's administration. The Society exists to serve its members but on the other hand it needs members who are willing to carry out these aministrative functions. Dr John Robinson will be resident overseas in the near future and will not be able to continue as Secretary of SPUMS after the AGM. SPUMS needs volunteers for this job. The organisation that is to be ratified at the AGM has markedly reduced the work load of the Secretary and it is no longer the equivalent of a court order for unpaid, unlimited, community service. It is unpaid but the work load is light except when writing the minutes of the various committee meetings !

ORIGINAL ARTICLES

SCUBA DIVING FATALITIES IN AUSTRALIA AND NEW ZEALAND

PART 3. THE EQUIPMENT FACTOR

Carl Edmonds and Douglas Walker

Background

In a previous report[1] it was determined that amongst recreational Australian and New Zealand diving fatalities during the 1980s, equipment faults contributed in 35% of the cases and equipment misuse in 35%. There was some overlap between these, with some divers having faulty equipment and also misusing that or other equipment.

In the Australian and New Zealand (ANZ) series we only documented the factors which materially contributed to the divers death. Errors in technique, which indirectly involved equipment (such as exhaustion of the air supply, failure to ditch weights and some problems with buoyancy) are errors of judgement and recorded in an earlier presentation.[1]

Under the equipment "fault" category were included problems that have developed which could not have been reasonably attributed to any action of the diver during that dive. It was not considered an equipment fault if the diver injudiciously chose the wrong equipment. This was included under the "misuse" category.

In many cases the information about equipment problems was imparted by the victim to his companions, whereas in other cases it was observed by the companions.

Equipment testing was carried out by the Water Police, Police Divers and Navy Diving units. Their reports included bench testing of the diving equipment used by the deceased, comparison with the national standards for compressed air equipment, and were often supplemented by in-water trials where an experienced diver of similar stature employed the equipment in a simulation of the fatal dive profile. Only if the abnormality was obvious and of practical relevance to the incident, was it counted as a contributor to the fatality. Gas analyses were routinely carried out at government laboratories.

One hundred consecutive deaths, which complied with strict requirements as regards data acquisition, were assessed. The figures therefore represent both actual numbers and percentages of the total. The equipment problems are detailed below.

Regulator problems (15%)

In 14 cases there was a significant fault in the regulator and in one instance it was misused. The faults were as follows:

Catastrophic failure	2
Increased resistance to breathing	4
Salt water inhalation	8

There is little doubt that the regulators of the 1980s cause much less resistance to breathing that those of previous decades, but they were still a significant contributor to 15% of the diving fatalities. In none of the cases was the regulator reported to be in a neglected state before the dive.

Although the most obvious regulator problem was with the sudden catastrophic failure, the commonest problem was the regulator producing, for a variety of reasons, a large degree of salt water during inhalation. This malfunction, together with the increased resistance to breathing noted in the other cases, was more likely to develop with increased respiration such as during exertion. The associated panic, removal of the regulator and the need to surface rapidly, were frequent observations preceding the death

Fins (13%)

In 13 cases there was an absence or loss of one or both fins. In 3 there was definite misuse, in that fins were not worn or were excessive in boot size, and were therefore lost. In another 10 cases one or both fins were lost. Whether this was cause or effect of the accident is not known.

The loss of one or both fins (13%) was a difficult problem to evaluate, as a cause or an effect of the accident. The frequency of the observation in this series was surprising and did cause concern to us. Presumably very active leg movements, such as during panic and swimming in strong currents, would be more likely to displace fins.

Fins must be retained if a current has to be negotiated. Fins are are also necessary if the diver is negatively buoyant and trying to remain on the surface. Divers over-weighted "to get down" are especially vulnerable to this dependency on fins to ascend or remain on the surface.

Buoyancy compensator (12%)

In 8 cases there was a malfunction of the buoyancy compensator (BC). In 6, two of which were also included in the previous eight, there was a misuse of the BC. The misuse involved such actions as gross over-inflation, producing the Poseidon missile type ascent, or mistaking an emergency CO_2 cord for the dump valve cord. In 2% the feed hoses were not connected to the BC. The faults included failures in the performance of the equipment, especially with the inflator mechanisms.

The buoyancy problems related to technique were described in part one of this report.[1] These greatly exceeded the frequency with which the BC malfunctioned or was misused. It is evident that the BC is a major contributor to diving accidents, as technique problems with the BC were present in 52% and malfunction or misuse in 12%, even allowing for some overlap.

The problems with buoyancy compensators highlighted the observation that using safety equipment can itself cause problems.[2-4] Unfortunately it is not known, for comparison, how many divers have been saved by the use of this safety apparatus. These figures, cannot therefore, be used to denigrate the use of the BC, but could be used to encourage more robust equipment and better training in buoyancy control.

Scuba cylinder (9%)

In each of these cases there was no actual fault in the equipment, but it was either inappropriately chosen or was misused in some other way. The following analysis was made:

Cylinder too small (28-42 cu ft)	3
Low air fills	3
Valve not turned on	2
Removed inappropriately	1

The scuba cylinder contributed to a low-on-air situation in each of these cases, by the victim using either a cylinder smaller than normal or a cylinder with less than customary air pressure. Most of the 9 divers had contents gauges.

In the case of the small cylinder, not only was there less air supply than that available to the other divers, but when the low-on-air situation developed the actual amount of reserve air was much less than usual. In some of the cylinders, holding only 28 cu ft, there was only a few breaths of air available once the low-on-air situation was reached at depth.

Harness (6%)

In 4 cases there was a contributing fault (not permitting release or not retaining equipment) and in 3 there was misuse in the wearing of the harness, such as wearing it over the weight belt. The result was an entrapment which either contributed to the accident or prevented rescue.

Mask (5%)

In 2 cases there was a fault in the equipment and in 3 there was misuse.

Problems with masks contribute to panic. One mask was designed to inflate a space around the ear (as the diver had a chronic tympanic perforation), but was unable to be cleared of water. Others broke or leaked to an unacceptable degree.

Protective suit (5%)

In 4 cases the suit was considered to be so tight as to have caused problems for the diver, either in restricting respiration or in causing panic, and there was one instance of the carotid sinus syndrome.

Lines (4%)

In 3 cases there was clearly misuse, and in one there was a fault. The result was entanglement.

J Valve (2%) **and Contents gauge** (2%)

These were rare contributors, but problems were encountered both from faults in performance and explosive "blow-outs".

Absence of equipment (6%)

In some other instances, not counted above as equipment misuse or failure, there were situations in which equipment should have been worn and if it had, may have helped to prevent the fatality. The following is certainly an underestimate, as negative data was not recorded as reliably as positive:

Absent equipment	**%**
Buoyancy compensator	2
Snorkel	2
Compass	1
Wet suit	1

Other equipment

Problems with weights and weight belts were also represented in our earlier report[1], showing the difficulties due to human judgement such as overweighting (45%), failure to ditch weights (40%) and the belt being fouled or unreleasable (6%).

It was impossible to determine the incidence of problems with snorkels. These were not at all well documented in the case reports, even though there was some indirect evidence of these as 8% died while snorkelling on the surface. It was not possible to determine whether these could be attributed to the snorkel design or misuse, or even whether this was a major contributor.

There were many other instances in which equipment was not used but could have been considered of possible value to the diver, but in which one would be hesitant to label as contributing to the death.

Discussion

The analysis of some equipment problems due to incorrect technique, was referred to in the first report.[1] Thus the problems with air supply have been previously recorded. The misuse of weight belts and many of the problems with buoyancy that were clearly errors of judgement, have also been recorded in that paper.

It is important to realise the difference between these figures and those given in the United States by the NUADC[5,6] and Australia by Project Sticky Beak.[7] In this ANZ series only when equipment fault or misuse actively contributed to the death was it recorded. Problems with diving equipment are reviewed elsewhere.[8,9] There are many other problems that are experienced in the field that are not evident in this series. An example is the diving computer, which was not commonly used during most of the period under discussion, but which has contributed to many problems since.

The reassurances given by the diving industry, regarding the reliability and sophistication of our current equipment, are possibly not correct. In many instances the misuse of equipment could be, at least partly, the responsibility of the equipment designers and at other times purely the responsibility of the diver himself.

When the equipment problems and misuse are combined with the fatalities related to equipment related techniques[1] (out of air situations, overweighting, buoyancy control, etc.), it is evident that more attention should be given to diving training and to training in the use of diving equipment.

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WHAT PRICE TASMANIAN SCALLOPS?

A report of morbidity and mortality associated with the scallop diving season in Tasmania 1990.

Margaret Walker

Introduction

The D'Entrecasteaux Channel is a narrow strip of water lying between Tasmania's southeast coastline and Bruny Island. It is a natural breeding ground for many forms of fish life, especially the famous Tasmanian scallop. Prior to 1969 the channel was heavily harvested for scallops by commercial fishermen using dredges. Divers could also collect scallops, but as it was dangerous to dive close to the dredging operations so this was only performed to a limited degree. In 1969 the area was closed because of the enormous damage to the sea bottom caused by dredging, which removes the top layer of sand and all weed and marine life. After a period of recuperation, the channel was reopened in 1982 and for three years was heavily dredged, before it was again closed to scallop fishing in 1985.

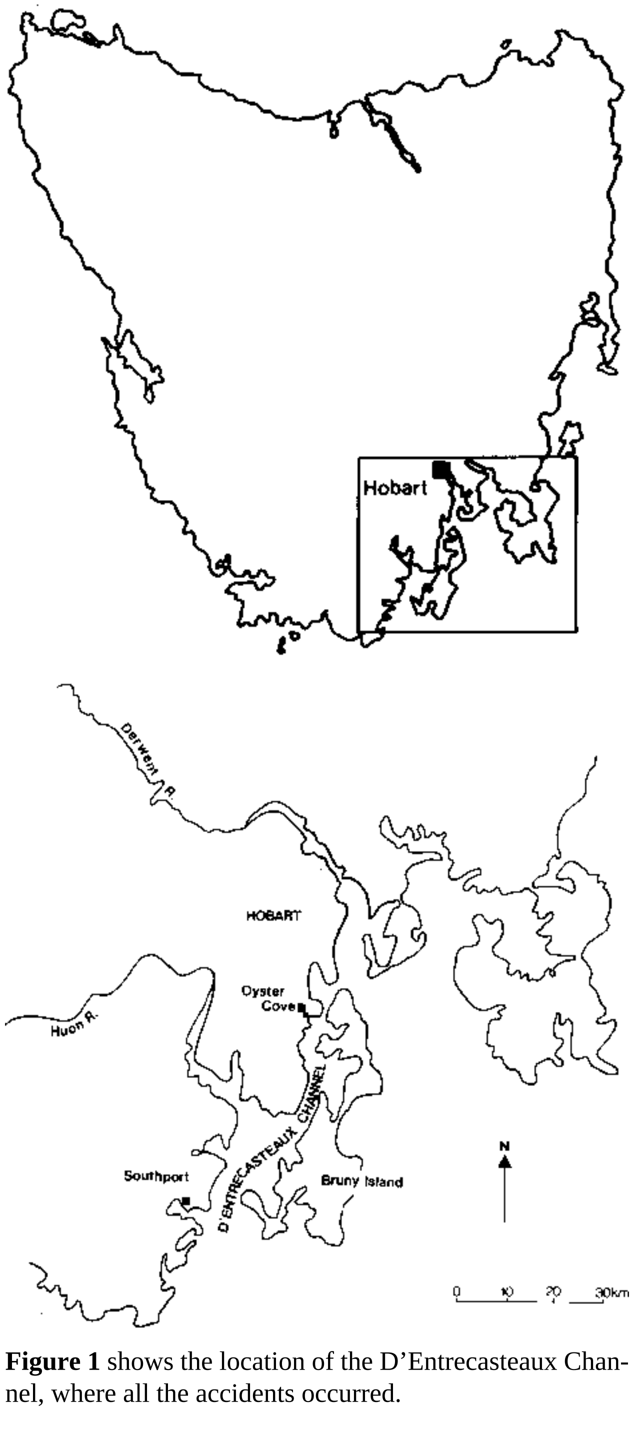

Figure 1 shows the location of the D'Entrecasteaux Channel, where all the accidents occurred.

In 1990, after many years in which it was just not legally possible for the average sport diver to obtain a meal of scallops in Tasmania, the Department of Sea Fisheries opened the channel for scallop fishing by sport divers only. For a short season of four weeks in the month of July, the average sport diver could dive unmolested, and take up to 200 scallops per day for his own use, with a maximum possession limit of 400. The area opened for diving extended from Oyster Cove in the north to Southport Bluff, and consisted of fairly uniformly shallow water no deeper than 16 m. Most scallops were found in water less than 9 m deep. (Figure 1.)

Unfortunately, the weather was unkind to the divers, with heavy rainfall washing tannin and other particulate matter from the Huon River into the channel, reducing the visibility to near zero in most areas. The water temperature was also very low, varying from 5 to 9 $^{\circ}$C. Despite the poor conditions, divers, enticed by the lure of fresh Tasmanian scallops, turned out in their hundreds. Many were inexperienced, unqualified and/or unfit, and the local police and Fisheries authorities were kept busy helping exhausted divers, bordering on hypothermia, from the water.

There were two deaths directly related to diving and three cases of decompression sickness (DCS) treated at the Royal Hobart Hospital (RHH) Hyperbaric Medical Unit during the four week season and these are reported here.

Case Reports

Case 1

J was a 34 year old man, very fit and keen on sport. The day before his diving accident, he had been snow skiing, but due to poor snow cover had decided to go diving the following day instead. He was an experienced diver who was said to be meticulous in his preparation and planning of dives, and had completed three advanced diving courses. The dive took place in water with a maximum depth of 11 m and temperature of 9 degrees Celsius.. There was a cool surface wind. The visibility was near zero. He wore a 9 mm wetsuit and used full scuba gear, which was later tested and found to be in good working order. He and his buddy had performed 5 dives, all of approximately 15 minutes duration, but had not found many scallops. On his 6th dive for the day, J went down alone with a torch in one last attempt to fill his quota. His buddy remained in the boat, and very quickly lost sight of J's bubbles. After 30 minutes he started to search for J. J was found on the surface floating on his back, with yellow froth coming out of his mouth. His regulator was not in his mouth and his buoyancy compensator was not inflated. His mask and weight belt were on. His tank contained 60 bar of air. J was retrieved from the water and cardio-pulmonary resuscitation (CPR) was commenced and continued for 90 minutes before being abandoned. His body temperature was 32 $^{\circ}$C, taken per rectum, on his recovery from the water, and had risen to 32.7 $^{\circ}$C by the end of the resuscitation period.

Unfortunately, the autopsy was performed with no special precautions and no prior X-rays[1,] despite there being a protocol for post-mortem examination of divers[2] approved by the RHH Administration, Radiology and Pathology Departments some four years earlier. This protocol was introduced by Dr Peter McCartney, Director of Diving and Hyperbaric Medicine. The infrequency of such post-mortems, a change of forensic staff, and the failure to involve the Hyperbaric Medical Unit in the early stages of the investigation, led to the protocol being overlooked. However, the examination performed found that the trachea and bronchial tree contained thick yellow frothy fluid and microscopically the lungs showed small areas of intra-alveolar haemorrhage. Also, there were vessels in all organs which were dilated and devoid of blood, suggesting air embolism. The official cause of death was drowning and hypothermia was suggested as a probable trigger.

Case 2

E was a 53 year old man, apparently in good health, who had no formal diving qualifications, but was said to be an experienced diver. He had not dived for over 12 months. On the first dive of the day, he and his buddy dived to 9 m maximum depth for 20 minutes on hookah (surface air supply). After depositing their scallops on the boat, they descended for more scallops. This time they were on the bottom for 10 to 15 minutes before surfacing. The water temperature that day was 5 °C, the visibility near zero, and there was a cool surface wind. They swam to the surface together. The buddy then swam back to the boat, thinking that E was following. However, on arriving at the boat, he was told that E had gone back down, so he returned to find him. He was unable to see under the water, so followed E's air hose down to locate him floating unconscious, just above the sea bottom in 9 m of water, with his regulator out of his mouth. He ditched E's weight belt and took him to the surface, where he put his own regulator in E's mouth and swam with him to the boat. It was thought that he was breathing at this time. He was transferred to a Police Boat where CPR was commenced and continued until a doctor made the decision to stop.

This time X-rays and CT scan were performed on the refrigerated body before autopsy 24 hours after death. The CT scan showed air bubbles in the brain, heart, aorta and blood vessels of the liver and mesentery (Plates 2-4). At autopsy the diagnosis of massive arterial gas embolism was confirmed by opening the major vessels under water in the approved manner.[2] Microscopically, there were distended and ruptured alveoli in the lungs, and distended empty vessels were seen in most organs. There was no extravascular gas. A myocardial infarction 3 to 4 weeks old was found, with severe generalised coronary disease. Information later received from his General Practitioner revealed that he had been seen earlier in the year complaining of chest pains and throat pains. He was found to have an elevated cholesterol, and was asked to return if the pains recurred, but did not return for follow up.

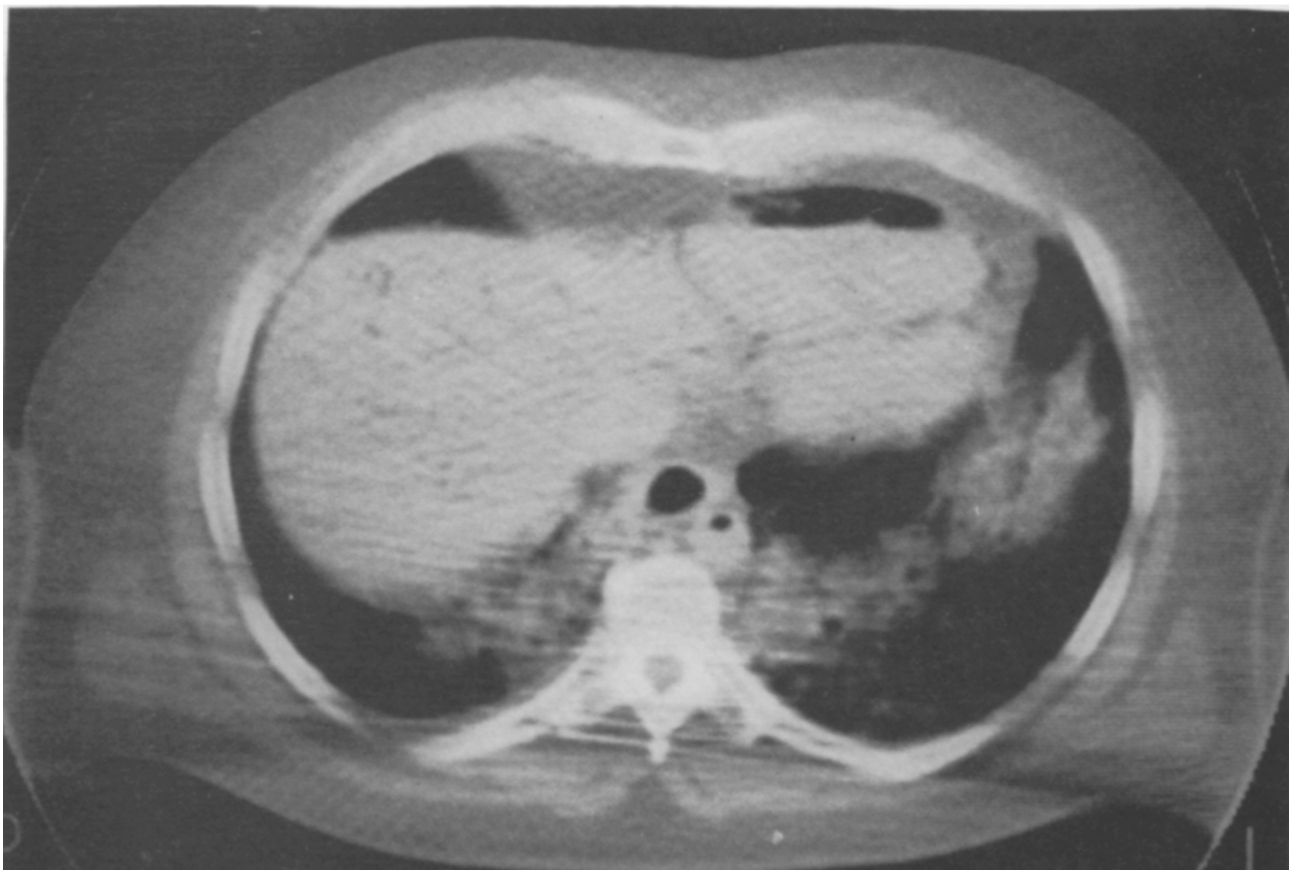

Figure 2 Post mortem CT scan of Case 2. Air can be seen in the left ventricle (black area at the upper right of the picture) and in the thoracic aorta (anterolateral to the vertebral body).

Case 3

R was a 37 year old self taught diver, who had not dived for 5 years. He was suffering from a respiratory tract infection, but decided to dive anyway. On the day of his dives the water temperature was 9 °C, and visibility was zero. He wore a 7 mm wetsuit. He dived on scuba to approximately 8 m (no depth gauge was used) for 30 minutes gathering scallops, returned to the boat, and after a 45 minute surface interval performed a second dive to 8 m for 20 minutes. Following the second dive he attempted to surface, but was pulled down by the weight of his scallops and due to the poor visibility could not see his bubbles to indicate which way was up. He panicked and swam actively to the surface finning vigorously. On surfacing, his nose bled and he felt some pain in his sinuses. This settled, and he felt reasonably well until about 3 hours later, when he developed an ache across his anterior chest, pain in both arms, tightness in his neck and vague abdominal discomfort. He had a marked feeling of dyspnoea but there was no pleuritic pain. After 3 hours of worsening discomfort, he presented to hospital for assessment.

His physical examination was normal, except for some blood in the nasal passages, and there were no neurological signs. An ECG was normal, and there was no pneumothorax on chest X-ray. Although his signs were not classical, he improved with 100% oxygen, and recompression to 18 metres of sea water (msw) produced complete relief of all his symptoms, confirming the diagnosis of decompression sickness. His chest discomfort recurred overnight, and two daily oxygen soaks to 18 msw were required before he remained symptom-free. He has decided not to dive again.

Case 4

B was a 25 year old professional sea urchin diver, who had performed his usual dives for urchins the day before he presented for treatment. These consisted of a 30 minute dive to 5 m on hookah followed 20 minutes later by a 70 minute dive to 16 m which included two bounces to the surface, with no decompression stops. Two hours later, he developed pain in his left elbow and shoulder and

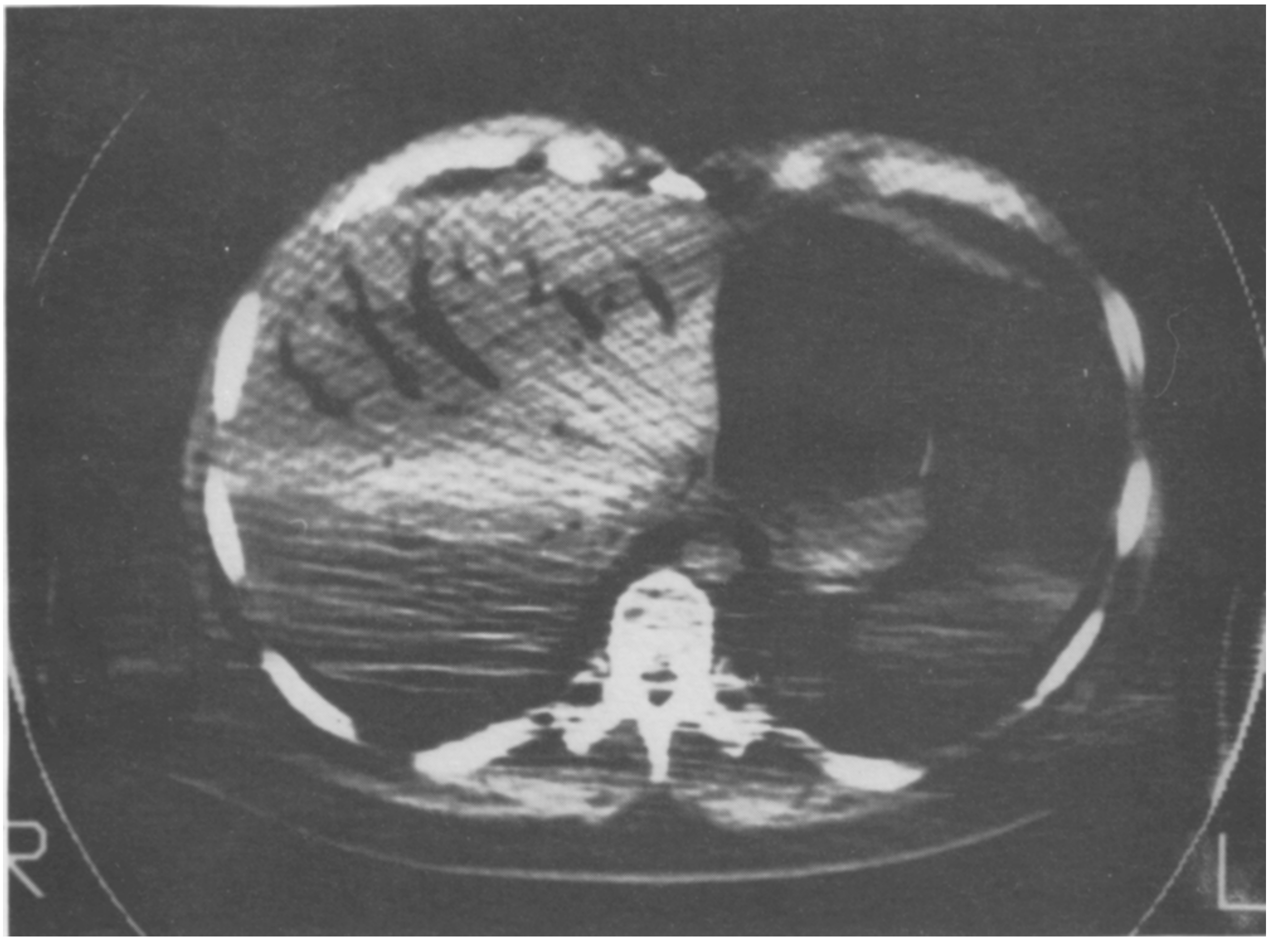

Figure 3 Postmortem CT of Case 2. Air (black lines) is shown in the blood vessels of the liver.

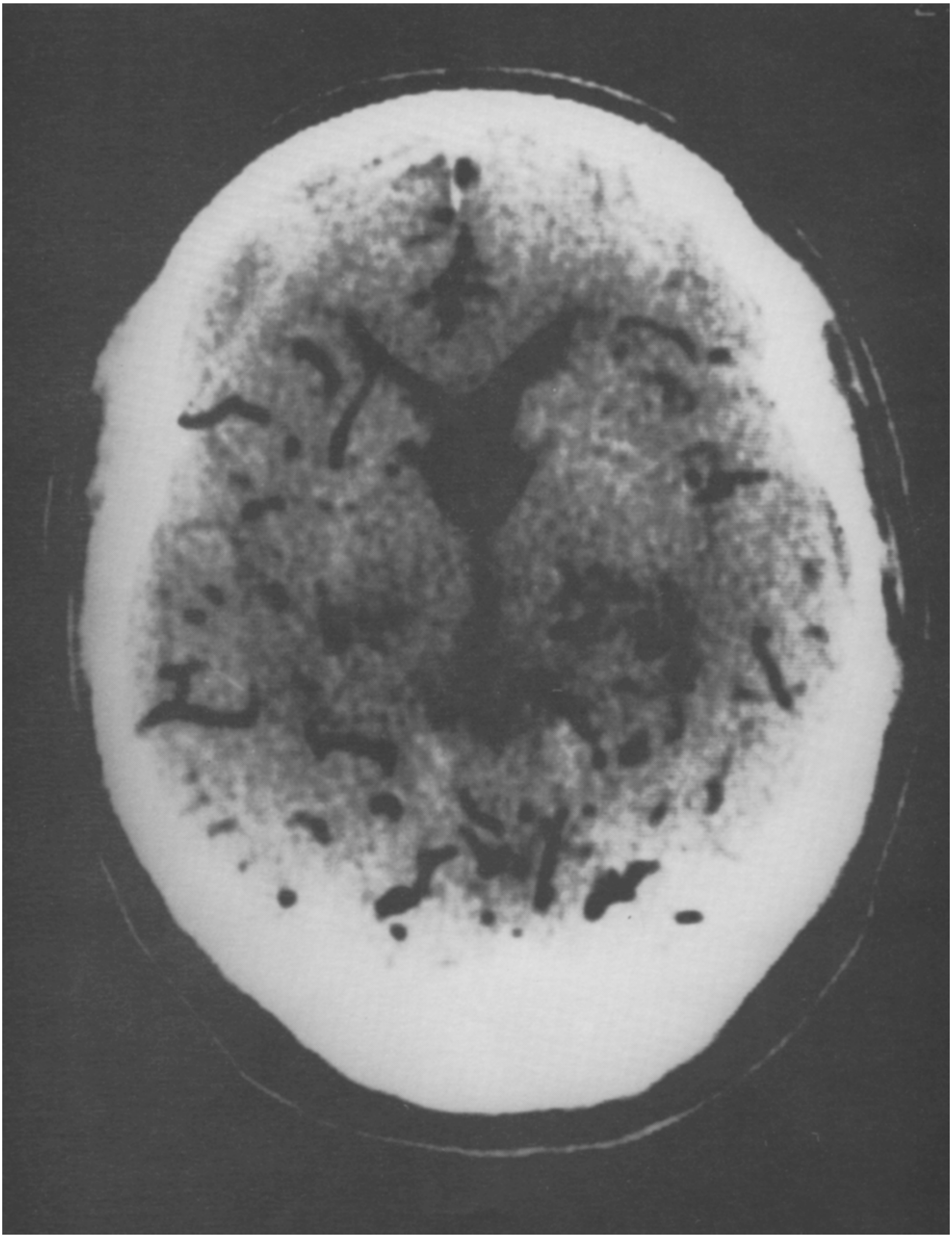

Fig ure 4 Post-mortem CT scan of Case 2.
Air is clearly shown, replacing blood in the cerebral blood vessels. Air is also present in the cerebral ventricles.

paraesthesiae in his left arm which lasted for two hours before resolving. The next day he decided to do some scallop diving, and dived to 5 m for 60 minutes. Twenty minutes later, his symptoms of the previous night recurred worse than before, and he presented to hospital for treatment.

Physical examination was normal, and no altered sensation could be detected in his left arm despite a persistent feeling of "pins and needles" in the arm. 100% oxygen produced significant relief of his symptoms. He was treated with recompression to 18 msw according to USN Table 6 with complete resolution of symptoms at depth. His left shoulder pain recurred the next day, and two further daily 18 msw oxygen soaks were required to prevent their recurrence. He remained well at his six week follow up appointment. He was advised not dive deeper than 10 m for three months and to be very conservative with decompression during his working dives in future.

Case 5

C was a 29 year old qualified sport scuba diver, who had completed several advanced diving courses. He had not used hookah apparatus before, and was diving on hookah for the first time that day. The water temperature was 9 °C and the visibility so poor he could not see his hand when he held it in front of his face. He wore a 7 mm wet suit. He had no depth gauge, but thought he had dived to 18 m for 45 minutes after a brief visit to the surface. He then had a 1 hour surface interval followed by another dive to 18 m for 60 minutes. His surface air supply then failed, and as he was unfamiliar with the equipment and had no alternative air source, he ditched his weight belt and made a rapid, uncontrolled ascent. On arrival at the surface, he had a bleeding nose, pain in his left ear, severe pain in both arms and both hips, and he developed chest pain and dyspnoea. His symptoms persisted en route to hospital, and became significantly worse on driving over the hills towards Hobart, where the road reached an altitude of between 250 and 350 m above sea level.

At hospital he was distressed and dyspnoeic but had no clinical or radiological evidence of pneumothorax. He was tender to palpation over both hips. Examination of the ears revealed a retraction pocket in the superior aspect of his left eardrum (probably a chronic problem), with erythema of the drum. His Eustachian tube function was normal, but he fell to the right after 5 seconds in the sharpened Romberg test. There were no other neurological abnormalities.

His symptoms greatly improved on recompression to 18 msw and he was treated with a USN Table 6. His hip pain was improved, although not abolished, and he required three further 18 msw oxygen soaks before his symptoms completely resolved. His sharpened Romberg test was normal at discharge. ENT review after treatment revealed no Eustachian tube or vestibular dysfunction and no treatment was required for the retraction pocket in the left eardrum.

Discussion

The cases described here represent a cluster of diving accidents associated with relatively shallow, cold water diving in both experienced and inexperienced divers. That it is possible to develop decompression sickness in water at less than 2 ATA is not well appreciated by the average diver but is documented.[3] When hypothermia is also present, the risk of DCS is increased.[4] The risks of pulmonary barotrauma are well recognised in shallow water. Recent articles reporting diving accidents in Australia[5,6] have emphasised contributions from both human and environmental factors in the aetiology of accidents, and both are relevant here.

Although the water was uniformly shallow, the extreme cold and zero visibility made diving very hazardous. Diving in cold water requires special precautions, especially when heat loss by conduction to the water is exacerbated by evaporative cooling, after the dive, by a surface wind. The neoprene of wetsuits provides good insulation while in the water, but is ideal for evaporative cooling once on the surface, making windproof jackets essential where there is a surface wind. In the water described here, where the temperature was 5 to 9 °C, a neoprene wetsuit of thickness 7 to 9 mm usually provides adequate thermal insulation when immersion times are not prolonged for much more than 60 minutes.[7] In Case 1, hypothermia probably contributed significantly as a result of prolonged immersion in 9 °C water, despite a 9 mm wet suit. Dry suits are required for colder temperatures, such as in Antarctica, where the water temperature is close to 0 °C.

It is documented, but unfortunately not well recognised, that some divers make a very poor assessment of their thermal status and may deny feeling cold and continue to dive when their core temperature is significantly reduced.[8,9] In cool climates it is likely that many divers have a significantly reduced core temperature after a 60 minute dive, and they are certainly cold peripherally. Such cold stress can then lead to decreased cognition, irrational behaviour, and poor judgement, especially in making emergency decisions. Cooling of the limbs impairs strength, coordination and the ability to perform fine movements which may be life-saving, such as ditching a weight belt, inflating a buoyancy compensator, or retrieving a dislodged regulator.[4]

For these reasons, trainee divers in cool climates should be carefully taught about the risks of hypothermia and how to prevent and treat it. Similarly, local medical officers and paramedics should be familiar with techniques for resuscitation and rewarming of hypothermic divers.[4] This does not overcome the problem of educating the large numbers of untrained divers who are currently diving in Tasmania.

Two of the divers in this report had no diving qualification, although they were said to have had some experience years before. At present in Tasmania a scuba diving qualification is not legally required to hire diving gear or have tanks filled, nor is it necessary to produce a scuba card to purchase a licence to dive for scallops or other fish. It is unknown how many unqualified divers were in the Channel during the 1990 scallop season nor how many of them suffered morbidity without seeking medical aid.

Two of the divers were qualified sport divers, who had completed advanced diving courses, but had not dived much during the cold Tasmanian winter. The fit, intelligent, qualified, but "out of practice" diver recurs frequently in diving accident statistics. It is important for qualified divers to keep refreshing their knowledge and safety skills, especially after a period of absence from the activity.

The fifth diver was a professional diver who developed DCS due to poor dive planning in his working dives the day before his scallop diving expedition. He did not seek treatment and elected to continue diving the next day. It seems surprising that a professional diver could ignore the symptoms of decompression sickness and continue to dive.

Medical conditions which should have precluded diving were found in these cases. Case 2 had coronary disease and a recent myocardial infarction. Case 3 had a current respiratory tract infection and a long lay-off time. Case 5 had a chronic middle ear problem which had not previously been addressed and although it is unlikely this contributed to his accident, he suffered barotrauma to this ear and developed marked disequilibrium with his DCS, manifested by a poor Romberg test. Prior to this accident, he had never been seen by a doctor experienced in diving medicine as his medicals had been performed by his local General Practitioner.[10]

Diving technique faults were evident in these cases. Poor dive planning and failure to make appropriate allowances for the poor conditions (e.g. limiting immersion times, avoiding repeated bounces to the surface and the use of buddy lines) were common faults. Diving alone, and in Case 5, diving with unfamiliar equipment and no alternative air supply, which lead to an out-of-air situation, panic and rapid ascent, are serious diving errors. Only Case 2 had contact with his buddy while underwater, due to the poor visibility. None used buddy lines. Cases 1,3,4 and 5 dived alone, or with a boat-boy only. It is important to remember that buddy diving is a specific, planned procedure, and is not just diving with a "mate" in the same area. Similarly, safe diving in zero visibility requires special techniques and knowledge, and the action of Case 1 in taking a torch down for his last dive was probably counter-productive as all it would produce would be glare reflected from the particulate matter in the water.

Buoyancy problems were also evident. None of the divers took into account the weight of the scallops, and the effort required to swim to the surface with a full bag of scallops and normal lead weighting. The three hookah divers in particular had no buoyancy compensators to help their ascent.

These cases serve as yet another reminder of the potential dangers of poorly planned compressed air diving. Adequate physical fitness, a sound understanding of the implications and limitations of scuba and hookah equipment, and a healthy respect for a hostile environment remain essential for safe diving. However, they continue to be hard lessons for divers to learn.

In view of the morbidity encountered amongst divers in 1990, the Department of Sea Fisheries in Tasmania is currently considering whether the D'Entrecasteaux Channel will be opened to scallop divers again in the future.

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QUEENSLAND SCUBA DIVERS AND THEIR TABLES

Jeffrey Wilks and Vincent O'Hagan

Introduction

Increasing emphasis is being placed on scuba diver safety by the world's major certifying agencies.[1,2] Though Australian statistics show recreational diving to be increasing in popularity[3], and that safety is improving relative to the number of divers in the sport[4], there are still many unnecessary accidents occurring. In particular, divers' inability to effectively plan dives using their tables[5,6] may place them at risk for out-of-air emergencies and decompression sickness.[7]

Australian divers are not alone in having problems with their dive tables. In one American study 2,576 divers were asked to complete five decompression problems similar to situations that might arise on charter trips.[8] Only 49% of the respondents successfully completed all five questions. In another study of 1,000 active certified divers only 20% could correctly answer a single repetitive dive problem.[9]

While there is growing evidence that many certified divers cannot use their tables to plan diving activities we still know very little about the type of mistakes that are being made in the use of tables. The present study examined divers' answers to two repetitive dive problems in an attempt to pin-point specific types of error.

Method

SAMPLING

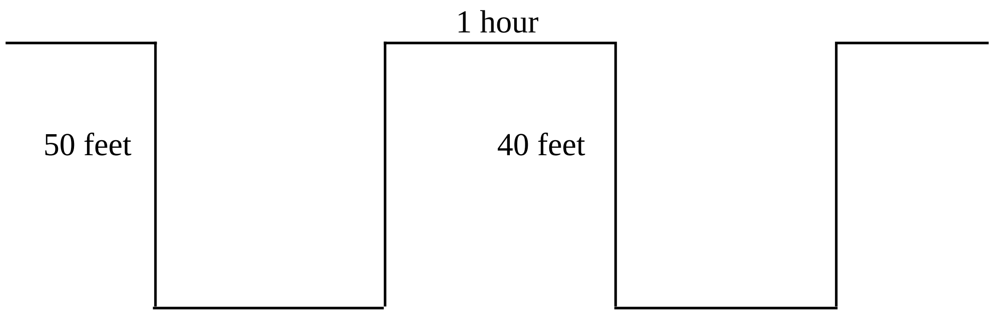
A random sample of 1500 certified divers in Queensland was drawn from the computer records of the National Association of Underwater Instructors (NAUI). After removing records where the address was incomplete, or "care of" a resort or dive shop, the first sample was reduced to 1373 divers. As the research project had a particular interest in the Great Barrier Reef, a second sample of 192 PADI (Professional Association of Diving Instructors) divers certified in Central Queensland, was also included in the study.

From a total of 1565 questionnaires mailed to divers throughout Queensland in September 1989, 291 were returned unopened as divers had left their previous address. Completed questionnaires were returned by 380 respondents.

SUBJECTS

Of the 380 completed returns, 285 (75%) were from active divers and 95 (25%) were from subjects who reported that they had not dived since gaining their open water certification. Active divers (who dive at least once a year), had an average age of 28 years, with a range from 14 to 60 years. There were 177 (62%) males and 108 (38%) females in the final sample. Based on scales of occupational status developed at the Australian National University[10] the sample represents a full range of employment categories. Sixty-six percent of the sample were single and only 25% had children. Overall, the characteristics of this sample compare well to profiles of active divers in other studies.[11,12] Most subjects (74%) had been certified for between one and four years. The majority of divers surveyed do most of their diving from commercial charter boats and are therefore subject to the requirements set out under Queensland's new Workplace Health and Safety Regulations.[13] These include logging each dive in the same format as used in the present

FIGURE 1 TWO DIVE PROFILE



Residual Nitrogen Time	=	Residual Nitrogen Time	=
<u>Actual Bottom Time</u>	= 42 minutes	<u>Actual Bottom Time</u>	= 50 minutes
Total Bottom Time	=	Total Bottom Time	=

study and having the dive profile checked by a dive supervisor.

DIVE PROFILES

Subjects were asked to complete two dive profiles (Figures 1 and 2). A separate question asked which tables they used so that the marker could check answers with the same tables. In addition, if subjects could not complete the profiles they were asked to indicate their reasons for not doing so. Finally, a separate question asked subjects if they would be interested in a skills and theory refresher course if one was offered by a local instructor.

Results

Only 126 divers (44.2%) completed the first profile correctly. Sources of error for the remaining 159 divers included: adding a figure for Residual Nitrogen into the first dive (16 cases); incorrect calculation of Residual Nitrogen for the second dive (2 cases); incorrect calculation of Pressure Groups (12 cases) and what could be called "No Understanding" of the task. This last, and largest group (129 divers or 45.3% of the sample), included subjects who did not attempt the question, partial attempts, and those whose answers were totally incorrect but the rationale for the errors was not clear.

On the second profile, which asked divers to calculate a Minimum Surface Interval between repetitive dives, only 105 subjects (36.8% of the sample) obtained a correct answer. Main sources of error included: 18 divers misunderstanding the idea of Minimum Surface Interval (confusing it with the 10 minutes which is the minimum time between separate dives for repetitive dive calculations); providing a Maximum rather than a minimum surface interval (2 cases); confusing maximum no-decompression bottom times (especially with Residual Nitrogen time) and ending up in the wrong repetitive group columns (7 cases); adding a Residual Nitrogen figure to the first dive (4 cases); trying to calculate the minimum surface interval between dives using Total Bottom Time from the second dive rather than the maximum no-decompression bottom time (6 cases); and finally, a large group who demonstrated no understanding of the task. Again, this group (143 divers or 50.2% of the sample), included subjects who did not attempt the question as well as those whose answers were totally incorrect.

In addition to the specific sources of error described above, Table 1 presents an overview of correct responses according to divers' gender and length of time certified, respectively. As can be seen, there were more female errors on both profiles, though the calculation of a minimum surface interval between dives (Profile 2) was poorly performed by both males and females. Table 1 also identifies divers certified for between 25 and 36 months as having the lowest proportion of correct responses, though statistical comparisons revealed no significant differences for dive table performance based on either gender or time since certification.

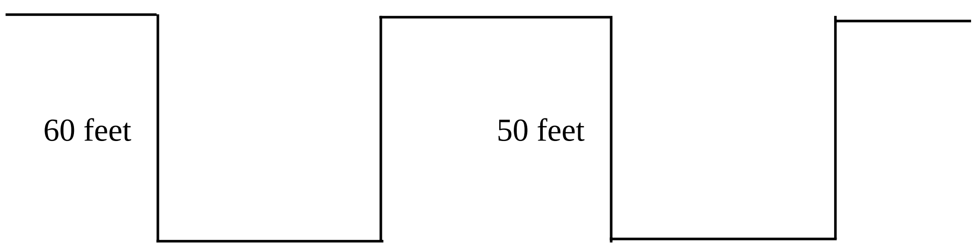
Asked why they could not complete the profiles, 74 divers (26% of the sample) replied that they could not remember how to use their tables, 46 divers (16%) said they did not have tables, and 14 divers (5%) indicated that they could not be bothered to do the exercise. On a more positive note, 197 divers (69% of the sample) reported that they would be interested to take a refresher course if one was offered by a local instructor. A larger proportion of women (77%) than men (64%) expressed interest in taking a refresher course.

Discussion

The effective use of dive tables is like knowledge of a second language: people become rusty and forgetful if the

FIGURE 2 MINIMUM SURFACE INTERVAL DIVE PROFILE

Minimum Surface Interval Time =



Residual Nitrogen Time	=	Residual Nitrogen Time	=
<u>Actual Bottom Time</u>	= 42 minutes	<u>Actual Bottom Time</u>	= 50 minutes
Total Bottom Time	=	Total Bottom Time	=

skill is not practised. All certified divers in this study were proficient with their tables at one time, or they would not have received certification. Moreover, subjects apparently do not consider that the problem lies in their initial training since 60.4% of respondents rated their open water course as excellent (38.2% rated it as adequate, and only 1.4% as poor). It remains for future studies to determine whether initial training with dive tables is indeed comprehensive enough.

Just over one quarter of the sample (26%) admitted that they could not remember how to use their tables. This figure is probably very conservative since conversations with divers who did not return their questionnaires revealed a high level of embarrassment in not being able to complete the two profiles. In an earlier Australian study, Knight[5] commented on the extent to which divers rely on divemasters for their repetitive diving information. This reliance also emerged from written comments made by divers in the present study. For example, "We always dive with a dive club. The divemaster calculates for us." (Male, 35 years, certified 15 months, 100% of diving on charter vessels, both profiles incorrect). On the other hand, the fact that 69% of the sample are interested to do a refresher course suggests that many divers would like the opportunity to be independent. While certifying agencies do offer tailored refresher courses, these programs need to be actively marketed and more readily available to the diving public. The prices divers' say they are willing to pay for refresher courses are currently being investigated.

Most instructors are aware that the main source of confusion and error when using flat dive tables is accounting for Residual Nitrogen while calculating repetitive dives.[14] Divers in the present study had many problems in this area. The recent introduction of circular tables such as the Dive Time Calculator II (NAUI) and The Wheel (PADI) automatically account for Residual Nitrogen. Instructors might consider teaching with these new instruments as a way of overcoming common dive table errors.

In Queensland, the recently legislated Workplace Health and Safety Regulations[13] require divers to log all of their dives. This provision offers divers an opportunity ask the dive supervisor for assistance if they have difficulty with their tables and allows the supervisor, time permitting, to do some brief remedial teaching. Only a minority of divers have made the transition to using dive computers[15], so improving divers' ability to use their tables is still critical. As mentioned above, encouraging refresher courses and the use of circular tables appear to be useful directions for overcoming common dive table problems.

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AUSTRALIA'S "DIVER EMERGENCY SERVICE" (DES) 008-088200

An analysis of recorded usage over a 35 month period during 1987-1990.

John Williamson, Christopher Acott, Robert Webb, Roger Capps, Fred Gilligan and Des Gorman.

Introduction

The Diver Emergency Service (DES) is Australia's (and its near neighbours') 24 hour, user-free emergency consultative telephone service for diving medical and diving safety information.

The service was born in 1984, and its origin and lively history to date have been described.[1]
We present a detailed report of the activities of DES over a period of 35 months since April 1986, which follows two previous overviews in the Journal.[1,2]

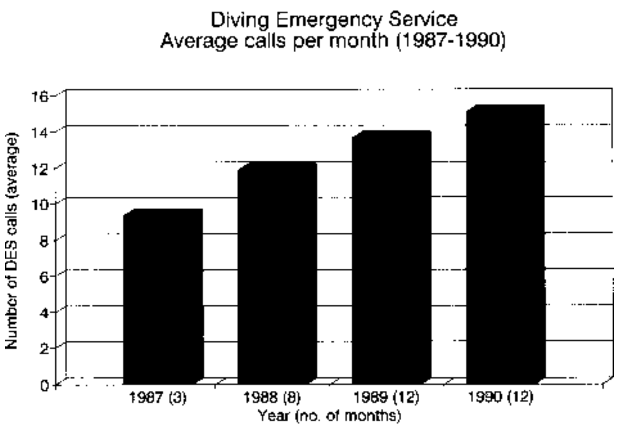

FIGURE 1. The average number of incoming DES calls per month, expressed on a yearly basis, over the 35 month period examined. The steadily increasing usage of the Service is shown. Note that records exist for only 3 months during 1987 and 8 months during 1988.

Method

We have analysed each written record of DES calls according to:-

1 Year, month, and time of day of call
2 Type of caller (diver, doctor, dive supervisor, etc.)
3 Location of caller, in Australia or beyond
4 Age of patient where recorded
5 Differential diagnoses over the 'phone'
6 Commonest presenting symptoms according to the provisional diagnoses
7 Medical referrals and aero-medivacs
8 Special features.

The advantages, disadvantages, lessons learned, trends usage characteristics, and future needs identified from this body of data are considered.

Results

The total of DES calls recorded in writing from 1987 to December 31, 1990 (35 months total) was 467. This approximates to 13 incoming calls a month.

USAGE TRENDS

Figure 1 shows the increasing recorded usage of the Service over the 35 month period.

Figure 2 shows that the busiest periods of usage during the year are the Australian warmer months of October to April.

The distribution of calls according to the time of day was:-

0800-1800	143	31%
1801-2300	58	12%
2301-0800	21	4%
Time not recorded	245	53%

OCCUPATION OF CALLER

Divers	223	48%
Medical Officers	107	23%
Dive Supervisors	40	9%
Friend or relative	17	4%
Rescue/First-Aid team	5	1%
Other	5	1%
Unidentified	70	14%

LOCATION OF CALLERS

WITHIN AUSTRALIA

Queensland	111	24%

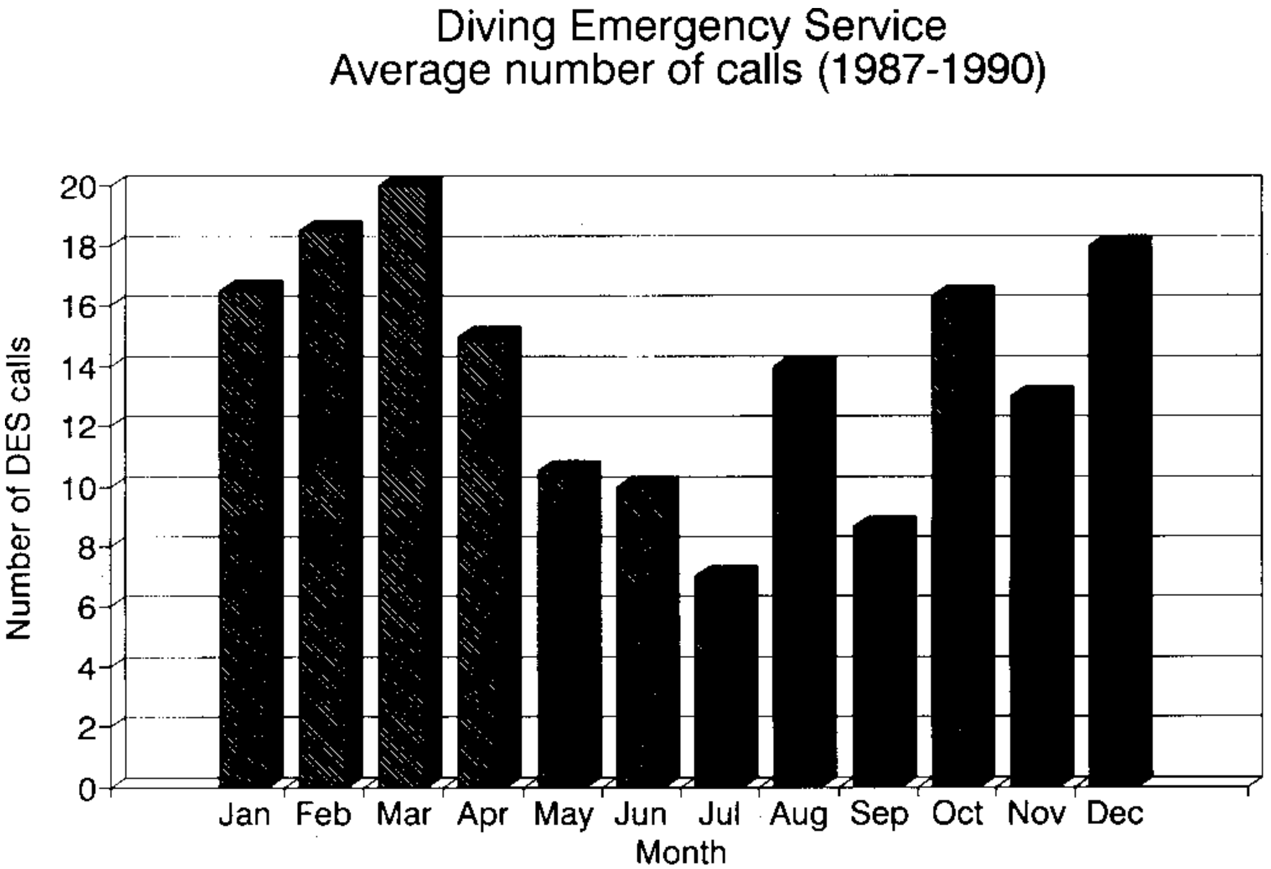

FIGURE 2.

The number of incoming DES calls received, during the 35 month period for which written records exist, plotted on a monthly average basis. The "quiet" months are the Australian winter months, while summer months are busier.

New South Wales	99	21%
Victoria	81	17%
South Australia	42	9%
Western Australia	29	6%
Northern Territory	16	4%
Aust. Capital Territory	3	
INTERNATIONAL		
Papua/New Guinea	11	2%
Sultanate of Oman	2	
Fiji	2	
New Zealand	1	
Bouganville	1	
Vanuatu	1	
Christmas Island	1	
UNKNOWN	62	13%

Figure 3 shows the 3 monthly totals of calls received from the most frequent user State (Queensland) from April 1987 to December 1990.

AGE RANGE OF PATIENTS

The vast majority of patients were between the ages 20-35 years. The youngest was 15 years, and the oldest 57 years. Both these patients had decompression sickness (DCS).

DIAGNOSES

DECOMPRESSION ILLNESSES		
Decompression sickness	210	45%
(1 life-threatening)		
Barotrauma		
Pulmonary		
Cerebral arterial gas embolism (CAGE)	27	60%
(3 fatal, 2 near fatal)		
Other pulmonary (e.g. surgical emphysema)	12	3%
Middle ear	17	4%
Inner ear	4	1%
Sinus	3	1%
Alternobaric vertigo	1	
NEAR DROWNING SYNDROMES	5	1%
(2 life-threatening)		

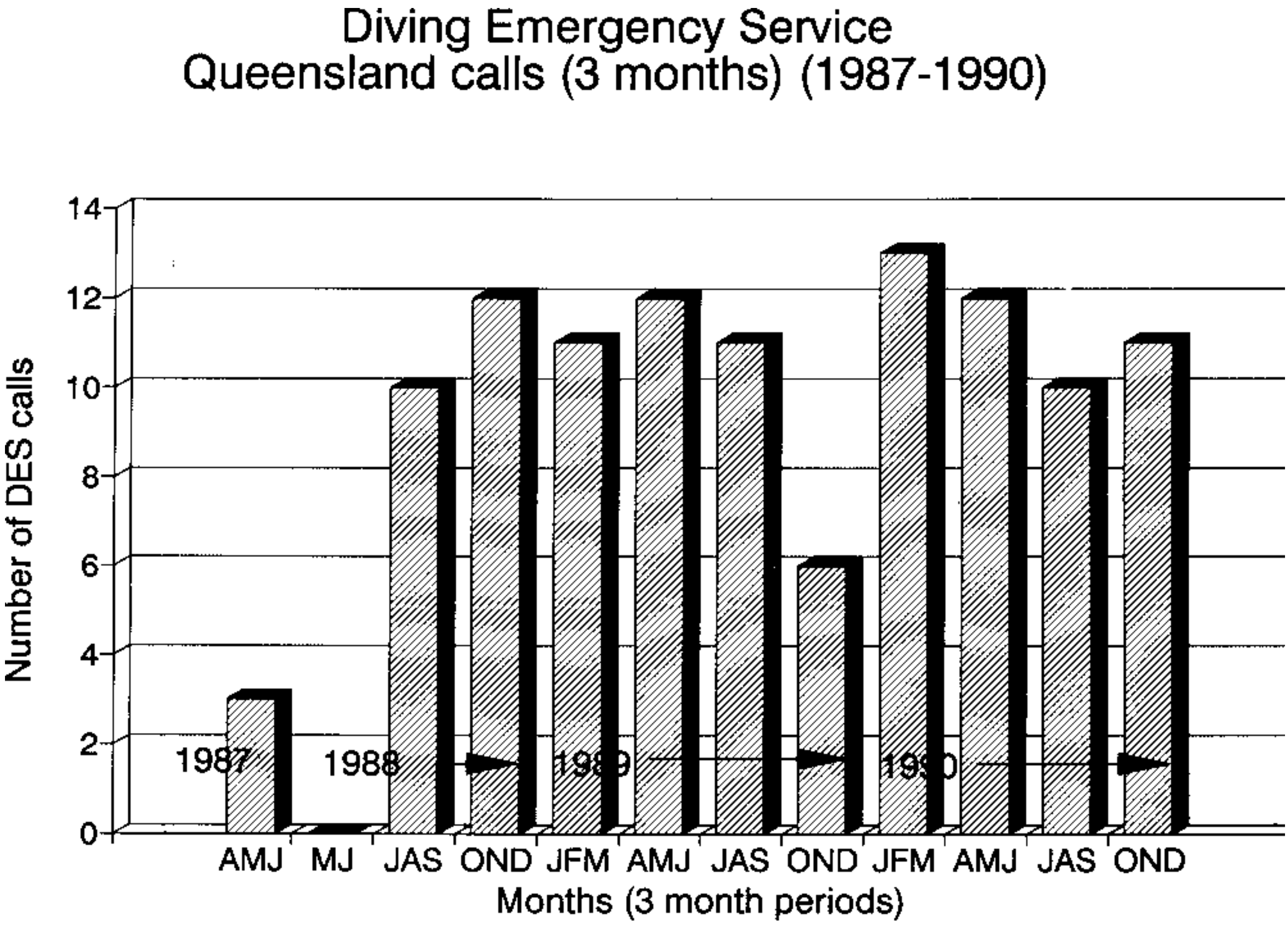

FIGURE 3

The number of incoming calls from Queensland during the 35 month period examined by this report. The calls are grouped into 3-month blocks. Note that the Queensland usage during this period was well sustained. (AMJ = April, May, June; MJ = May, June; JAS = July, August, September; OND = October, November, December; JFM = January, February, March.)

MARINE ENVENOMATIONS

"Irukandji" sting	2
Stingray	1
Stonefish	1
Blue-ringed octopus	1
Shellfish allergy	1

MISCELLANEOUS DIAGNOSES

Acute otitis externa	1
Hyperventilation	1

CALLS FOR ADVICE 52 11%

The commonest group was medical colleagues, seeking advice

NON-DIVING DIAGNOSES

18 4%

e.g. muscle and joint injury, respiratory tract infection, gastroenteritis and acute abdomen

DIAGNOSES UNKNOWN

109 23%

MEDICAL URGENCY AND/OR COMPLICATIONS

Most calls involved medical situations which could be attended to in a relatively unhurried manner. However some could not.

CAGE

27 calls all treated as relatively urgent.

Two deaths occurred subsequent to DES contact, but both patients were comatose from their appearance on the surface, and a third death was dead on the surface.

Two other cases were in a dangerous condition, but survived with good first-aid, and rapid recompression.

DCS

One call, a patient with life-threatening pulmonary DCS, which responded to urgent recompression.

NEAR DROWNING

Two cases were in a critical condition, both survived.

LOST BUDDY

An urgent situation!

NON-DIVING RELATED MATTERS

One septicaemia and one carbon monoxide poisoning

MULTIPLE PATIENTS

Two calls involved more than one patient each.

COMMONEST PRESENTING SYMPTOMS

DECOMPRESSION SICKNESS

There were 202 cases where the presenting symptoms had been recorded

Pain	112	55%
Paraesthesiae, numbness	63	31%
Headache	40	20%
Dizziness, vertigo	30	15%
Lethargy, fatigue	25	12%
Nausea	16	8%
Weakness of muscles	15	8%
Visual disturbance	11	5%
Skin itch and/or rash	10	5%
Poor higher mental function	6	3%
"Chokes"	3	
Tinnitus	3	
Abnormal conscious state	2	
Speech affected	1	

The commonest presenting symptom groupings in DCS cases were joint pain and paraesthesiae followed by headache and dizziness.

CAGE

There were 18 survivors in whom no DCS coexisted

Collapse on the surface	5	27%
Impaired vision	4	22%
Respiratory distress	3	17%
Hemi- or para-plegia	3	17%
Dizziness	2	11%
Pain	2	
Paraesthesiae	2	
Haemoptysis	1	
Headache	1	
Vomiting	1	

OTHER PULMONARY BAROTRAUMA

There were twelve patients with pulmonary barotrauma without CAGE

Chest pain on surfacing	5	42%
Haemoptysis	5	42%
Surgical emphysema (voice change in 2)	4	33%
Pneumothorax,pneumomediastinum	2	
Acute dyspnoea	1	

The presenting symptoms of all the other diagnoses listed in this report were medically predictable, and unremarkable from a diagnostic point of view.

MEDICAL REFERRALS AND AERO-MEDIVACS

Hyperbaric referral details are available from 160 of the recorded DES calls during the period examined. Patients were referred to the following hyperbaric units for assessment:-

Townsville	57
Alfred Hospital, Melbourne	32
Prince Henry Hospital, Sydney	25
Royal Adelaide Hospital	14
HMAS PENGUIN, Sydney	9
Royal Darwin Hospital	8
Fremantle Hospital, W.A.	7
Royal Hobart Hospital	7
HMAS STIRLING, W.A.	1

34 air retrievals were recorded. They were to:-

Townsville	17
Prince Henry Hospital	9
Royal Adelaide Hospital	3
Alfred Hospital	2
Royal Darwin Hospital	1
Fremantle Hospital	1
HMAS "Penguin"	1

It was not recorded which of the air retrievals employed portable recompression facilities.

SPECIAL FEATURES

The three deaths in the series were all CAGE cases.

Two near drownings and 1 DCS ("Chokes") had life-threatening illnesses requiring resuscitation and critical care medicine.

The longest aero-medical retrieval was from Christmas Island to Townsville (approximately 4,500 kms).

The furthest away DES call was from the Sultanate of Oman.

Discussion

Although from the inception of DES at the Royal Adelaide Hospital an attempt was made to keep a written record of every call that it received, this did not happen. Two major practical difficulties interfered with this best of intentions. First, the service had to be located within the Intensive Care/Retrieval Centre at the RAH, where the 24 hour cover with the necessary communication skills already existed. The work load of this busy Unit mitigated against the staff having adequate time to spend on keeping records of DES calls, which may be protracted. Second, DES offers a service to international callers outside Australia (ISD 61-8-223 2855). This international access telephone is separate from the DES "008" number, is not free of charge, and is used by the RAH Intensive Care medical staff to handle international retrieval, emergency and consultative needs that range far beyond diving medical matters.

As a result the early written records on which this report is based are incomplete covering 3 months in 1987, 8 months in 1988, and only become reasonably complete in late 1989. However the data that is available is objective, accurate, and sufficient for valid analysis.

On 13th September, 1990, the Communications Centre of St John Ambulance in South Australia agreed to accept the DES telephone interconnector link. From that time records have been precise,and the speed and reliability of connecting DES callers to the diving medical officer on duty has been much improved. This has been enhanced by the expert back-up received from Telecom Australia, for DES servicing requirements.

USAGE OF THE SERVICE

The increasing usage of the Service by the nation during the period reported is shown in Figure 1. Figure 2 shows that there is an annual variation in usage, with the Australian summer months being busiest.

Most callers use the service during "office" hours. However, as with all medical practices, "after hours" usage is significant. There is a preponderance of more urgent calls during the 1800-0800 period. Interestingly, the incidence of nuisance callers is remarkably low for a user-free service. Is it possible that the DES number is not widely known outside diving circles ?

THE CALLERS

Not surprisingly nearly half of the callers were divers. The great majority were recreational divers, but some abalone divers, and a few professional divers were represented.

Usage of the Service by medical colleagues seeking advice concerning diving medical examinations, and clinical decision making related to diving is steadily increasing. This is to be commended and encouraged. Likewise calls from would-be divers querying the compatibility of diving with particular conditions (diabetes, asthma, ileostomy, etc.) is on the increase.

In general, taking a medical history from a friend or relative is less satisfactory than speaking to the diver, when this is easily possible and it frequently is ! Often it is obvious that the diver had been unwilling to phone the DES, and the friend or relative, has initiated proceedings.

Unusual callers included a fireman with carbon monoxide poisoning, a pilot concerned about recent aviation decompression, occasional angry patients wanting to know why they were failed by their doctor for a diving medical examination, and a worried diver phoning to say he had lost his buddy ! Fortunately the buddy was safe.

OUTGOING DES CALLS:

Incoming DES calls that involve a diving medical emergency frequently result in the DES doctor on call making 3 to 5 outgoing calls immediately following the initial DES contact. These will be to the hyperbaric facility nearest to the problem site, followed by further calls to the nearest medical facility, to the people initially involved, back to the dive site and then possibly back to the hyperbaric facility which will manage the problem.

Consequently although the records show only an average of 13 incoming DES calls per month, the number of calls, both incoming and outgoing, actually made to and by DES would number more like 40 per month, during the 35 months examined. The records used for this report dealt only with incoming calls. At the time of writing (February 1991) the frequency of incoming DES calls has increased to between 1 and 2 daily.

WHERE DO THE CALLERS COME FROM ?

This data is of particular current interest. Clearly Queensland dominates overall during the period examined. However the State-based DES call frequency varies from month to month. For example during 1990, Victoria made the most calls in March, and New South Wales in November. Western Australians may perhaps tend to call their local hyperbaric facility more than other States, although they are never discouraged from using the DES first. It is of interest that the usage pattern, month by month, by Queensland divers and doctors fails to show the same summer/winter variation revealed by the national figures (Figure 3).

DES has long provided a service for diving in New Guinea, and the South-West Pacific, however its function in the Indian Ocean is less well known.

DIAGNOSES

The predominant incidence of decompression sickness reflects our current understanding.[3]

The overwhelming dominance of neurological DCS in this series may reflect self selection by callers with more serious and protracted symptoms. However, the concept that the human central nervous system is a prime target for the effects of DCS[3] now has wide medical acceptance.

Of note is the relatively common incidence of pulmonary barotrauma (9% of all diagnoses), two thirds of whom (including all the deaths in this series) had CAGE. Reference has been previously make to the need to abandon the long held myth that these dangerous events are rare in diving.

Also as the data shows, divers can still drown, and/or suffer marine envenomations. Once again the "Irukandji" sting (a small tropical jellyfish of the *Carybdeidae* family)[4] has (understandably) been confused with DCS [5]. Divers should remember the availability of the user-free Marine Stinger Hotline - 008-079909, a 24 hour service for expert medical advice concerning marine envenomations. However divers are not expected to make difficult differential diagnoses, and should continue to use the DES when in doubt.

Non-diving related diagnoses may also be important for the health and safety of the diver, and the differential diagnosis and subsequent appropriate referral of these cases are DES functions.

PRESENTING SYMPTOMS

This data is valuable because of its relative objectivity, and its immediate nature. Not often in medicine can a doctor obtain such early history as is made possible by the DES.

We wish to call attention again to the prominence of neurological symptoms in the DCS series. Pulmonary DCS ("chokes") is of serious prognostic significance, both cardiovascularly and neurologically, for it may be promptly followed by spinal DCS. Respiratory distress may occur in both DCS and pulmonary barotrauma. As this series both diagnoses co-existed in 5 cases.

This series again shows that convulsions (fitting) are not the commonest presenting symptom of CAGE. Collapse (i.e. acute loss of muscle power with variable sensory loss) and visual impairment are more common. Such collapse may be accompanied by retention of awareness by the patient. Attendants must mind what they say in the patient's hearing, and continue to talk to him or her during transport and treatment ! One case occurred with co-existent CAGE and pneumothorax.[6]

Haemoptysis appeared to be more commonly associated with pulmonary barotrauma, not involving clinically detectable gas embolism, which commonly presented with chest pain.

DIVING PRACTICE AND ERROR[7]

While the incomplete nature of many of the records did not permit a quantitative analysis of the dive profiles of the DCS patients, it was obvious that the diving of many was outside even mildly conservative guidelines. Diving too deep for too long and/or too often (repetitive diving), and/or ascending too fast were the prime determinants of DCS. Rapid ascents carry additional serious potential penalties.

Of the 288 diving-related medical calls recorded, it is salutary to note that 21 (7%) of these were associated with a rapid ascent. Three of these developed CAGE. The remainder (18) had symptoms of DCS. The ascents came under a variety of different names, such as "rushed", "panicked", "emergency", "excessively rapid", "uncontrollable" and "runaway"; one of them was even listed as "multiple rushed ascents" ! Inexperience featured amongst this group. Five of the divers recorded running out of air. Another diver phone for advice following his rapid ascent and remained well.

The dangerous diving practice of making multiple ascents also featured in the dive profile of at least 5 of the DCS cases in this report.

Six DCS patients admitted to being exposed to altitude following their diving, and at the time of onset of their symptoms (4 flying, 2 crossing mountains by road).

PARTICIPATING HYPERBARIC UNITS

A third of the recorded referrals, and half the retrievals involved the Townsville Hyperbaric Unit. The geographical situation of this recompression chamber makes it one of Australia's most used facilities by divers, and for diving retrievals.[3] This chamber also acts as the referral facility for much of the South-West Pacific region, and at present is the only chamber between Darwin and Sydney; so diving retrievals are especially common to there. However all the Australian Units (Royal Darwin Hospital, Townsville General Hospital, Prince Henry Hospital, HMAS PENGUIN, Alfred Hospital, Royal Hobart Hospital, Fremantle Hospital, HMAS STIRLING) together with the two New Zealand Units (HMNZS PHILOMEL at Auckland, and the Christchurch Unit) have co-operated wonderfully with DES, and the Hyperbaric Medicine Unit at the Royal Adelaide Hospital, to the great benefit of divers everywhere.

FUNDING OF THE SERVICE

This has been previously described.[1] Some of the usual funding sources were interrupted during much of 1990, and the Australian Patient Safety Foundation provided on-going financial support for DES during that time.

Perhaps as a result of these events, temporary but unfortunate rumours, with no basis in fact, began in late 1990 that DES was financially destitute and in imminent danger of collapse ! As our data shows, during all this time the DES maintained its unbroken 24 hour service to divers and doctors. This rumour has now been dispelled, and the financial needs of DES are securely provided for, irrespective of future development.

THE PRESENT AND FUTURE ROLE, FUNCTION, AND RESPONSIBILITIES OF DES[1]

The Australian Diver Emergency Service (008-088-200) continues to provide a valuable "safety net" for all Australian (and beyond) diving. It exists and operates on the fundamental principle that in the event of a diving medical emergency the first essential requirement, following the ABC of resuscitation, is to make contact with a trained diving medical physician.

This facility can only be provided 24 hours a day, 7 days a week by a service such as the DES. The round-the-clock functions of such personnel, are to correctly diagnose the problem, offer relevant medical advice and choose the appropriate response to deal with the problem. This may involve immediate referral to the nearest medically staffed Hyperbaric Unit to the problem site. Excepting retrieval activities to the Royal Adelaide Hospital Hyperbaric Medicine Unit itself, DES' role is not to initiate retrieval activities (ground or air) to any Hyperbaric Unit. That decision can only be intelligently and efficiently made by the Units themselves. Immediate referral by DES doctors to a Hyperbaric Medical colleague, following emergency medical advice, is appropriate and demands excellent communication facilities. The Communication Centre of St John Ambulance, in South Australia provides just that.

Naturally it is essential that the divers know the DES telephone number ! An "aide memoire" to this has recently been suggested. [8]

The DES data as it accumulates and is anonymously analysed, is combined with that from the Diving Incident Monitoring Study (DIMS)[7] and constantly fed back to divers, and diving training establishments, in order to improve the safety and enjoyment of all diving. The vehicle for such diver feedback is the DES Newsletter "Divesafe"[1], while diving medical physicians are reached through the pages of this Journal. The continued support and participation of divers and doctors is essential to this aim.

INTERNATIONAL DES

As can be seen, the international role of DES is significant and, despite the cost of international access to callers via 61-8-223-2855, continues to be patronised. These calls can be expected to increase in number in the future.

In February 1991 a meeting will be held in North Carolina, USA to initiate the organisation of the world's diving emergency telephone services into a co-operative unit that will simplify their world use, irrespective of the nationality and the location of the diver in need. DES (along with the New Zealand Service) will be an inaugural member of this enterprise and will be represented at the North Carolina gathering.

Acknowledgements

It is a pleasure for three of the authors to acknowledge the pioneering efforts of Dr Des Gorman and Dr "Fred" Gilligan in the establishment of DES, and the on-going and expert collaboration of our medical colleagues and staff who man, around the clock, the (now 11 soon to be 12) Australian and New Zealand Hyperbaric Medicine Units. All authors also acknowledge with gratitude the financial and practical support of the Professional Association of Diving Instructors (PADI), the federation of Australian Underwater Instructors (FAUI), the National Association of Underwater Instructors (NAUI), the Australian Underwater Federation (AUF), the Commonwealth Department of Community Services and Health, Telecom Australia, the Australian Patient Safety Foundation, and the South Pacific Underwater Medicine Society. However, pivotal to the success and efficiency of DES, present and future, is the 24 hours a day skill, patience and attention to detail provided by the officers of the Communications Centre within the Headquarters of St John Ambulance, South Australia, in Adelaide. To them to our grateful thanks.

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Key Words

Diving, scuba-diving, diving emergency, retrievals,

diving safety, and medicine.

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THE RESPONSIBILITY OF DOCTORS PERFORMING "FIT TO DIVE" ASSESSMENTS

Michael Gatehouse and Tom Wodak

A doctor providing a medical service, be it advice, clinical or surgical treatment, is entering into a legal relationship with a patient which creates contractual rights and obligations and gives rise to a duty of care.

While the doctor is entitled to be paid for the service provided, the patient is entitled to expect that the service delivered will accord with the appropriate professional standard.

We wish to consider what constitutes the appropriate standard, in the context of an assessment by a hyperbaric doctor of the fitness of a candidate for an entry level diving course having regard specifically to the latent condition of patent foramen ovale (PFO).

A doctor must act in accordance with the practice accepted as proper by a responsible body of medical practitioners with commensurate experience and qualifications. What constitutes the requisite standard in particular circumstances will be determined by a court having regard to the skill, training, qualifications and experience of a reasonable body of peers of the doctor whose conduct is under scrutiny.

An entry level diving medical has a number of well established and essential ingredients which include, amongst other things, consideration of the age, cardiovascular status, respiratory function, patency of the Eustachian tubes and the circulatory system of the candidate. There can be no doubt that a hyperbaric doctor who conducts an examination without regard to one or more of the universally accepted ingredients has failed to meet the requisite standard of care appropriate to such an examination.

PFO, and specifically the implications to a person who has such a latent condition and who is or has aspirations of becoming a diver, is the subject of on-going debate and research. At present there are no clear and established guidelines for use by hyperbaric doctors.

We do not believe that sufficient is known of the implications PFO holds for divers to justify candidates undergoing expensive and potentially hazardous echocardiography. However there is the question of what the candidate should be told about PFO.

English and Australian courts have ruled that the duty of care owed by a doctor to a patient does not extend to requiring the doctor to warn and advise the patient of every conceivable potential risk of a proposed treatment or procedure, irrespective of the grave and serious nature of the consequences which could follow. In a recent English case a patient requiring vital spinal surgery was not informed by the surgeon of a remote, but nonetheless known, risk of quadriplegia associated with the procedure. Unfortunately the patient was rendered quadriplegic. Evidence was heard from experienced surgeons whose practice it was not to inform their patients of that particular risk. Ultimately the court found that the surgeon in question had not breached his duty of care to the patient by failing to give such a warning.

If a patient asserts a breach of duty on the part of a doctor, it is incumbent on the patient to establish, on the balance of probabilities, that, had such warning been given, he or she would have accepted and acted upon that advice. For example, the patient would have refrained from undergoing the procedure as a consequence of having been so warned.

It is our view that PFO, and its consequences for a person with that congenital abnormality who dives, is well understood by the general body of hyperbaric doctors. This makes it incumbent upon a doctor, conducting an entry level diving medical examination, to provide the candidate with a sufficient understanding of the condition, and its potential to cause injury and disability, to enable the candidate to make an informed decision whether to undergo investigation for PFO or to take up or to continue diving.

Our conclusion is based on two factors. Firstly to a non-diver, and indeed to those who dive or practice hyperbaric medicine, sport diving is a recreation associated with medical risks beyond those encountered in many other sporting and recreational pursuits. The health of participants in sport diving is of far more critical consideration than it is in, for example, tennis, skiing or sailing.

Secondly, there is a marked distinction between the circumstances of a critically ill patient seeking advice concerning a life saving procedure and those in which a person is contemplating taking up a new recreational activity. A court is more likely to sympathize with a position of a medical adviser seeking to assist a critically ill patient, where time is of the essence, than with a doctor consulted by a prospective diver.

It is largely for these reasons that we have formed the view that a doctor performing an assessment of fitness to dive ought to inform the candidate about PFO, the implications the latent condition has for divers and the technique available for its diagnosis and the risks associated with it. In so advising the patient the hyperbaric doctor greatly increases the probability that the obligation imposed upon him by the law will be discharged.

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SPUMS ANNUAL SCIENTIFIC CONFERENCE 1990

THE PATHOLOGY OF AIR EMBOLISM OF THE BRAIN IN DIVERS

Des Gorman and Stephen Helps

Introduction

The conventional pathophysiological model of air embolism of the brain circulation does not fit either animal or human data well. A revised model is proposed, based on bubbles precipitating deleterious effects in blood vessels and in blood constituents.

Aetiology

Bubbles can enter the brain arteries of divers either after pulmonary barotrauma or in decompression sickness (DCS).[1-6]

Pulmonary barotrauma is largely seen in novice and trainee divers[7] and occurs in 1:2,500 free/buoyant-ascents performed by submariners in training.[8,9] The latter occurs despite these candidates having a normal chest X-ray and a spirometric ratio of FEV_1 to FVC of greater than 75%.

The lung vessels act as a filter for venous bubbles in DCS,[10,11] but bubbles can overload this mechanism and can also by-pass it via shunts such as a patent foramen ovale.[4-6] Arterial gas embolism (AGE) may underlie much of the brain damage in DCS.[1]

The incidence of AGE of the brain in Australasian divers and trainees is unknown.

Bubble distribution

Bubbles distribute in large vessels in accordance with blood flow and their buoyancy relative to blood, and in small vessels with flow alone.[12-15] In divers this distribution and the invariable upright posture on ascent explains the preponderance of brain involvement.[8,9] Bubbles entering one carotid system tend to distribute ipsilaterally and the middle cerebral artery is primarily affected.[8,9,16]

These bubbles usually do not become trapped and pass through the arteries, arterioles and capillaries to the veins;[13,14,17] to be collected in jugular vein air traps introduced into experimental animals.[15,17-20] This passage of bubbles is promoted by the relatively large calibre of the venous end of capillaries, the hypertension and vasodilatation that follow embolism of the brain-stem vasomotor centres and the local vasodilatory response to bubbles.[16,17]

Indeed, bubbles will only become trapped when they are large enough to occupy several generations of branching arterioles such that net surface tension pressure exceeds cerebral perfusion pressure.[13,14,17] The vessels at the junction of the grey and white matter may be predisposed to such trapping.[21]

Effects of bubble trapping

Very large bubbles or bubbles in a hypotensive diver may be trapped to block flow in a region of the brain; the degree of ischaemia and the development of an infarct is dependent upon the adequacy of the collateral circulation.[2,18,19,21-24] Most of these larger bubbles will however only be trapped temporarily and will eventually be displaced by blood that advances progressively with cardiac systole.[13,14,16,17] Such interruptions of flow are poorly tolerated and even after flow is restored brain function may remain suppressed.[25] Also, if redistribution of bubbles does not occur within 20 minutes of embolism, vessels may collapse so that subsequent reperfusion will require extremely high pressures.[17]

Effects of bubble transit

Fortunately most bubbles pass through the brain circulation and do not become trapped.[13,14,15,17,20] During bubble passage local brain function is lost, but returns as bubbles clear.[26-30] These mobile bubbles damage endothelial cells,[31-33] perhaps by stripping them of surfactants, cause a persistent vasodilatation,[16,25] which may itself be a result of the endothelial damage, but is not indicative of vasoparalysis,[13] and activate platelets and leucocytes both to aggregate and adhere to vessel walls.[26-29,34-37]

The accumulation of leucocytes is rheologically important[34] and making animals leucocytopenic, but with normal red blood cell and platelets, prevents the typical decline in cerebral blood flow seen after AGE of the brain.[38] This endothelial damage will also potentiate leucocyte adherence and probably underlies the immediate but temporary (several hours) increase in extravasation of fluid across the blood-brain-barrier into the brain interstitium.[23,32,39-42]

The flow of this increasingly viscous blood[43] through these damaged vessels consequently decreases even though bubbles may no longer be present,[16,25] and may eventually become inadequate for neuronal function.[26,29,35,44] This can explain the typical history of AGE in divers; sudden loss of brain function, early recovery and perhaps a deterioration or relapse within several hours.[30] A sudden relapse, particularly if it involves an originally affected area of brain, may also be due to re-embolism.[9]

AGE and DCS

The pathological consequences of AGE will also depend upon whether the diver has DCS or significantly increased tissue insert gas tensions.[45] DCS may even be precipitated by AGE (Type III DCS).[45] The outcome after AGE of the brain consequently worsens with increasing dive duration/depth.[46]

Summary

Arterial gas embolism of the brain is not a simple mechanical occlusive event. Much of the brain dysfunction/damage is due to the effects that bubbles have on blood vessels and on the blood itself.

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THE BS-AC '88 DECOMPRESSION TABLES

Greg Adkisson

The British Sub-Aqua Club 1988 (BS-AC '88) Decompression Tables were introduced, after numerous delays, into general usage in the latter months of 1988. I was first introduced to them by a patient I was treating for an episode of neurological decompression sickness (DCS). Before I create the wrong impression, I should state that the patient was not using the new tables, but had completed his dive in accordance with the older RNPL/BS-AC tables of 1972.

The dive in question was to 26 m for 31 minutes with appropriate decompression conducted for 5 minutes at both 10 m and 5 m depths. As I monitored this patient's extended RN table 62 treatment, I had a chance to read through the new tables. I was surprised to find that using the new tables, while the definitions were slightly different, a more lenient dive of 27 m for a bottom time of 32 minutes could have been performed and would require only a 1 minute decompression stop at a depth of 6 m. I examined them further and noted that, for the same 10 minutes of decompression, the allowable bottom time would have been 43 minutes. I was fascinated.

Call me old fashioned, call me conservative, but this notable reduction in decompression requirement or, conversely, increase in available diving time, seemed just too good to be true so I went looking for the magic formula upon which these changes were based. I found myself, within a very short time, embroiled in controversy with the BS-AC. I had the pleasure of several lengthy discussions with the author of the tables, Dr Tom Hennessey, but I find myself still in search of the magic formula and remain as firmly against their general use now as I have been since the first day I read them. I have been asked here to comment on the format, design, algorithms and testing of these tables.

The BS-AC gives four basic reasons for introducing new tables in their BS-AC '88 Decompression Tables Instructor's notes. Since the introduction of the RNPL/BS-AC tables, "the pattern of diving has changed, the possibilities available to sports divers have developed, much experience has been gained in the use of the tables and understanding of decompression has improved". To quote *DIVER*, the magazine of the British Sub-Aqua Club, August 1988, "it has become increasingly clear that the RNPL/BS-AC table is insufficiently flexible for the patterns of diving required by divers today".

It is my personal opinion that, despite other objectives, the single most important factor in the introduction of a new set of tables is that they must not increase the risk of DCS and other accidents in the general diving population. The introduction of a new set of diving tables is no easy task and for acceptance in the commercial diving world one of two conditions must apply. The tables must be more conservative than previous versions or must have undergone extensive testing and evaluation prior to their use. While it is laudable that the BS-AC would desire to give its members greater flexibility in their diving, it must also accept the responsibility that any new tables it introduces should be safe and well tested.

Testing and evaluation of the BS-AC '88 tables

To my knowledge, the BS-AC '88 tables have never been tested in any type of controlled situation. Dr. Hennessey maintains that the BS-AC '88 tables are more conservative and provide a "greater margin of safety than the classic military-based tables". This is despite significant reductions of in-water decompression requirements and with an emphasis placed on decompression stop and repetitive diving. When asked about the lack of testing, Dr. Hennessey has argued that actual in-water testing would be impossible to do across the range of the tables. He says that limited testing might be conducted, but would not be statistically valid, and relies on unproven theoretical considerations to claim that the tables are more conservative than their predecessors and do not, therefore, require testing.

Comparisons of BS-AC '88 and established tables

Admittedly, it is difficult to do straight across comparisons of diving tables. The wide variation of designs makes exact comparisons impossible but I believe that general comparisons are not only possible but prudent. The gold standard for tables within the diving community for years has been the U.S. Navy standard air decompression tables. In England, the standard is the RN table 11. Either of these tables, properly used by experienced divers, produce very low levels of DCS. Several navies, notably Canada, Sweden and the Netherlands have produced new diving tables in an attempt to minimize the risk of DCS still present in the US and RN tables.

In 1968, the Royal Naval Physiological Laboratory (RNPL) at Alverstoke, England, produced a set of Air Diving Tables for the same purpose but they never came into general use. It is interesting to note, however, that these tables, designed when Drs Hempleman and Hennessey were working together, are arranged in a similar fashion to the new BS-AC '88 tables. The similarity stops quickly, however, as the 1968 Air Diving Tables are far more conservative than their latter day cousins.

The preceding is important because the BS-AC tables are said to be based on original RN table data but are said to benefit from the experience and knowledge acquired since they were first published. Additionally, it is said that distinct changes were made in the underlying principles behind the design of the tables and the way in which they are to be used. It is difficult for me to understand how tables can be based on same data but with "distinct changes in principles".

To my knowledge, Dr Hennessey has never revealed the algorithm upon which the BS-AC '88 tables are based. I have heard numerous lectures about new, improved theories and, indeed, continue to be told that the new tables are more conservative than their predecessors. I have yet to be convinced.

If one takes a sample of dives conducted at various depths and times, the observation is that the BS-AC '88 tables advocate a markedly reduced decompression requirement in comparison to any other table. For comparison I have chosen the 1972 RNPL/BS-AC table, the USN table, RN table 11 and the new SAA table. Any number of examples might be selected to compare these tables on equivalent or near equivalent dives, either as single dives or in the more likely context of repetitive diving. The reduction in decompression requirements is particularly significant for repeat dives, a factor involved in 63% of U.K. recompression treatments in 1988. Several examples are listed below. My conclusion is that many dives advocated by these new tables allow so little decompression time that they must be regarded as highly dangerous.

It is well known that the U.S. Navy Tables, particularly in the deeper ranges, carry a 5% or greater risk of DCS, especially when pushed to the limits. It must also be remembered that the USN tables are a combination of tested tables plus years of adjustment based on empirical diving experience of hundreds of thousands of dives. They were not designed for sports diving use and the risk of DCS was balanced against operational requirements. The US Navy trains its divers carefully in the use of these tables and emphasizes the importance of staying within clearly defined limits.

In the first example (Table 1) the USN table allows for the least total decompression time of any table except for BS-AC '88. For that reason, I have selected these two tables for a more in depth comparison. It has been argued that these two tables are too different in their design to allow adequate comparison but, indeed, the same comparison may be conducted with any of the tables I have listed and the results are the same. As a diver goes deeper, goes longer or goes more often, three significant factors in the development of DCS, the decompression required by the BS-AC '88 tables becomes dangerously lean.

It has also been argued that sports diving is so different from military diving that a military table should not be used for comparison. The argument is that a military diver is more likely to do a "square profile" dive than a sports diver who is likely to do a multi-level dive. This has not been my experience in over 10 years of treating accidents, but it is a moot point. Any table introduced into general use must allow for all types of diving that are likely to be conducted.

Table 2 shows a comparison of decompression requirements on a series of dives using BS-AC '88 and USN tables. The reduction in decompression requirements is argued to be possible on the basis of a more efficient table. On a single dive, a diver may get by with the seemingly small reduction in times but the danger becomes more apparent when one looks at the repetitive dives possible in 90 minutes time.

TABLE 1
DECOMPRESSION TIME REQUIRED BY VARIOUS TABLES

Dive	RNPL/BSAC	USN	RN	BS-AC'88	SAA
26m/32min	10 min	8:30 min	10 min	4 min	10 min
39m/25min	30 min	12:10 min	20 min	11 min	27 min
40m/25min	30 min	18:20 min	20 min	14 min	27 min
42m/23min	30 min	18:20 min	20 min	11 min	47 min

TABLE 2

DECOMPRESSION TIMES FOR VARIOUS DIVES

Dive	USN	BS-AC '88
33 m/40 minutes	24:50	23:00
36 m/30 minutes	16:00	13:00
39 m/30 minutes	23:10	20:00

TABLE 3

DECOMPRESSION TIMES FOR REPETITIVE DIVES

	Decompression Time	
1st dive	USN	BS-AC '88
39 m/30 minutes	23.10	20.00
Surface interval	90min	
2nd dive		
18 m/39 minutes	27:40	10:00
30 m/16 minutes	27:00	10:00
42 m/10 minutes	46:20	11:00

Let us follow a series of dives based on a first dive to 39 m for 30 minutes. (Tables 3 and 4).

The third dive is listed to highlight one of the design flaws in the BS-AC '88 tables. It is generally accepted that the risk of DCS increases significantly if a diver does a repetitive dive to a depth deeper than his or her original dive. This is allowed by the BS-AC '88 tables but would not be allowed on the USN or most other tables.

If this example is continued, listing the 30 m/16 minute dive as the 2nd dive, a routine 3rd dive might be to 18 m for 30 minutes (Table 4). During the day's diving, the USN table would have required a total decompression time of 65 minutes 10 seconds. The same dives, conducted according to the BS-AC '88 tables would require a decompression time of just 35 minutes. This is an impressive reduction as this is the kind of diving after which we often see very serious neurological DCS.

I would feel more confident if there was some degree of testing to verify such a schedule but, in the same way that I believe unwitting divers are being used to prove the tables on which the algorithms in the majority of decompression computers are based, I consider it difficult to justify issuing new tables which, to the best of my knowledge, are completely untested. Had these new tables been proposed for US or Royal Navy use, they would have required ethical approval prior to extensive controlled trials. Time alone will tell if the BS-AC '88 tables are inherently safe or dangerous. My greatest concern is that these tables are designed to promote what I view to be dangerous diving practices.

TABLE 4

DECOMPRESSION TIMES FOR A THREE DIVE SEQUENCE

	Decompression Time	
1st Dive	USN	BS-AC '88
39 m/30 minutes	23.10	20.00
Surface interval	90 minutes	
2nd Dive		
30 m/16 minutes	27.00	10.00
Surface interval	90 minutes	
3rd. Dive		
18 m/30 minutes	15:00	5:00
Total required	**65.10**	**35.00**

Design Considerations

DECOMPRESSION DIVING

The BS-AC '88 tables are designed to promote decompression stop diving. The instruction manual states "It can easily be seen that use of the BS-AC '88 tables will introduce a new approach to sport diving in the BS-AC". The first major change will be that "Decompression Diving" will be seen to be inevitable, and "Decompression Stop Diving" will become preferable.

Many of the tables are deceptively conservative in their approach. An example of this is a first dive on Table A to 18 m. The allowable bottom time is 50 minutes. If one looks closer, however, it is noted that a diver may gain an additional 17 minutes of diving time for a single minute of decompression at 6 m. If a diver is willing to spend 3 minutes, the trade off is an additional 27 minutes. This approach seems to tempt a diver away from the safer practice of no stop diving into the realm of decompression stop diving.

REPETITIVE DIVING

The tables are designed specifically with repetitive diving in mind. This was one of the goals in "increasing flexibility". The BS-AC will allow any number of dives a diver cares to make in a 24 hour period while most tables recommend a limit of 3 dives. Also, and perhaps more significantly, the BS-AC '88 tables allow repetitive dives to depths deeper than the original dive, a practice known to increase the risk of DCS.

FLYING AFTER DIVING

This is confusing so hang on!

The BS-AC manual states that a diver may fly in "a normal commercial aircraft with a pressurised cabin if their current tissue code is B. The maximum time this can take is 4 hours." If a diver wishes "to fly in an unpressurised aircraft, probably a private aircraft or a helicopter, then they must wait until they reach code A. The maximum time this can take is 16 hours."

A commercial airliner normally pressurises its cabin to an altitude of 8,000 feet so a diver with a tissue code B (some residual nitrogen load) is exposed to a reduced pressure of approximately 0.75 of an atmosphere. Helicopters and commercial airliners that do not pressurise their cabins are restricted from flying at altitudes greater than 8,000 feet and normally fly about 2,000 feet. This is based on the partial pressure of oxygen rather than pressure requirements. Pressure is only slightly reduced from atmospheric.

What this boils down to is that it is normally safer to fly in an unpressurised craft than a pressurised one and the requirement to have less nitrogen in your system makes no sense. The only situation in which it might apply is that of an unpressurised private aircraft that flies above the recommended 8,000 foot level. Here oxygen partial pressure is reduced below the equivalent of 16% at sea level and no one will be thinking clearly!

This particular contraindication was discussed with the BS-AC and, hopefully, they have seen fit to modify the rule.

ASCENT RATE AND BOUYANCY CONTROL

This is an area in which I am in complete agreement with the BS-AC. Ascent rates by most divers, in most situations, are simply too fast. I believe, as does Dr Hennessey, that too fast an ascent adds to the risk of DSC. An old study by Spencer on the rates of ascent showed divers routinely exceeding the recommended limits and in some cases reaching 118 feet/minute. My problem is in the degree of accuracy expected of BS-AC divers. A high degree of buoyancy control is necessary to follow the rules laid out in the new tables. Controlled ascents can be difficult under the best of circumstances and it takes practice, experience and a constant degree of vigilance to maintain controlled rates of ascent.

On diving holidays, divers will be trained and put into the water with minimal experience and I do not believe they will be able to maintain such a degree of accuracy. Even well trained and experienced divers will have difficulty. It can be argued whether these rates are critical but if it achieves the desired goal of slowing divers down the rule makes sense.

General Layout

The tables were designed to minimize the number of required calculations and allow for greater flexibility in one's diving. The layout of the BS-AC '88 tables is confusing at first, particularly to someone trained with different tables but is easy to use once one gets familiar with them.

I would not say, however, that there are fewer calculations. The first thing one must do is to calculate the actual bottom time allowed by subtracting out the ascent time to the first stop. If you forget to do that on the surface, hopefully one will be thinking clearly enough at depth to do it. If you overstay your planned time, it is a good idea to have a submersible dive table with one. I tried to memorise the tables but just could not manage it. If one overstays one's time limit and does not have, or cannot read, the submersible table, the rule says that a "safety stop" of 3 minutes at 6 m will be "adequate in the majority of occasions." I hope you are in the "majority" if it ever happens to you.

Summary

Dr William Shane, a senior NOAA diving physician was quoted in an old *Undercurrent* article as saying "The truth is that every time anyone dives with a decompression meter (and on most tables, for that matter), he or she becomes a human experiment. In essence, most times we dive we are exploring unknown physiological terrain. Under these circumstances, caution, and not a cavalier approach, should be our guide".

It is my belief that the price of the freedom sought by recreational divers is already far too high and that these new tables could well make the price even higher. To paraphrase Dr Shane's concluding remarks, "Today I am at a conference in Palau, the temperature is 84^o and the seas are calm. I am going diving. However as I do, in contrast to most sport divers, believe I have some slight idea of the risk".

Dr Greg Adkisson is a medical officer in the U.S.Navy. He had recently completed exchange service with the Royal Navy when this paper was presented.

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PADI TEACHING ABOUT DECOMPRESSION SICKNESS AND HOW TO AVOID IT

Drew Richardson

Summary

The population of recreational scuba divers is at an all time high, numbering in the millions. This year more entry level divers will be certified than ever before. The ability to produce a safe diver relies on the effectiveness of presenting the risks and how to avoid them to that diver, and subsequent demonstration by the student of mastery of this information. This is paramount to the reduction of the incidence of decompression sickness (DCS) in the field. In 1990 approximately two-thirds of the new entry level divers will be certified by PADI Instructors using an instructional system. The mechanism and philosophy of transferring information about decompression sickness, decompression, dive tables, ascents and computers to students and how PADI is meeting the responsibility of preparing todays diver to avoid the hazards of DCS into the 1990's is outlined.

Introduction

PADI is an international diver training association with headquarters in the United States and local area offices located in Australia, Canada, Switzerland, Japan, New Zealand, Saudi Arabia, Norway and Sweden. PADI's 28,000 members teach diving in over 80 countries internationally.

Our goal is to promote the training and education of the general public in the techniques of safe scuba diving. To do this we have established standards for the training of students in skin and scuba diving from entry level through the scuba instructor training.

Our methods of diving instruction are based on progressive training in the classroom, pool and open water. In 1989 PADI members trained and certified approximately 400,000 scuba divers. This represents approximately 70% of the U.S. market and an estimated 50% of the global marketplace. In 1990 this number is expected to increase.

PADI International believes that training and education are the cornerstones to diver safety. PADI is not interested in promoting a diving activity that might lie beyond the borders of safety. Our programs shape the thoughts, attitudes and behaviour of a significant portion of the diving community.

PADI Instructors teach entry level divers with an instructional system of diver education that is produced in metric and imperial versions and is translated into a variety of languages e.g.: Dutch, English, French, German, Italian, Japanese, Spanish and Swedish.

The ability to produce a safe diver relies, in part, on the effectiveness of presenting the associated risks of diving and how to avoid them to that diver, and subsequent demonstration by the student of mastery of this information.

In consideration of decompression education, this is paramount to the reduction of the incidence of decompression sickness in the field. A presentation of the mechanism and philosophy utilized in transferring information concerning DCS, decompression, dive tables, ascents, and dive computers to entry level diving students will follow. An outline of how PADI meets the responsibility of preparing todays divers to avoid the hazards of decompression sickness will be discussed.

The PADI System of Diver Education

When we design instruction and training programs at PADI Headquarters, many factors are taken into account. PADI standards and educational materials are based on considerations of student safety, learning, and enjoyment in addition to prudent instructor conduct. The safety of the diving public is considered first and foremost. Our goal is to train individuals who after completion of training have the skills and confidence to enjoy safe scuba diving without an instructor present.

The design of the PADI system of education follows a technological approach. Instructional technology emerged from the fields of psychology, neuro-physiology, systems design and computer science. The U.S. aerospace industry has used an instructional technology design approach to education for 20 years because of its ability to teach high tech skills efficiently in an environment of high costs and government accountability.

The technological approach to diver education is a process of planning instruction in consideration of bringing forth all the necessary conditions of learning. In education today, the most modern and effective means for providing training involves a systems approach. The PADI Modular Scuba Course, our entry level training system, utilizes this technological approach to education.

The Modular Scuba Course

The design of the Modular Scuba Course is objective driven using measurable performance requirements as criteria for success. Assessment items are derived directly from the objectives and performance requirements. These assessment items constitute our exercises, quizzes, exams and Knowledge Reviews.

A PADI instructor is a manager of instructional resources and uses the Modular Scuba Course system, adapting it to the needs and abilities of the student. Student comprehension and mastery of information and motor skills are consistently measured.

PADI's educational approach is founded on the belief that maximizing effective instruction requires more than simply dispensing information.

Our systems approach takes into consideration how people learn and the proper guidance and preparation necessary that will allow virtually anyone with reasonable abilities to deliver effective instruction. However, the instructor must first have a high level of diving knowledge and know how to use this system, in addition to having expertise in dealing with student problem diagnosis. Our instructor development training process accomplishes the necessary development and training of these skills.

The Modular Scuba Course underwent a 10 month evaluation before receiving recommendation for college credit by the American Council on Education (ACE). PADI is the only diver training agency ever to receive this prestigious recommendation. ACE recommendation is based on the educational validity of our programs and our administrative capability to execute the educational goals we claim. We believe the ACE recommendations testify to the high educational quality PADI programs.

Component Parts

The PADI Modular Scuba Course system includes in part the PADI Open Water Diver Manual, The Open Water Diver Course Instructor Guide, Modular Lesson Guides, Quizzes and Exams, Audiovisual program and the Recreational Dive Planner.

The PADI Open Water Diver Student Manual is a teaching aid that approaches material at the same level and complexity as is discussed in class. It is important to understand its four unique characteristics.

The first is a controlled presentation of material. A carefully planned sequence of steps leads the diving student from a present state of knowledge to predetermined educational objectives.

The second is an incorporation of managed reinforcement. Learning is not left to chance, the learner actively participates by continually responding to questions. Immediate instructional feedback and correction is provided.

The third is a self-paced design. The learner can control reading pace and learning rate. The course is therefore able to accommodate students with a wide range of backgrounds.

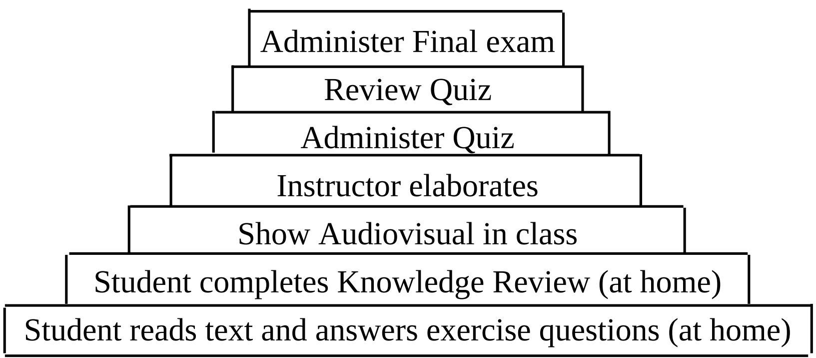
The fourth characteristic is learning efficiency. Diving information pertinent only to the objectives is presented. This programmed instructional approach assures increased student motivation and maximizes learning retention.

The other component parts enrich the instruction and combine to form the PADI Learning Pyramid. (Figure 1) Key diving information is reiterated at least 7 different times

FIGURE 1

THE PADI LEARNING PYRAMID

Essential information is reiterated seven different times using a variety of media



Maximum effectiveness is achieved only if the entire system is used as designed
TO OMIT A COMPONENT RISKS OMISSION OF ONE OR MORE "LEVELS" OF THE PYRAMID

using a variety of delivery methods. The student will read about decompression in the manual and complete the exercises in the book. The student will then complete the Knowledge Review at the end of the chapter. The student will then see an audiovisual tape reinforcing key points. The instructor will then deliver a lecture with overhead support elaborating on the concepts of decompression and answer questions. The student is then tested on recall and administered a quiz. The quiz is graded and reviewed with the student. Finally, at the completion of the course, the student is tested by a final exam to demonstrate mastery of this information. Advancement from one step to the next is determined by performance. The student progresses only when he demonstrates he has met objectives. Certification is based on demonstration of meeting all objectives, not how many hours he sat in class. This sequence assures that no important objectives or content is omitted while accommodating various student learning styles.

Decompression teaching

How does the Open Water Diver Manual guide students towards mastery of decompression information ?

The topical section on decompression sickness begins with clear student objectives that organize the instruction into relatively small sequential steps as reflected in the body of the text. The exercises that follow each section are based on the concepts of practice and reinforcement.

The objectives for decompression sickness an entry level PADI diver must master are stated in the Open Water Diver manual as follows:

"After reading this section on decompression sickness, you will be able to:

1 State the two primary factors that influence the absorption and elimination of nitrogen in a diver.
2 Name the condition that occurs when established depth and/or time limits have been exceeded, producing bubbles in the body during ascent.
3 List nine secondary factors that can influence the absorption and elimination of nitrogen from the body.
4 Identify eight signs and symptoms generally associated with cases of decompression sickness.
5 State the necessary treatment for a diver suspected of having decompression sickness.
6 Outline the first aid procedure for assisting someone with decompression sickness.
7 Explain how to prevent decompression sickness."

The text clearly describes the cause and effect of decompression sickness including symptoms. For example, the student is informed that "In the most severe cases (of DCS) unconsciousness and death can result". Perhaps most importantly, the student must demonstrate mastery of knowledge on how to prevent DCS.

In the topic section under Dive Tables, the entry level student is presented with the following objectives to master.

"After reading this introduction on dive tables, you will be able to:

1 State the primary use of dive tables.
2 Explain why the maximum limits listed on dive tables should be avoided.
3 Define repetitive dive.
4 Explain what is meant by no-decompression diving and decompression diving.
5 Explain why a diver's body nitrogen level is higher after a repetitive dive.
6 State one reason why the Recreational Dive Planner distributed by PADI is different from other dive tables.
7 Define bottom time.
8 Apply the nine general rules when using the Recreational Dive Planner.
9 State the maximum depth limitation for all recreational diving."

Throughout this section the student is encouraged to dive conservatively. An example, is found in the following:

"Be aware that although dive tables give you maximum limits, you need to dive conservatively, avoiding the maximum limits. This is especially true if any of the factors that contribute to decompression sickness (vigorous exercise, cold, older age, etc.) apply to your situation. Take extra precautions to not allow yourself to become dehydrated, for example, especially after several days of diving. Because people differ in their susceptibility to decompression sickness, no dive table can guarantee that decompression sickness will never occur, even though you dive within the table limits. It is always wisest to plan dives well within table limits, especially if any contributing factors apply."

This section also encourages an attitude towards slow ascent with a safety stop at the end of a dive. The PADI S.A.F.E.Diver (Slowly Ascend From Every Dive) philosophy is emphasized throughout. The diver learns to treat an ascent rate much like an no decompression limit i.e. to avoid reaching or exceeding it and to ascend slowly and take a safety stop for 3 minutes at 15 feet or 5 meters.

The specific student objectives for safety stops are:

"After reading this section on safety stops, you will be able to:

1 State the depth and time of a safety stop.
2 Explain the purpose of a safety stop.
3 Describe the three recommended situations in which

a safety stop should be made."

Additional information about decompression.

There are many other related areas of discussion regarding decompression in the Modular Scuba Course. For example, dive computers are discussed and the student is instructed to dive within the computer limits and always back up the dive plan with a table.

Entry level PADI divers are informed that dive tables and computers are mathematical models that approximate a physiological process and no matter how well designed or tested, they only approximate how the body absorbs and eliminates nitrogen. Divers are also advised to avoid decompression dives.

PADI has also adopted a strong position on insisting that divers be conservative with regard to multi-day repetitive diving. The following warning appears in the student manual and on the Recreational Dive Planner (RDP). "Since little is presently known about the physiological effects of multiple dives over multiple days, you are wise to make fewer dives and limit your exposure toward the end of a multi- day dive series."

Rules for flying or driving to altitudes after flying are also presented and must be mastered by the student.

The rules of use for the RDP reflect the conservative nature of our instructions. Recently, concern for deep repetitive diving emerged in the scientific community. PADI has printed the following additional rule on the RDP and educational materials to discourage this activity. "Limit repetitive dives to depths less than 100 feet/30 meters."

Instructor Education

The introduction of the RDP has made two major contributions:

1 an increased emphasis for dive planning and control,

2 a heightened decompression awareness educational campaign.

PADI has launched a decompression education campaign in its educational system as outlined, and also to our instructor members through our professional journals and training materials.

For example in 1990 we are teaching our instructors in the PADI update series to heed the following information:

A Make sure all of your students know that:

1 Even when tables are adhered to, divers have a statistical chance of contracting decompression sickness due to:
 a Biological variability. Each individual on this planet is different, hence there is a great deal of biological variability.
 b Imprecise decompression theory knowledge. In the real world, we actually know little about the dynamics of decompression; including bubble formation, etc.
 c Medical conditions. Just as there is variability between individuals, each individual has some amount of variability from day to day based on their medical condition.
 d Environmental conditions. Some environmental conditions (like cold water) can contribute to the likelihood of getting decompression sickness.

2 They can create their own trouble, by ignoring:
 a Their training.
 b Their table or computer.
 c Accepted safety rules.
 d Their dive pattern. For example, inappropriate dive patterns include "Sawtooth Dives" down, up, down, up, down, etc. and "Bounce Dives", making a short deep dive just prior to or just after a long shallow dive.

B As diving professionals, we need to foster a greater awareness of the importance of taking responsibility for diving intelligently. Divers should be advised that when diving, DCS is always a possibility.

C To help divers decrease their chances of contracting DCS while making repetitive dives on multi-day trips. Have divers:

1 Stay well within the limits of their table or computer.
2 When possible, wait 24 hours after a dive to fly.
3 Limit the depth of their first dive to 130 feet.
4 Limit repetitive dives to 100 feet or shallower.
5 Follow S.A.F.E. philosophy: Maintain neutral buoyancy, rise slowly (no faster than 60 feet/min. Treat this limit like an NDL) and make a safety stop at 15 feet for 3 to 5 minutes at the end of each dive.
6 Take a day off on day three or four when on a multi-day dive trip (this is a Divers Alert Network (DAN) recommendation).
7 Avoid making deep dives after shallow dives at any time during the multi-day excursion.
8 Begin each dive at the deepest level and move slowly shallower as the dive progresses (avoid "saw-tooth" and "bounce" diving)
9 Heed all rules and warnings for the RDP, regardless of the computer or table you use (the rules and warnings are generic and NOT RDP specific). Following RDP rules and warnings is always important.

Conclusion

Tables 1 (Certification Trends From 1978 To 1987), 2 (Number Of Fatalities Per Year 1970 to 1985) and Figure 2 (University Of Rhode Island Fatality Statistics)present data serving as an indicator that we are on the right track in diver safety and education. In terms of reducing the occurrence of decompression sickness, the number of reported cases appears to stay between 500 and 600 cases reported to DAN in the USA annually.

While the total number of dives being made is not known, it is likely to be increasing in proportion to the number of certifications issued. However, we can say that there are at least 1,200,000 dives annually. This is calculated by multiplying 300,000 new divers in the U.S. by the required 4 training dives giving a minimum of 1,200,000 dives. Assuming that there is no other diving of any kind, that is excluding active divers, this gives a worst case DCS/dive incidence of 0.05%. In view of the increasing number of divers a relatively stable occurrence of DCS may be a positive sign for the safety of scuba diving.

Decompression is highly complex. PADI is committed to decompression awareness and education. The more we learn about it the more definitive answers evade us. There are many variables to consider and divers need to be trained to take responsibility for themselves to avoid creating their own trouble.

PADI will continue to train divers to control their dive planning in consideration of their training in addition to keeping strong warnings and cautions on a variety of our educational materials.

TABLE 1

CERTIFICATION TRENDS 1978 - 1987

	1978	1980	1983	1987
PADI	70,000	130,000	190,000	340,000
All other agencies	150,000	110,000	120,000	135,000
Total	**220,000**	**240,000**	**310,000**	**475,000**

TABLE 2

NUMBER OF FATALITIES PER YEAR 1970 - 1985

Data on non-occupational scuba diving fatalities compiled by the University of Rhode Island National Underwater Accident Data Center Underwater Safety Project.

Year	Number of fatalities
1970	110
1971	112
1972	119
1973	125
1974	144
1975	131
1976	147
1977	102
1978	116
1979	130
1980	109
1981	103
1982	74
1983	110
1984	70
1985	76

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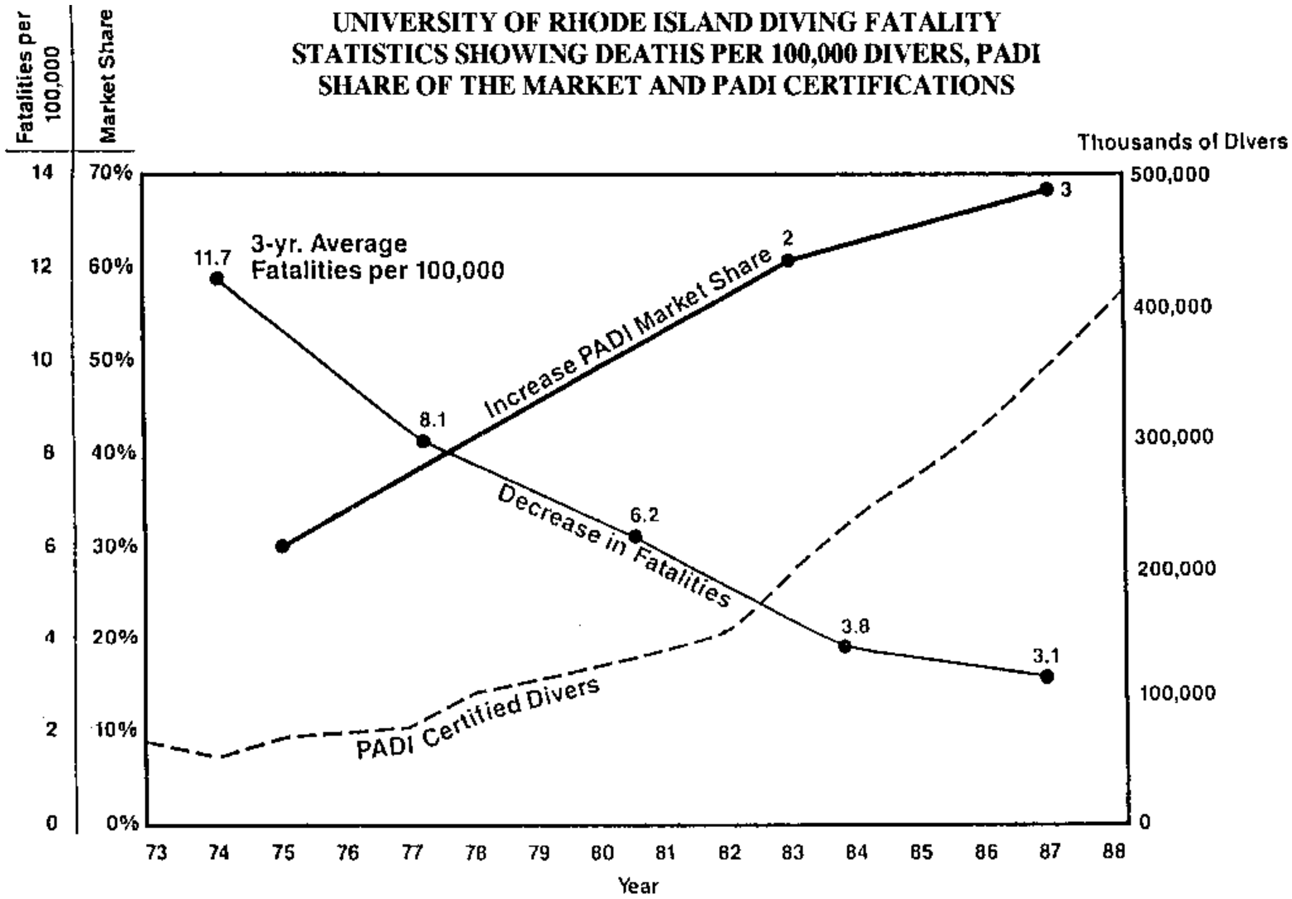
FIGURE 4



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TANK CARRIER'S LATERAL EPICONDYLITIS: CASE REPORTS AND A NEW CAUSE FOR AN OLD ENTITY

Lori L. Barr and Larry R. Martin

Introduction

Lateral epicondylitis is a common injury which may be difficult to treat. While the injury is classically associated with tennis playing, a number of other causes have been reported.[1,2] However, the entity has not previously been associated with the carrying of compressed air tanks. We report five cases of lateral epicondylitis related to the carrying of compressed air tanks during dive-related activities.

Methods

After an episode of acute elbow pain was noted in a research diver during intensive periods of lifting and carrying compressed air tanks, the authors performed a retrospective literature search to review the causes of lateral epicondylitis and to evaluate the likelihood of cause and effect between the association. During the year between presentation of the first case and the present time, four other cases of tank carrier's lateral epicondylitis were discovered. We present five cases for consideration.

Case 1

This 46 year old male has a twelve year history of intermittent pain localized to the lateral aspect of the right elbow. While the majority of his year is spent in a supervisory position, two months per year involve intensive research diving trips. These activities require lifting and carrying of equipment (A180 compressed air tanks) over rough terrain for at least fifty yards twice a day. He has no history of other predisposing factors for lateral epicondylitis. The pain typically occurs during his research dive trips and lasts one to nine months after returning to his sedentary lifestyle. The pain occurs during rest and is not associated with grip weakness. He experienced a three year pain free interval approximately eight years ago. Since the last episode, he has been pain free for eleven months.

Over the course of the illness, he has consulted several physicians. He has tried the entire spectrum of non-steroidal anti-inflammatory agents with variable success. During medical therapy, he experiences a decrease in rest pain but suffers from gastrointestinal side effects. He feels that after his last trial with Feldene (piroxicam), 20 mg daily for one month, his return to a pain free state was more rapid.

Physical examination was significant for point tenderness over the lateral epicondyle aggravated with resistive wrist dorsiflexion. No clinically apparent evidence of swelling or discolouration was present. No grip weakness was elicited. Radiographic examination was negative. Ultrasound examination was positive for thickening of the right common extensor tendon.

Case 2

This 34 year old male dive instructor complained of pain the day after he was required to carry ten to twenty compressed air tanks (A180, A150) from the dive shop to the local college pool used for certification classes via a station wagon. He typically teaches large classes of five weeks duration four times per year. The onset of pain occurs the day after the first pool session and lasts from days to weeks. He has experienced no grip weakness. Although he has tried taking aspirin for his pain, no objective relief has been noted. He feels he has modified his lifting technique to compensate for the pain. Physical examination was positive for point tenderness over the lateral epicondyle without grip weakness. No radiographic examination was performed.

Case 3

This 33 year old male had a one and a half year history of fencing when he began working for a local marine park. His job consisted of extensive scrubbing of sides of aquariums and carrying 11 tanks to be filled each week. He would carry the tanks from a dive locker to a pick-up truck, load them and drive to the local dive shop where he would unload them, wait whiled they were filled, carry them to the pick-up truck, load them and then unload at the other end and carry them to the storage. This involved lifting each tank eight times. After nine months, he developed right lateral elbow pain. He did not seek medical attention. Instead, his pain was relieved by cradling the tanks instead of carrying the by the valve stems and stopping the scrubbing motion he was using. The pain lasted for less than one year and did not interfere with fencing. He has since changed jobs and is not required to clean aquariums or lift tanks. He has been pain free for one year.

Case 4

This 40 year old female was in her normal state of health until she played tennis for the first time three years ago. She is 155 cm tall and right handed. After playing tennis for one afternoon with her brother, she noticed that her right elbow was occasionally painful. Aside from this isolated attempt at tennis, her history was negative for other racquet sports, golf or occupational predisposition to elbow injury. Three months later, she began taking a scuba diving class for open water certification. At the pool sessions, each diver was required to participate in the loading and unloading of the forty tanks (A180) used for class. Specifically, the tanks were passed from one diver to the next while the divers stood in a line between the two points where the tanks were being transported.

Three weeks into the class, the patient awoke with a sharp pain in her right elbow joint which felt like a hot poker. The following day she sought medical attention. Physical examination revealed exacerbation of lateral pain and grip weakness with right wrist dorsiflexion. She was started on passive therapy including anti-inflammatory agents and splinting. However, her pain and grip weakness continued to increase and by the time of her check out dives, the pain was incapacitating. Her doctor injected the area with a steroid/lignocaine mixture which temporarily provided relief.

After the course, the patient chose to purchase A150 and A160 tanks for her personal use. She continued to lift the tanks by the valve stem and began using her left hand more than her right due to her disability. Consequently, her left elbow became symptomatic within nine months of the start of her right elbow pain. Radiographic examination was negative. Her orthopaedic surgeon operated on the right elbow one year ago. She has been pain free on the right since that time. Her left elbow was operated on six months ago. She still experiences some pain on the left as she is well within the expected time frame for post operative recuperation.

Case 5

This 48 year old research diver averages approximately fifty dives per year but otherwise lives a sedentary lifestyle. His job also requires that he drive long distances and much of his time is spent working at a computer. His history was significant for playing golf as a hobby.

Four years ago, he developed agonizing dull pain in the left elbow. For one year he endured the pain which occurred even with simple activities such as lifting a coffee cup. When his grip weakness became severe enough that he feared a diving mishap might occur, he sought medical attention. Physical exam was positive for limited range of motion of the left shoulder, grip weakness and left lateral epicondylar pain. His diagnosis of lateral epicondylitis was followed by a six month trial of various anti-inflammatory agents which gave him no relief. He endured a total of five cortisone shots in the left elbow which were effective for approximately three days after injection. Passive splinting of the elbow did not decrease the pain.

MRI examination of the left shoulder revealed nerve impingement and surgery was recommended. He decided to have the left elbow operated on at the same time. Surgery occurred approximately eighteen months ago and he has been pain free since. The patient also has a history of right medial epicondylitis which has been present for four years but which has gradually worsened since his left arm pain became disabling. He plans to undergo surgical therapy for his right medial epicondylitis during the coming year.

Discussion

Lateral epicondylitis is a common injury which in the chronic state, can be difficult to treat. The injury usually presents in the fourth decade of life.[3] The patient may have a history of racquet sports, golf, throwing sports or an occupation which requires lifting such as baggage handling.[4]

Patients complain of pain along the lateral aspect of the elbow which extends inferiorly.[5] They may experience grip weakness or aggravation of the condition with a gripping activity. In acute epicondylitis, the patient is usually able to identify the motion with which the injury was associated. However, since the damage is cumulative, patients presenting in the chronic state may not be able to relate the pain to a specific activity. Patients often do not seek medical attention until the pain has affected their lifestyle for several months.

On physical examination point tenderness along the lateral epicondyle is elicited with resistive wrist dorsiflexion.[6] Radiological examination of the elbow is usually negative. Occasionally, a bone spur is noted along the lateral epicondyle in chronic cases (less than 10%). In Case 1, elbow ultrasound revealed thickening of the symptomatic common extensor tendon with certainty. Increased use of ultrasound may aid in a more rapid diagnosis of musculoskeletal injury in the future.

Pathologically, there is inflammation of the common extensor tendon as it inserts along the lateral epicondyle.[7] Often, a tear is identified through the extensor carpi radialis brevis portion of the common extensor tendon. Granulation tissue and fibrosis are often identified. There is an increase in the number of subtendonous free nerve endings in symptomatic patients.

Treatment of acute lateral epicondylitis centres around cessation of the offending activity and the use of non-steroidal anti-inflammatory agents.

The majority of patients with acute epicondylitis respond to conservative management and return to a normal lifestyle. However, some patients develop chronic epicondylitis since damage to the common extensor tendon is cumulative. When symptoms are persistent and debilitating, subtendonous injection of a combination of steroids with lignocaine into the area of tenderness may provide relief. While some authors feel that steroid injection contributes to injury, a large series has not shown any significant increase in morbidity after repeated steroid injections.[3] Most patients require more than one injection to achieve relief. Other non-invasive measures include plaster splint immobilization of the involved wrist in dorsiflexion and limitation of hand activity.

A small percentage of patients will require surgical treatment. Indications for surgery vary but if the patient has had symptoms for over one year or has failed conservative treatment and has sufficient discomfort to cause incapacity then he is usually considered a candidate. While some surgeons advocate radical resection of the synovium or complete exploration of the elbow joint, a more conservative approach includes excision of the tear which is identifiable in the majority of cases or resection of the area of obvious degeneration. One group performed all surgery under local anaesthesia so the site of tenderness could be better localized. Surgery is highly successful for relief of symptoms. Patients usually resume normal activity within a year of operation.

Since injury to the common extensor tendon of the forearm is a cumulative phenomenon, it is important to identify all factors contributing to the development of the condition. The medical literature has not previously noted that the carrying of compressed air tanks associated with scuba diving activities may predispose patients to the development of both acute and chronic lateral epicondylitis. This is not surprising when one considers that the mechanism of injury (a weight load on the forearm with wrist pronation and dorsiflexion) is the exact mechanism required for tank handling.

Conclusion

Although a number of factors have been previously implicated in the formation of lateral epicondylitis, the carrying of compressed air tanks has not been associated with this entity. The authors report five cases of lateral epicondylitis where periods of intensive tank carrying either caused or contributed to the disease. Both research and recreational divers are at risk for the development of the condition.

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TANK CARRIER'S LATERAL EPICONDYLITIS: A BIOMECHANICAL RATIONALE FOR INJURY AND PREVENTION

Lori L. Barr, Denis Brunt and Larry R. Martin

Introduction

Five cases of lateral epicondylitis, in which the carrying and lifting of compressed air tanks led to injury of the common tendon affixing the extensor muscles of the forearm to the lateral epicondyle, have been reported.[1] The following experiment was performed to investigate the biomechanical effects of tank lifting on the forearm and to determine whether hand position could be altered to reduce the amount of muscle activity during lifting.

Materials and Methods

Four subjects ranging in ages from twenty-eight to forty-five years were asked to lift an A180 compressed air tank filled to capacity (3,000 PSI). Three of the subjects were healthy volunteers with no arm symptoms (subjects 1 - 3). One subject was symptomatic for chronic lateral epicondylitis and will be referred to as Subject S. Subject 1 was 152.5 cm in height, subject 2 167.5 cm, subject 3 170 cm and subject S 167.5 cm.

Surface electrodes were applied unilaterally to the skin overlying the common extensor muscle group of the forearm and the ipsilateral biceps brachii muscle. Each recording electrode consisted of two silver-silver chloride one centimetre diameter electrodes embedded in an epoxy-mounted pre-amplifier system. The electromyographic signal was high pass filtered (40 Hz), further amplified, RMS processed and low passed filtered (400 Hz). Processed signals were sampled on-line at a rate of 1000 Hz for one second.

The experiment was started with the compressed air tank lying on its side on the floor. Subjects were asked to begin the experiment with bent knees, without raising the heels from the floor, and to pull the tank into a neutral carrying position next to their side as rapidly as possible without a jerking motion (Figure 1).

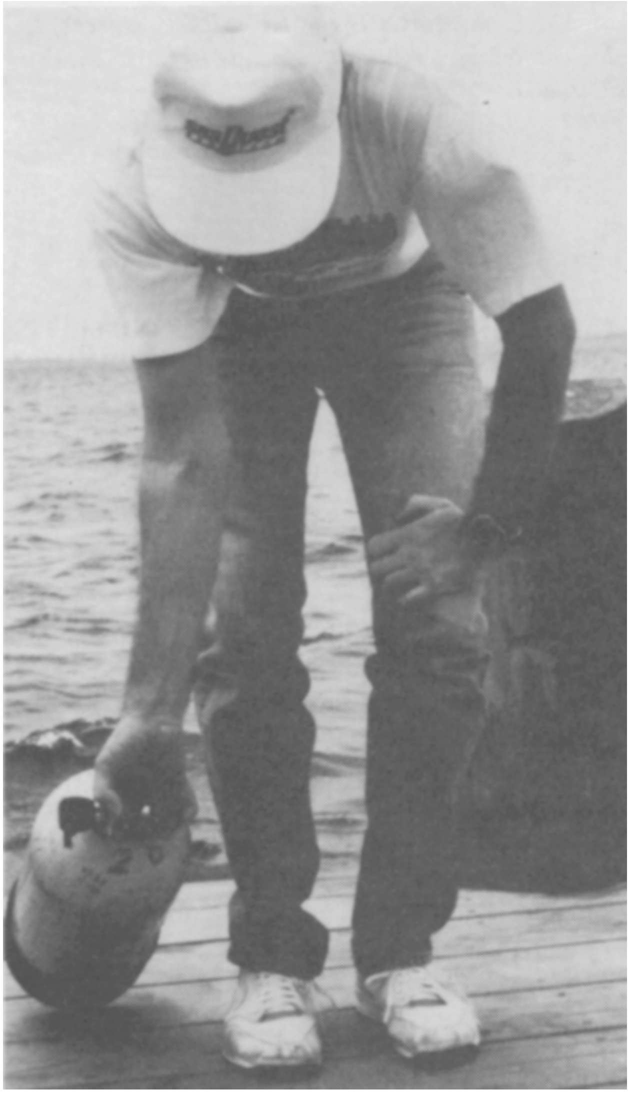

Figure 1. The position for lifting used in this study.

Random sequencing was used to perform sixteen separate lifting trials using four hand grips. The first grip (split hold grip) consisted of grasping the tank by the on/off knob and having the valve neck located between the index and middle fingers (Figure 2). The second grip (single grip) consisted of grasping the tank valve by the on/off knob with all fingers located on the knob side of the valve (Figure 3). The Tank Handle[2] (Figure 4) was utilized because of the sloping sling design for the third hold (sling grip). The Standard Tank Carrier No. TA-10[3] (Figure 5) was utilized for the classic baggage-style handle design for the fourth hold (H grip).

Data analysis consisted of normalization to the split hold grip RMS data which was given a value of one (Figures 6 and 7). The data is described according to percentage

Figure 2. Split hold grip.

Figure 3. Single grip

change in muscle activity (RMS) between the different groups.

Results

Analysis of the electromyographic activity revealed a biphasic curve with peak activity of the common extensor muscle group in early lifting which decreased when the neutral carrying position was achieved. The peak activity for the biceps muscle was achieved in the neutral carrying position after a delayed onset. With the use of the single grip there was more activity in both the extensor muscles and the

Figure 4. The tank handle

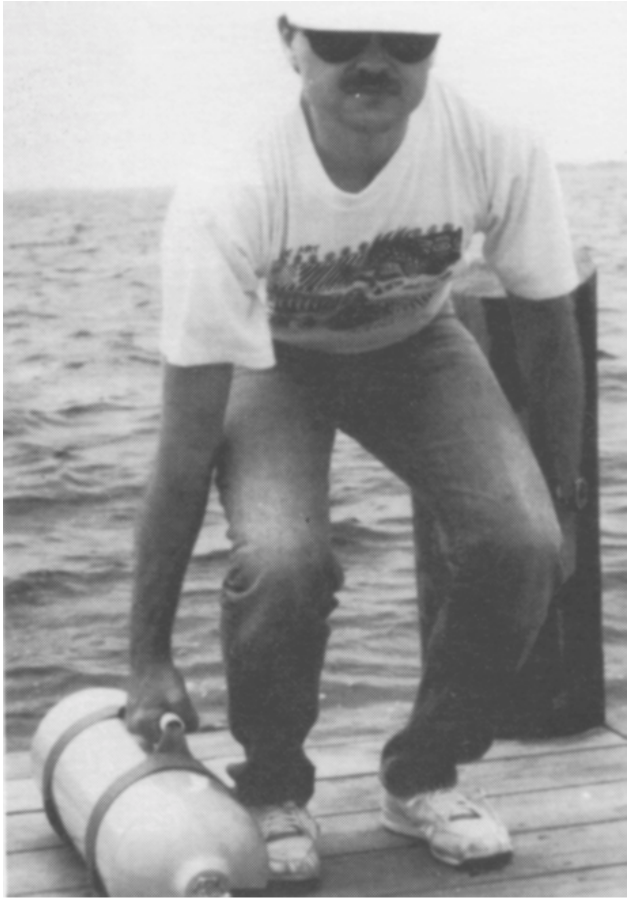

Figure 5. Standard Tank Carrier

biceps when compared to the split hold. However, both the extensor muscle group and the biceps demonstrated a dramatic decrease in activity with the use of either the sling tank carrier or the H style tank carrier.

In normal subjects, use of the sling grip resulted in a 45% decrease in extensor muscle group activity and a 61% decrease in biceps activity. With the use of the H grip, the extensor muscle group activity decreased 33% and the biceps activity decreased 52%. The H strap was least effective in the shorter subject who demonstrated only a 10% decrease in the extensor muscle group activity and a 13% decrease in the biceps. In the symptomatic subject, the sling strap was less effective than the H strap with only a 17% decrease in extensor muscle activity and a 65% decrease in biceps activity.

Discussion

The biomechanical actions implicated in the formation of lateral epicondylitis are the combination of wrist pronation with dorsiflexion. In this position, the extensor muscle group functions as a forearm flexor. The most extreme example of this motion is seen in major league baseball pitchers as documented by slow motion photography of the pitch.[4] Decreased degrees of pronation and wrist dorsiflexion are combined in a variety of sports and occupational activities.[5] It is well-documented that tennis players who are not properly conditioned and abuse their arm are more likely to develop lateral epicondylitis than those who are pre-conditioned.[6]

It is the combination of unconditioned forearms and over use during dive trips that predisposes both recreational and research divers to the formation of lateral epicondylitis. Our experiment demonstrates that wrist dorsiflexion is necessary in order for the average person to carry an A180 tank by their side. Shorter subjects may require elbow flexion to keep the bottom of the tank off the ground (Figure 8). Depending on the tank hold used, there is a variable amount of pronation required for tank lifting.

We have shown that both the common extensor muscle group and the biceps muscle group demonstrate decreased activity when carrier straps are utilized for tank handling because of less pronation. The exact reason why the sling strap was slightly more effective at decreasing muscle activity than the H style strap is uncertain. Perhaps the strap slope allows for better distribution of the weight to all of the muscle groups of the forearm.

Physicians involved in scuba diving activities, either as a consultant or as a diver should be aware of the risk of cumulative epicondylar injury which may be caused by improper tank handling.[1] A pre-dive training program involving both isometric and weight-bearing exercise combined with the active use of tank carrier straps during dive excursions may decrease the risk of injury.[6]

Conclusion

We have demonstrated a biomechanical rationale for the formation of lateral epicondylitis with the carrying of compressed air tanks. Lifting the tank requires both wrist dorsiflexion and pronation of varying degrees dependent on subject height and the grip used. These are the mechanisms

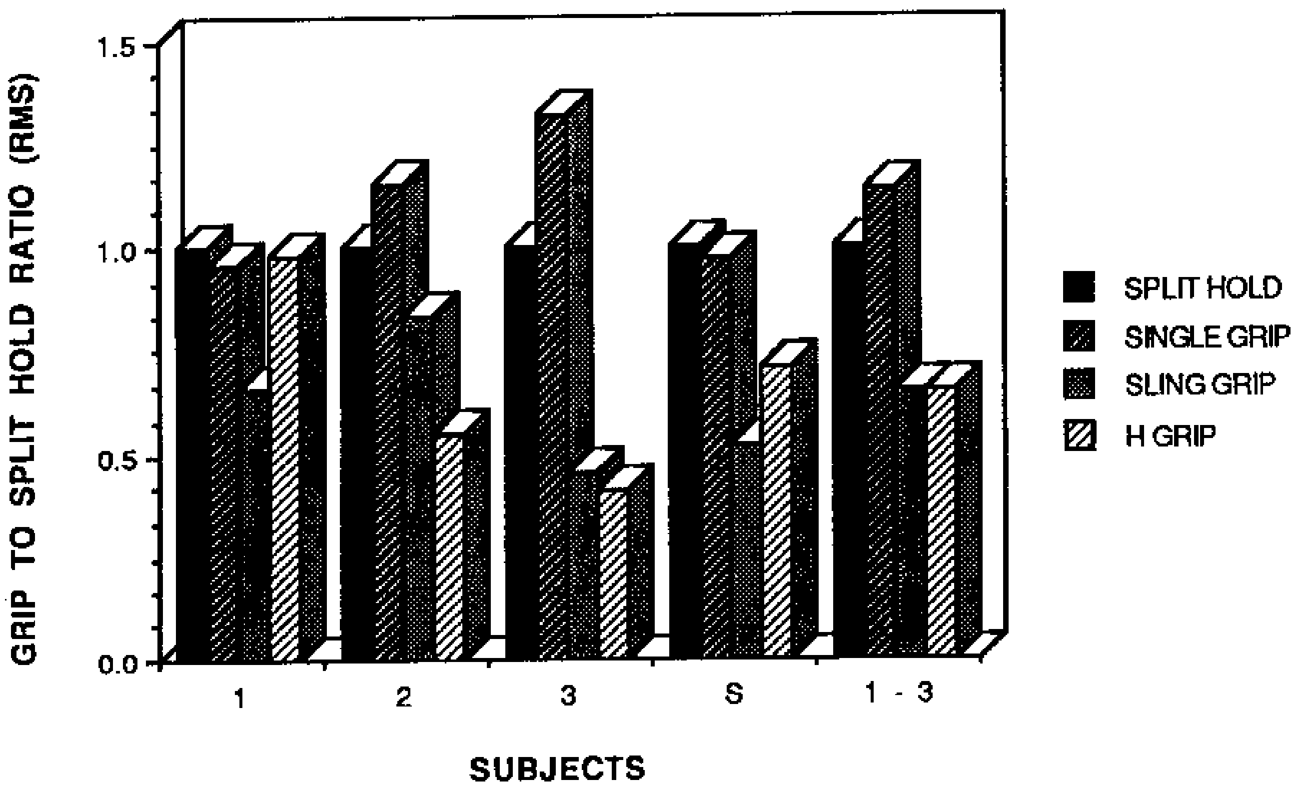

Figure 7. Effect of various tank grips on percentage change in muscle activity (RMS) for the common extensor muscle group of the forearm (split grip activity normalised to one).

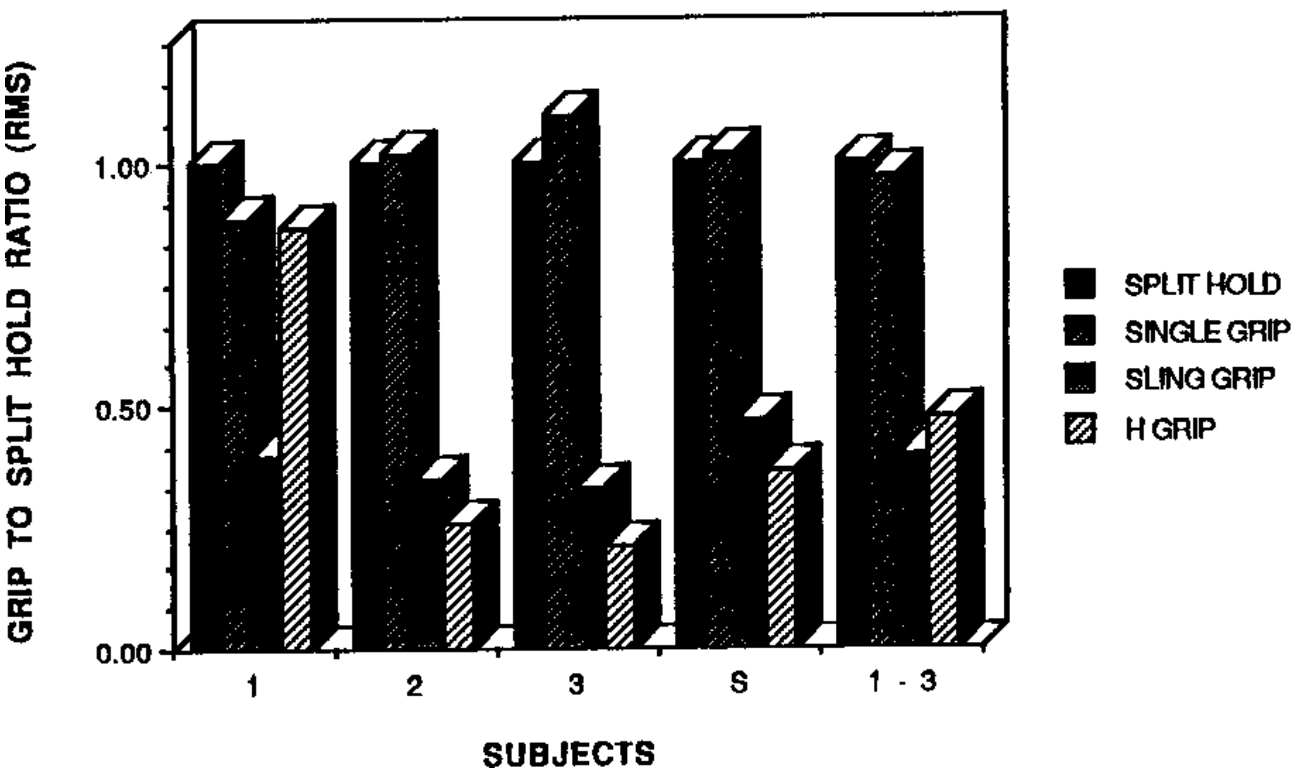

Figure 6. Effect of various tank grips on percentage change in muscle activity (RMS) for the biceps brachii muscle (split grip activity normalised to one).

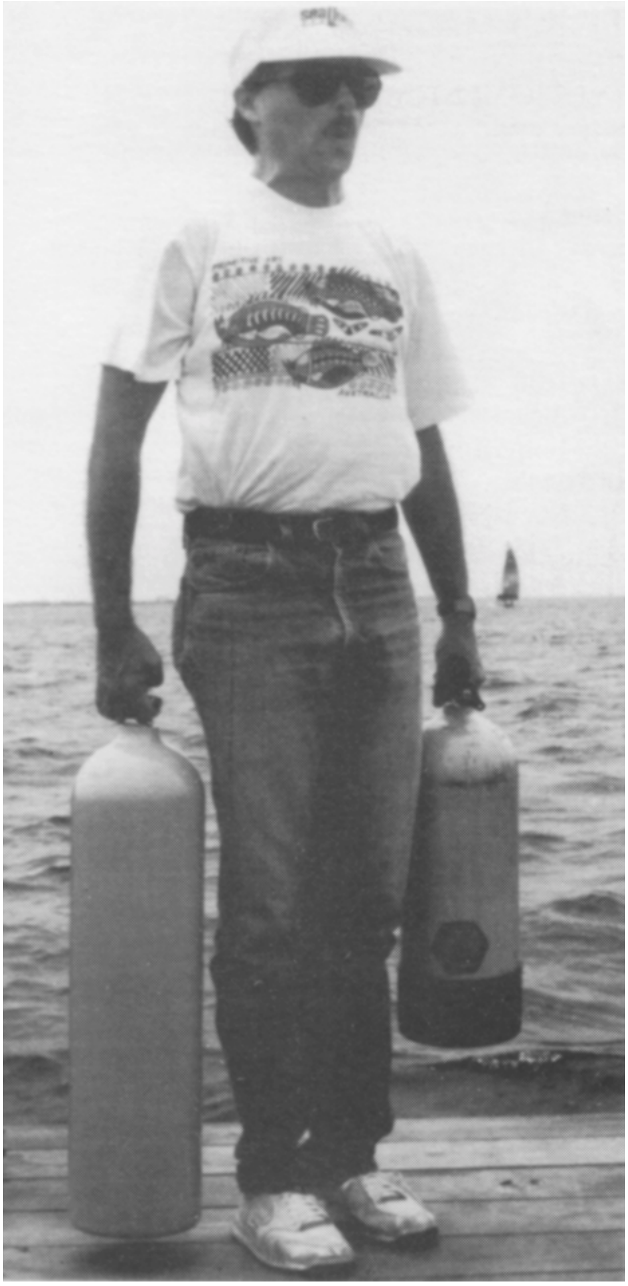

Figure 8. showing typical tank carrying posture.

which predispose humans to the formation of lateral epicondylitis. The use of tank carrier straps decreases the amount of activity of the forearm extensors and the arm flexors because less pronation is required. We recommend that dive physicians recognize tank carrying as a predisposing factor toward the formation of lateral epicondylitis. Active encouragement of patients to precondition the arm prior to dive excursions and the use of tank carrier straps may decrease long term disability.

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SPUMS NOTICES

1991 SPUMS ANNUAL SCIENTIFIC MEETING PROGRAMME

Session 1
Sunday 2nd June Chairman Des Gorman

1600 - 1730
SPUMS Executive meeting
1730 - 1800
Break

Introduction and key-note address

1800 - 1815 Des Gorman
Introduction and welcome
1815 -1845 Geoff Skinner
Housekeeping and diving arrangements
1845-1900
Break

1900-1945 Glen Egstrom
The state of the art in recreational diving equipment and the impact of changing equipment configurations on diving instruction and performance
1945-2000
Discussion

Session 2
Monday 3rd June Chairman Tony Slark

Fitness for diving

1600 - 1630 Drew Richardson
The PADI diving medical
1630 - 1645
Discussion
1645 - 1715 John Knight
The SPUMS diving medical submission to Standards Australia
1715 - 1730
Discussion
1730 - 1800
Break

1800 - 1845 Glen Egstrom
The mechanical, physiologic, methodologic and psychologic aspects of adequate preparation for diving
1845 - 1900
Discussion
1900 - 1945 Andy Veale
Lung function testing and diving fitness
1945 - 2000
Discussion

Session 3
Tuesday 4th June Chairman John Robinson

Open session

1600 - 1630 David Davies
A clinical review of the Hyperbaric Unit, Fremantle Hospital 1990
1630 - 1645
Discussion
1645 - 1715 Chris Acott
A clinical review of the Hyperbaric Medicine Unit, Royal Adelaide Hospital 1990
1715 - 1730
Discussion
1730 - 1800
Break

Buoyancy control devices

1800 - 1845 Glen Egstrom
Biomechanics of buoyancy control devices and the impact upon ascent rates
1845 - 1900
Discussion
1900 - 1920 Terry Cummins
NSQC buoyancy control instruction
1920 - 1930
Discussion
1930 - 1950 Chris Acott
DIMS; buoyancy control device incidents
1950 - 2000
Discussion

Session 4
Wednesday 5th June Chairman Chris Acott

Open session

1600 - 1630 Drew Richardson
An overview of the recreational diving industry
1630 - 1645
Discussion
1645 - 1715 Terry Cummins
A training agency perspective on DES funding and other topical issues
1715 - 1730
Discussion
1730 - 1800
Break

Diving emergency procedures

1800 - 1845 Glen Egstrom
The impact of equipment on the effective execution of air sharing techniques and other loss of control situations
1845 - 1900
Discussion
1900 - 1930 Peter Sullivan
A trial of in-water oxygen therapy in Antarctica
1930 - 1945
Discussion

Session 5
Thursday 6th June Chairman John Knight

Decompression procedures

1600 - 1630 Ray Rogers and Drew Richardson
The RDP and the PADI experience 1990-1991
1630 - 1645
Discussion
1645 - 1715 Glen Egstrom
Dive computers, tables and decompression procedures
1715 - 1730
Break

Diving accident investigation

1800 - 1845 Glen Egstrom
Equipment and diving accident investigations
1845 - 1900
Discussion
1900 - 1945 Douglas Walker
The adequacy of diving accident investigation in Australasia
1945 - 2000
Discussion

Session 6
Friday 7th June Chairman Des Gorman

Reports from other meetings
1600 - 1610 David Davies
Indonesian Society of Hyperbaric Medicine, 1990
1610 - 1620 Andy Veale
Underwater and Hyperbaric Medicine Society, European Undersea Biomedical Society, International Congress on Hyperbaric Medicine, combined meeting, 1990
1620 - 1630 Des Gorman
International DAN network meeting, 1991
1630 - 1640 Andy Veale
Australian and New Zealand Thoracic Society meeting, 1991
1640 - 1650
Discussion
1650 - 1700
Break

Annual General Meeting
1700 - 1830 Annual General Meeting

Conference Banquet
1930

MINUTES OF SPUMS EXECUTIVE MEETING (TELECONFERENCE) HELD ON SUNDAY NOVEMBER 11

at 1000 Eastern Summer Time

Present

Drs Gorman (President), Acott, Knight (Editor), Robinson (Secretary), Barry (Treasurer), Slark and Williamson.

Apologies

Drs Davies, Chapman-Smith and Wallner.

1 Minutes of the previous meeting

These had been distributed andwere taken as a true record. Proposed Dr Gorman. Seconded Dr Barry

2. Business arising from the minutes

2.1 AGM 1991

Dr Rasheed has not responded to our invitation to open the meeting. No further information has been received about funding from AIDAB. Latest costings for Kurumba Village, Maldives, have been distributed and were considered to be good value. Scientific Programme: Dr Gorman informed the meeting that planning was at an advanced stage and he will be able to present this to the next meeting in February, and, thereafter, call for papers.

2.2 AGM 1992

Dr Williamson advised no further discussions had taken place with Dr Pichon. Dr King has been away and unable to assist at this time. Dr Robinson reported that we may have exclusive use of Quicksilver at a cost comparable to previous dive packages, but only by offering a 3 day dive package compared to the usual 5. This proposal was agreed to, further, it was suggested by Dr Knight that on dive days we have a mini lecture programme compared with a more intense programme on other days. All present agreed to this. Dr Robinson will speak to Geoff Skinner and instruct him to proceed accordingly.

2.3 AGM 1993
No further information.

2.4 HAWAII
At the request of Geoff Skinner information was circulated about Kona as a possible future conference venue. Discussion was deferred till February but it was thought to be an option for 1994.

2.5 PADI MEDICAL STATEMENT.
Dr Gorman's draft was discussed. The Committee approved the draft but added a stronger emphasis should be made as to the compulsory nature of the diving medical. It needs to be clear SPUMS will not compromise on this point. Dr Barry added Leukaemia need not necessarily be an absolute contraindication. It was noted by Dr Williamson that with advances in understanding absolute contraindications could become relative. Dr Slark felt that no medical should proceed if it was overwhelmingly obvious it would fail. These points were agreed and Dr Gorman will write a final letter and send it to PADI.

2.6 HYPERBARIC SOCIETY
Dr Williamson advised there will be a meeting in Adelaide on the 23rd of November. There is a total of 14 people involved. After discussion it was agreed it should be a standing Committee of SPUMS. The newly formed Australian Hyperbaric Medicine Society should report to SPUMS and have their proceedings published in the SPUMS Journal. The committee will involve only those members engaged in full time Hyperbaric Medicine, which, in fact means largely clinical directors of units. A teleconference is to be held soon and it was agreed SPUMS will fund this.

2.7 AUSTRALIAN-CANADIAN MEETING
Dr Gorman reported a private conversation with Carl Edmonds. It seems this meeting was organised in Canada with no local input. A token Australian representation was invited but they had no organisational role. It was agreed there was no point pursuing the matter further.

2.8 COFFS HARBOUR MEETING
There was nothing further to report.

2.9 STANDARDS ASSOCIATION MEETING
A meeting has been arranged for November 24 at Carl Edmond's house. Attending will be John Knight as Chairman, John Williamson, Chris Acott, Bob Thomas and Carl Edmonds. Dr Gorman inquired as to how decisions were to be made and was advised it had already been decided by consensus. Dr Knight will report to the next meeting.

2.10 SCIENCE CENTRE FOUNDATION
A letter from Ruth Innal had been circulated. There was much discussion about the Foundation's role in SPUM'S affairs. The major problem is continuing high costs. There is no doubt these had to be reduced. All agreed a permanent address necessary. Whether this involved using the Foundation as a letter box or getting a new address remained to be decided. Dr Knight said he would investigate the possibility of using The Australian College of Occupational Medicine. The Committee felt this was a promising suggestion. It was felt if we are going to change address it should be soon. Opinion seemed to favour Dr Barry's suggested reorganisation. It was decided Drs Knight, Barry and Robinson, as those most involved with running the Society, should have a separate link up and resolve this issue. This was agreed by all, the outcome will be reported at the next meeting.

3 General Business

3.1 SPUMS JOURNAL.
Instructions to authors: John Knight advised these had been amended and will appear in the next journal. Theme Issues he felt were difficult to organise at this point due to a lack of material. There had been one Guest Editor so far. He thought in time Leading Articles may be possible. John Williamson and John Knight have been in communication frequently and established a good working relationship concerning the Journal. John Williamson informed the Committee that RAH has an extensive range of educational courses that are in increasing demand. It was recommended these be advertised again in the Journal.

3.2 DES PHONE
Chris Acott spoke and stated that while the Agencies continued to support the Service, by way of a levy, no payment had been received this year. This was due, in part, to some unease about the Trust Fund wording. He expected this to be resolved by consultation with the Agencies themselves. Chris drew the Committee's attention to a move in Queensland to establish a separate DES service in that State. This move was strongly opposed by all members of the Committee who felt this caused confusion, was against moves to link up with the DAN and European Service, and resulted in splitting of Agencies funds. It was suggested a policy statement should be submitted to the Journal. John Williamson mentioned that Tom Heron, who is a prime mover in this matter, had little diving experience and no medical background. It was hoped education might help resolve this issue. Insertion of a leading article in the next journal was discussed, but it was decided to defer this till the March issue so as not to inflame the situation.

3.3 DIMS.

Chris Acott said 121 incidents had been reported and were being currently analysed.

4 Correspondence

Dr Gibbs: A letter critical of the awarding of our Diploma was read. This matter has already been fully discussed in the Journal and it was felt unnecessary to discuss it further. The Secretary will write indicating the appropriate avenue for the doctor to seek this qualification.

5 Business without notice

5.1 DIVING DOCTORS

Dr Robinson reported that many complaints had been received about this list. These were mainly concerning omission from the list. In future the list will only include financial members of SPUMS with an appropriate diving qualification or six months experience in a hyperbaric unit. A statement will appear in the next Journal to that effect.

5.2 FUTURE MEETINGS

Dr Robinson requested as much notice as possible for items on the Agenda.

Meeting closed at 1150.

SECRETARY'S NOTICES

NOMINATIONS FOR THE EXECUTIVE COMMITTEE

Nominations for the Executive Committee of SPUMS should be in the hands of the Secretary by the fourteenth of April 1991.

Besides the office sought nominations must bear the names and signatures of the proposer, seconder and nominee. A member may nominate for more than one position.

A nomination form was enclosed with the last Journal.

ANNUAL GENERAL MEETING 1991

The Annual General Meeting will be held during the Annual Scientific Meeting at the Karumba Village Resort, Republic of Maldives, June 1-8 1991.

Members wishing to have matters placed on the agenda of the AGM must notify the Secretary in writing, in the form of a motion, before 14th April 1991. Matters not on the agenda cannot be discussed at the AGM (see Rule 8).

LIST OF AUSTRALIAN MEMBERS WHO DO DIVING MEDICALS

In the future the of list of members who do diving medicals will only include the names of those who have done the appropriate training (RAN basic course, Royal Adelaide Hospital basic course, Diving Medical Centre Brisbane medical examiner course or equivalent).

As it is likely that the records held by SPUMS could be out of date it has been decided that **members wishing to be on the list shall submit to the Secretary** the following information. Name, date and place of training, the address where diving medicals are done (including postcode) and the telephone number (including area code) to be rung to book medicals.

Without all this information names will not be included on the list.

NOTICE OF INTENTION TO ALTER THE RULES OF THE SOUTH PACIFIC UNDERWATER MEDICINE SOCIETY INCORPORATED

The Executive Committee of SPUMS has given notice of its intention to move two motions to alter the rules of the Society at the 1991 Annual General Meeting (SPUMS J 1990; 20 (3):143). Notice is now given of a third motion to be moved at the same time. The motions will then have to be passed by a three fourths majority of the full members and life members in a postal ballot. This rather cumbersome arrangement is necessary because the Corporate Affairs Office, Victoria, requires motions to alter the rules to be presented to a meeting.

The motions now seek to add an Education Officer to the Committee , to enable members resident outside the South Pacific, specifically North America, to form a local branch of SPUMS and to alter the procedure for registering membership to conform with what actually happens.

Motion 1.

"That rule 22 (a) be altered by inserting the words "an Education Officer," after the words "the Editor of the Journal," and inserting the word "the" before the words "South Pacific Underwater Medicine Society" and inserting the word "Incorporated" after these words."

Rule 22 (a) would then read (with the added wording in **bold** type)

"The Committee shall consist of a President, Immediate Past President, a Secretary, a Treasurer, Public Officer, the Editor of the Journal**, an Education Officer,** a representative appointed by the New Zealand Chapter of **the** South Pacific Underwater Medicine Society **Incorporated** and three other members of the Association entitled to vote."

Motion 2.

"That rule 41 (b) be altered by deleting the words "in the South Pacific area"."

Rule 41 (b) would then read

"A regional branch of the Association may be established at any place to further the objects of the Association in that place."

Motion 3.

"That rule 4 be altered by deleting paragraphs a to h, and substituting paragraphs a to f below."

Rule 4 reads

"(a) Any person seeking full membership or associate membership or corporate membership may apply for membership in the form set out in Appendix One which shall, after it is completed, be lodged with the Secretary of the Association.

(b) As soon as it is practicable after the receipt of a nomination, the Secretary shall refer the nomination to the Committee.

(c) Upon a nomination being referred to the Committee, the Committee shall determine whether to approve or to reject the nomination.

(d) Upon a nomination being approved by the Committee, the Secretary shall, with as little delay as possible, notify the nominee in writing that such a person is approved for membership of the Association and request payment within the period of 28 days after receipt of the notification of the sum payable under these Rules as the entrance fee and for the first year's annual subscription.

(e) The Secretary shall, upon payment of the amounts referred to in sub-clause (d) within the period referred to in that sub-clause, enter the nominee's name in the register of members kept by him and, upon the name being so entered, the nominee becomes a member of the Association.

(f) A right, privilege or obligation of a person by reason of his membership of the Association -

(i) is not capable of being transferred or transmitted to another person; and
(ii) terminates upon the cessation of his membership whether by death or resignation or otherwise.

(g) The Secretary shall also inscribe the name of any life member or honorary member in the register of members and shall delete the name of any person ceasing to be a member from the register immediately after such person ceases to be a member.

(h) The Committee shall be under no obligation to give any reason for its decision not to accept an application for membership of the Association."

The words to replace the paragraphs above are:-

"**(a) Any person seeking full membership or associate membership or corporate membership may apply by writing to SPUMS Membership C/o Australian College of Occupational Medicine, P.O.Box 2090, St Kilda West, Victoria 3182.**

(b) When the completed application form, with the sum payable under these Rules as the entrance fee and for the first year's annual subscription, is received by the Treasurer the applicant's membership shall commence.

(c) Upon notification by the Treasurer that membership has commenced the Editor (or the Secretary) shall enter the applicant's name in the register of members kept by him.

(d) A right, privilege or obligation of a person by reason of his membership of the Association -

(i) is not capable of being transferred or transmitted to another person; and
(ii) terminates upon the cessation of his membership whether by death or resignation or non-payment of subscription or otherwise.

(e) The Editor (or Secretary) shall also inscribe the name of any life member or honorary member in the register of members and shall delete the name of any person ceasing to be a member from the register immediately after such person ceases to be a member.

(f) The Committee may reject any new member at its next meeting and shall be under no obligation to give any reason for its decision not to accept an application for membership of the Association."

The explanation of the inclusion of the Editor in paragraphs c and e is that, at present, the Editor is responsible for keeping the list of members up to date. It is possible that at some future time this task might be taken over by the Secretary.

John M.P.Robinson
Secretary of SPUMS.

LETTERS TO THE EDITOR

COSTS OF ANNUAL SCIENTIFIC MEETING.

For the information of members we reproduce below the text of a letter sent by Allways Travel to a member who wrote to the Secretary of SPUMS pointing out that his travel agent could offer a cheaper fare to the Maldives.

Allways Travel Service
168 High Street
Ashburton
Victoria 3147

25 January, 1991

Dear Sir

I have recently received a copy of your letter to the Secretary of SPUMS in relation to this year's SPUMS meeting in the Maldives and feel there are certain matters you have brought to his attention that require immediate clarification.

Allways Travel Service works very hard at securing the best possible hotel rates and air fares for the SPUMS group and it is always our intention to keep costs at a minimum.

Your letter prompted me to phone the group department at Singapore Airlines in order to air your views and I was given this response which I will detail in point form.

1 The airline package you are referring to has limited availability and on each departure Singapore Airlines will only accept up to ten people. Once the ten seats have been sold, the package is considered full, and anyone else wishing to book are requested to pay a more expensive air fare. They will not fill an aircraft of passengers travelling on cheap fares due to the very low profit margin involved.

2 The flights to the Maldives continue on to various European cities and Singapore Airlines will not release a large number of seats, at a substantially reduced rate, for a group terminating their travel arrangements in Male. The reason, of course, is that it is far more profitable for them to protect the bulk of their seats for their passengers travelling through to Europe.

3 We are very fortunate to have secured the number of seats we have.

Our cost for this years meeting is $1,860.00 which includes return air fares, seven nights accommodation, breakfasts daily, two evening meals and transfers. This price is not subject to air fare increases. The Singapore Airlines package is $1,849.00 and offers the same as our package with an additional four evening meals. This price is subject to increases and I believe we have secured a very good price in comparison.

I should point our that a lot of hard work is put into the organisation of the SPUMS meetings to ensure that reservations are handled efficiently, the diving is handled with safety and care, the Conference is run successfully and the non diving programme is varied and interesting.

I believe it is of great assistance to all members to have the staff of Allways Travel in attendance each year with queries and generally oversee arrangements for the group.

These advantages would not be made available if all members were to book independently. Individual travel would also mean you would have scattered arrivals and departures which would be a difficult situation when organising the actual meetings.

I trust I have responded adequately to all points set out in your letter and I would be more than happy to answer any further queries you may have.

Adrienne McKeone
Group and Convention Manager
Allways Travel

THE MALDIVE MYSTERY

GPO Box 1317
Hobart, Tasmania 7001

January 16th 1991

Sir

I have just read Thor Heyerdahl's "The Maldive Mystery", published by George Allen and Unwin, and recommend it to the members going to the Maldives as a useful update on the Maldives from the cultural and ethnic point of view.

Some members know of my interest in marine archeology. I have to report an interesting correspondence with the Maldives Deparment of Linguistic and Cultural Studies touching topics mentioned in the book.

Peter McCartney

Editor's note

A review of this book appears on page 49.

DivEvac

DivEvac
5th Floor, Heerengracht, 87 Korte St
Braamfontein, Johannesburg
South Africa

21 December 1990

Dear Sir,

We would like to introduce you to DivEvac.

DivEvac is a 24-hour multi-network system designed to service all recreational scuba divers throughout South Africa, neighbouring countries and Indian Ocean Islands, in the case of a diving accident or when in need of diving medical advice.

DivEvac's Operations Centre, based in Johannesburg, already has an emergency evacuation plan for each known local diving area and has highly trained medical staff (Doctors, ICU Nurses and Paramedics) capable of dealing with diving related incidents. It has many air ambulances, fixed-wing aircraft and helicopters, based around major spots in South Africa, i.e. Durban, Johannesburg and Cape Town, which ensure the rapid arrival and immediate access to the injured diver wherever he may be. The diver is also guaranteed access to the appropriate medical facility and all the evacuation and medical expenses arising from the recreational Scuba Diving incident, are covered provided he/she is a member of DivEvac.

DivEvac has fully equipped recompression facilities on a 24-hour standby, manned by expert personnel and is instituting facilities at many of the major diving spots.

In addition:

1 DivEvac provides responsible travelling companions for minors who are in the company of the diver at the time of the incident, to see them home safely after the accident or injury has occurred, if left unattended.

2. DivEvac will cover policy holders for medical and transportation costs of any recreational scuba diving related incident outside DivEvac's area of operation, provided DivEvac is informed of the destination prior to the departure of the scuba diver (up to R50,000).

3. DivEvac also works in close collaboration with all other rescue services throughout Southern Africa to ensure the maximum protection of the recreational scuba diver's needs. DivEvac covers the policy holder in the case of a non-diving related incident, such as a car accident, etc., but for evacuation only and not the hospital medical costs.

We would kindly appreciate any materials or information that you may offer us to enhance our service. We are aiming to commence our own diving accident statistics data and would like to read your references as well, i.e. your statistical reports, and to share ours with you in the future. We have done 12 treatments during 1990 and are very keen to compare our services with others and to learn more.

Please send us more information on your services, as we ultimately would like to liaise on an international basis, to ensure our clients are furnished with the necessary emergency number and cover, should they travel internationally.

Bridget Scott
DivEvac
Medical Rescue International

LOW PRESSURE GAS ALARMS

Hyperbaric Medicine Unit
Department of Anaesthesia and Intensive Care
Royal Adelaide Hospital
North Terrace
Adelaide, South Australia, 5000

28/2/91

Sir,

The Hyperbaric Unit of the Royal Adelaide Hospital has fitted a new low pressure oxygen alarm to its recompression chamber. The problem was to acquire an alarm that could cope with a range of oxygen supply pressures to accommodate either high pressure through a reducer at 10-16 bar or reticulated liquid oxygen (V.I.E.) at 6-8 bar.

Existing alarms were generally expensive, bulky and very limited in function. As we were not happy with the available choices we decided to set down the design parameters for a more suitable low gas pressure alarm, in this instance for oxygen.

The alarm was required to perform the following functions.

1 Power should be supplied from a switch on the panel that would normally be on before a dive.

2 The sampling point must be immediately adjacent to the hull penetration point for the oxygen supply to the built-in breathing system (BIBS).

3 The display must have lights for power, high pressure and low pressure warnings, plus an audible and visible low pressure alarm.

4 The warning audible alarm and the light settings must be easily adjustable.

5 The display panel of the proposed alarm must be compact enough to fit on the limited space of the existing control panel.

The satisfactory unit supplied utilizes a transducer which feeds to a solid state integrated circuit controller, having a remote LED display for flush panel mounting.

Advantages of this system are that the three component parts are small and joined only by wiring, which makes fitting the system to existing chamber pipe-work and control panels easier. During the last three months the unit has functioned trouble free.

We can recommend this low gas pressure alarm. It is available from Microscan (phone 08 276 4691) for $A650.00 ex Adelaide.

R.Ramsay
S.Goble
Senior Hyperbaric Technicians

BOOK REVIEW

"The Maldive Mystery"
by Thor Heyerdahl
George Allen and &Unwin, 1986

The modern Maldive nation dates its history from the conversion to Islam in 1153 A.D.

However, the question remains, where did the inhabitants of this group of 1200 islands come from originally?

In 1982, Thor Heyerdahl was sent a photograph of a stone statue discovered in the Maldive islands, representing the upper part of a person with long ears.

"The Maldive Mystery" is an account of his subsequent investigations, archeological digs and extensive research into this fascinating puzzle.

With his wide experience of reed boats and excellent recall of ancient masonry walls, seen in scattered locations around the world, and his knowledge of currents and seafaring, he was the ideal person for this task.

However, when the participants to the 1991 SPUMS Annual Scientific Meeting in the Maldives travel by boat from Male to the resort island, they should note the arched, incurved prow ending in a fan shape, on the ferries. The Maldive Islanders say, "It is only for beauty", "it has has no practical purpose", "it is an old tradition", "it has no practical purpose and can be detached when it disturbs our work". Thor Heyerdahl immediately noted that this in stylized form resembled the typical shape of the bow of the elegant reed ships, shared by the world's three oldest civilizations; Egypt, Mesopotamia and the Indus Valley.

We recommend this book with its fascinating theories to all SPUMS readers.

Drs. Penny and Peter McCartney
Hobart, Tasmania

ARTICLES OF INTEREST REPRINTED FROM OTHER JOURNALS

FINAL SUMMARY OF RECOMMENDATIONS ISSUED FROM 1990 DIVING ACCIDENT WORKSHOP

Editor of Pressure's Note

The March/April 1990 issue of *Pressure* presented the draft recommendations of the Diving Accident Management Workshop held at Duke University Medical Centre in January. Since then, all workshop participants have reviewed the draft. This review resulted in the revised recommendations below. In the future, to ensure that the recommendations published in *Pressure* represent the final consensus of workshop participants, we will not publish UHMS workshop recommendations until the workshop report has been sent to the printer.

1 The increasing complexity of diving equipment, for example, decompression computers and dry suits in addition to some diving techniques such as enriched oxygen breath-

ing mixtures, requires skills beyond the minimum that are learned during a basic diving course. The workshop group suggests that additional training in the use of each of these types of apparatus may be necessary so that a diver can reach a specified level of skill in order for this equipment to be used safely. There is a need to continue to emphasize the importance of training divers in middle ear pressure equilibration in order to prevent inequalities of middle ear pressure (and hence inner ear barotrauma) during descent.

2 It has been suggested that some degree of preparation for a dive trip and adaptation to the environment may be necessary to ensure total diving safety. Although the issues have not been well worked out scientifically, an analogous situation would be that of a skier, who should optimally prepare for a ski trip with some leg exercises in order that injury may be minimized. Examples in diving might be prehydration prior to a dive, attention to current diver health status, exercise training before dive trip, etc. It is recommended that hydration be vigorously maintained during diving operations or leisure diving trips. Beverages containing alcohol or caffeine promote diuresis and should be avoided. Direct sun exposure should be minimized.

3 In terms of first aid and treatment of dysbaric diving casualties, the following measures are recommended:

DELAYS

One of the biggest factors related to ultimate therapeutic success is to minimize the time between onset of symptoms and therapeutic recompression. It is suggested that part of the initial process of taking care of the patient include immediate contact with the appropriate EMS system in order to expedite transport. Anyone responsible for a dive should be familiar with mechanisms for evacuation of a diving casualty to a sophisticated hospital facility with minimum delay and then to the nearest appropriate recompression facility. Recreational divers need to be aware of the difficulties which can occur when diving in area where facilities for assessment and treatment of decompression illness are not readily available. Divers should receive better training on symptom recognition and the need for early treatment.

OXYGEN

Paul Bert[1] first reported that the signs of bends in experimental animals could be ameliorated using surface O_2. The use of oxygen in the period prior to recompression has a reasonable rationale. First, the increased tissue oxygen tension is likely to hasten inert gas elimination and bubble resolution, even prior to therapeutic recompression. Second, some patients with dysbaric disease have associated pulmonary pathology, such as "chokes", or aspiration of water or vomitus, all of which may lead to arterial hypoxemia. Supplemental O_2 may also ameliorate tissue hypoxia due to the effects of gas bubbles. Pre-hospital oxygen administration is not detrimental and there is no reason to withhold it from a diver with symptoms of decompression illness.

It is suggested that an inspired oxygen concentration as close to 100 percent as possible be administered to any injured diver. It is recommended that all dive boats be equipped with an apparatus that can deliver close to 100 percent inspired oxygen concentration to a spontaneously breathing patient and as high a concentration of O_2 as is feasible to an apneic patient, concomitant with the training and level of skill of the rescuer. A demand valve or bag-valve with a tightly sealing oronasal mask is one of the most efficient devices to accomplish this. Oxygen administration should be continued from the time of accident is recognized until the patient reaches a facility for definitive diagnosis and treatment. It is further suggested that dive instructors and dive masters, who are responsible for conducting dives, be trained in the use of oxygen with these types of apparatus. The absence of an individual trained in oxygen administration should not preclude equipping a given dive boat with oxygen apparatus. The presence of O_2 on a boat should be reserved for suspected diving accidents and should not be used as an excuse for deliberately omitting decompression and using O_2 to treat the consequences.

FLUIDS

Immersion and cold results in loss of intravascular fluid volume due to diuresis. The clinical experience of many of the participants suggests that patients with gas bubble disease are dehydrated. Therefore, fluid administration to an end-point of adequate urine flow is recommended. In divers with neurological DCS, intravenous fluid administration is preferred, since the optimal balance of water and electrolytes may be most easily attained. Isotonic electrolyte containing solutions (e.g., normal saline, Ringer's) are preferred. In other setting (e.g., stroke) there is evidence that the intravenous administration of glucose-containing solutions may worsen neurological function, therefore glucose should be avoided unless symptomatic hypoglycemia is suspected. Hypotonic fluids (e.g., dextrose in water, half normal saline) may promote edema within the CNS and are not recommended. In the awake patient, who is not nauseated or vomiting and whose airway reflexes are intact, oral administration of fluids is recommended.

HEAD-DOWN POSITION

There was no clear cut consensus on the value of head-down position. Anecdotal reports suggest that symptoms of arterial gas embolism can sometimes improve when the patient is placed in steep Trendelenburg position. Animal experimentation supporting the traditional recommendation of head-down position has been done by Atkinson[2] with embolized (open skull) cats, showing disappearance of the bubbles in the direction of arterial flow when the animals were placed in steep Trendelenburg position. However, more recent animal work (e.g., presented by Dr. Dutka at this workshop) suggests that prolonged head-down position may be detrimental, possibly because of extravasation of additional fluid into the brain due to the higher intravascular pressures.

The possibility that head-down position may prevent cerebral AGE in the event of ongoing embolization from the lungs or trapped gas in the pulmonary vessels or heart is negated by some studies showing only a minor effect of buoyancy in determining where gas bubbles are distributed[3]. Nevertheless, Dr. Gorman anecdotally reported a small percentage of patients who abruptly worsened after arterial gas embolism when they were allowed to sit upright.

While a brief (less than 10 minutes) head-down position might conceivably facilitate the clearance of bubbles from the cerebral circulation after AGE, it seems prudent thereafter to keep the patient in the supine position rather than in prolonged head-down or head-up position. Head-down position in the initial treatment of AGE should be secondary to maintenance of an adequate airway, oxygen administration and rapid transfer to a hyperbaric chamber. Head-down position has no role in the treatment of DCS. Unconscious patients should be kept in the lateral decubitus position to minimize the risk of aspiration of vomitus.

PRESSURE

The vast majority of dysbaric dive accidents can be managed at a maximum ambient pressure of 2.82 ATA, using U.S. Navy Table 5 or Table 6. In a small percentage of cases observed in the U.S. Navy and commercial diving, further compression to 6 ATA has resulted in immediate benefit. This benefit may conceivably be realizable only when hyperbaric chambers are available on dive stations for prompt recompression therapy. For cases refractory to compression to 2.82 ATA (a small percentage of cases) a chamber capable of compression to 6 ATA with the facility to administer mixed gases (e.g., 50-50 N_2-O_2) should ideally be used.

MONOPLACE CHAMBERS

While the use of monoplace chambers in the treatment of diving accidents can be less than ideal, one should not preclude their use since access to a suitable monoplace chamber is often more readily available than to a multiplace chamber. Ideally, the use of a monoplace chamber for the treatment of a dysbaric accident should be supervised by an individual competent and experienced in the management of diving accidents. The monoplace chamber should also have a system such that air may be administered via BIBS mask in an oxygen atmosphere or vice versa. therefore, at least a standard U.S. Navy Table 6 may be administered. The patient should be carefully screened for pulmonary barotrauma, or conditions that might predispose to pulmonary barotrauma (particularly tension pneumothorax), prior to therapeutic recompression in a monoplace chamber. If pneumothorax exists, or there is pulmonary pathology that might predispose to barotrauma, prophylactic chest tube placement by individuals skilled in placement and management (with one-way valve or underwater seal) may be considered prior to compression. A transportable monoplace chamber should have transfer-under-pressure capability into a multiplace facility.

Certain types of diving operations have a procedural requirement specifying recompression chamber availability. Monoplace chamber use in this setting may preclude safe treatment of some types of diving accidents. If a monoplace chamber is used to fill this role, the procedure should specifically address monoplace chamber specifications and the conditions under which it may be used.

INERT GAS

Clinical success is achieved in a high percentage of divers with dysbaric injury after air diving by using air and oxygen as treatment gases. In a small number of cases success has been achieved by switching the breathing gas to heliox (HeO_2) after a trial with air. Theoretical considerations would predict that nitrogen bubbles in tissue, but perhaps not in blood, would shrink faster when HeO_2 is breathed. Experimental support has been provided by in vivo observation of bubble size while breathing various gases, indeed revealing more rapid shrinkage of nitrogen bubbles in some tissues during HeO_2 breathing[4]. A canine study using pulmonary hemodynamics as an end-point showed no advantage of HeO_2 over air breathing at 1 ATA in treating DCS after air diving[5]. In this study HeO_2 breathing resulted in an 11 percent increase in pulmonary vascular resistance. A study in guinea pigs showed slower recovery from tachypnea when the animals were precompressed with HeO_2 versus air[6]. The adverse effects of HeO_2 breathing in these latter two studies are perhaps explained by the particular model, which was predominantly a measure of the effects of venous gas embolism (intravascular bubbles). However, no deterioration has been recorded as a result of switching the breathing gas from air to HeO_2 in the treatment of human DCS. Indeed, some European commercial dive operations do use HeO_2 for bends occurring as a result of air dives. Nevertheless, the number of clinical observations in humans is too small to draw any conclusions and there is as yet no definitive scientific evidence unequivocally supporting the use of HeO_2. Therefore, while HeO_2 use appears to cause no harm in humans, its use cannot be generally recommended at this time for the treatment of air DCS without additional discussion or until further experimental work has been performed.

There was discussion among participants in the workshop about the reverse situation, the use of air to recompress divers who have suffered DCS after HeO_2 dives. The U.S. Navy experience is that air and 100 percent O_2 have been equally effective in treating both HeO_2-induced bends and air-induced bends[7]. However, this experience has been in HeO_2 dives of 300 fsw (91 msw) or less, and in Type 1 DCS arising after surfacing from saturation dives. Experience from commercial diving in the Gulf of Mexico also supports the use of therapeutic air tables (e.g., U.S. Navy Tables 6, 6A, 7) after HeO_2 bounce dives. Others have observed acute deterioration in clinical condition when switching the breathing gas from HeO2 to air at depth. Severe clinical deterioration of a diver recompressed on air to treat DCS after a 600 fsw (183 msw)/30 minute dive has also been reported[8]. This type of adverse effect of air is believed to be most likely after deep bounce dives or saturation dives in which HeO_2 is breathed throughout the entire decompression.

No global recommendations are made on the use of HeO_2 versus air for treating HeO_2 diving operations in which decompression time is not excessive, air/O_2 recompression appears adequate. For DCS associated with HeO_2 saturation dives or extremely deep bounce dives, some participants believe that HeO_2/O_2 recompression may be most prudent, particularly in the event of DCS occurring before surfacing, or if significant amounts of decompression time have been missed or serious symptoms occur. In addition to considerations of gas diffusion, the use of HeO_2 will allow return to a greater ambient pressure than air or nitrox. In the experience of the U.S. Navy, cases of Type I DCS arising after surfacing from saturation dives in which no decompression time has been missed, have not shown any signs of clinical deterioration when recompressed in air, and the U.S. Navy continues to use that option.

Inert gas considerations are most relevant when the depth of recompression is greater than 60 fsw (18 msw, 2.82 ATA) or saturation treatment is used. Otherwise, the mainstays of treatment are pressure and oxygen. The inert gas, breathed for only brief intervals during standard oxygen therapeutic tables (e.g., U.S. Navy Table 6), is a secondary consideration.

ANTICOAGULANTS

There is no scientific evidence at the present to support the use of any anticoagulants, including aspirin, in the treatment of diving injuries. Some forms of decompression sickness, for example, inner ear DCS and spinal cord DCS, may have associated hemorrhage, which could be worsened by the administration of anticoagulants.

FOLLOW-UP HYPERBARIC TREATMENT

It is recommended that after the initial hyperbaric treatment, follow-up treatments be administered on a daily or twice daily basis until there is no further stepwise improvement in the patient's clinical condition.

4 It is recommended that a consensus on terminology and disease classification be developed in order to remove one possible impediment to multi-centre trials.

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PROJECT S.A.F.E.R. DIVERS - PROVISIONAL REPORT

Hans W. Telford

Project S.A.F.E.R. Divers (acronym for "Statistical Analysis File of Emergencies for Recreational Divers"), launched in January 1990, is intended to provide statistical information on Decompression Sickness and Arterial Gas Embolism cases from 1980 to 1990 as well as correlate expert opinion on the causes of these accidents. To obtain this information, a series of questionnaires were sent to each Hyperbaric facility operating through the Diving Emergency Service (DES) Network in Australia and New Zealand.

Many of the Hyperbaric Units that operate through the Diving Emergency Service expressed difficulty in obtaining the statistics as many did not have the luxury of computerized data normally accessible at the touch of a key stroke. Also, time was a critical factor, many reports were not completed and forwarded until September and October, 1990. For future access, it is hoped that the central co-ordinating point of the Diving Emergency Service (Royal Adelaide Hospital) could provide a full data base service and produce accurate statistics for the 1990's and future years. This will obviously require extensive cooperation between all DES operations.

At first glance, there appears to be a disturbing trend towards an ever increasing number of DCS. cases being treated with each progressing year. Most cases reported, involve certified recreational scuba divers (average approx. 90%). It is true that the recreational scuba diver certification numbers have boomed, particularly in the 1980's, resulting in more scuba divers frequenting the waters. It is also true that the scuba diving training associations have implemented a number of changes to their respective training standards in the 1980's to make the sport safer (e.g. changes to dive tables, safety stops and general procedures). It seems that students involved in scuba training are rarely involved in DCS. accidents, as they are largely controlled by their instructors who monitor depth/time limitations closely. Once certified, the "student" divers then build up their experience by planning and making regular dives in accordance with their training. If involved in charter boat diving or club diving, these dive activities are largely co-ordinated and controlled by qualified divemasters.

Then, if diving is safe, why do these accidents occur ?

The U.S. Navy tables (or their derivatives) were commonly used by recreational sport divers in the 1980's being taught by the major training agencies. These tables were "modified" to include "safety factors" or "fudge factors" in order to maximize the safety of the diver using them. Much attention was also paid to "predisposing factors" to DCS., but probably the greatest cause of DCS. is due to repeated exposure, i.e. repetitive diving. Many divers may not be aware that repetitive diving is tiring and sometimes leads to chilling. It certainly drains the energy resources (everybody has felt hungry and tired after a dive). Combine this with the dehydration effects of continually breathing dry compressed air, the effects of spending time out on a boat (seasickness, heat exposure etc), and the diver would certainly be increasingly predisposed to DCS. - more than what the individual may think.

Dive tables in the late 1980's and 1990's have evolved somewhat to reduce "bubble-forming" dives, however it is vitally important, that whatever dive table is used, it has to be used conservatively - and particularly so for repetitive diving ! Those adjusted dive time limits calculated for repetitive dives <u>must</u> be planned for very carefully - you may have been fit and ready, physically and mentally on your first dive - but do you feel the same way for your repetitive dives ? Remember - there can never be a 'perfect' dive table that gets you out of trouble every time. The latest tables take into account many factors - however they do not take into account the many physiological changes that our bodies go through day after day.

It appears that most diving accidents are attributed to human error - that element that seems to affect everything we do. Some people call it "Murphy's Law". We take 'calculated risks' in just about everything we involve ourselves with; however the 'calculated risk' is usually a rational decision based on our own experiences and knowledge of the potential dangers. But, as the old saying goes, "accidents can happen" - all it takes is a split-second of wrong timing in some cases - doing the wrong thing at the wrong time- and we certainly hear of the resulting accidents via media sensationalism. Some of the decisions we make may not have been rational in hindsight, nor were they really based on knowledge or technique, (or lack thereof) - many of us have been there - yet some of us have 'escaped' the consequences. Some suffer the consequences and worst of all - don't admit it (isn't denial the real number one symptom of DCS.?)

The signs and symptoms of DCS. are taught at the basic level to all divers. In spite of this, most divers would only admit to the possibility of having CD.C.S. if the pain was profound or disabling, and, even then, only if the dive profile was severe. Modern research has shown that the risk of DCS. exists on almost all dives. The belief that "I cannot be bent at the dive was safe and according to the tables" seems to be widespread in the diving community, but held to be misguided by the hyperbaric medical profession. The truth is that even severe DCS. can be pain free. The symptoms could be loss of feeling or an abnormal sensation.

How do you avoid getting Decompression Sickness ?

Well the honest answer may be - don't dive ! However, as we have a sizeable recreational diving industry (it is conservatively estimated that 500,000 dives take place in the Cairns area alone each year), it may not be practical. The following recommendations are provided:

* Understand first of all what Decompression Sickness really is. How and why it is caused. If you have forgotten or you have not kept up to date with the latest research - do so.
* Be ready and prepared (physically and mentally) for the dive - how you feel for the dive is vitally important for your safety in the water. Avoid being over weight, and drinking alcohol prior, between and after dives. It is always a good idea to drink non-alcoholic fluids (water, juice etc) after a dive to replenish lost fluids.
* Use dive tables and/or dive computers conservatively. Don't put absolute trust in them. Never dive them to the limit and avoid dives that require staged

Safer diver tables here

Safer diver tables here

decompression stops.

* Commence your dive to the deepest point first and work your way gradually towards the surface in a step-ladder fashion, always ascend slowly no faster than 18 metres per minute (ideally 9 to 10 metres per minute) - you really should avoid bounce diving or making "yo-yo" dive profiles.
* Perform a safety stop prior to surfacing at a depth range of 3 to 6 metres (5 metres is usually best) for a period of 3 to 5 minutes. This is not an actual decompression stop, but a precautionary one.
* Limit the number of your repetitive dives. Always make your repetitive dives shallower than the last. Avoid repetitive dives in excess of 30 metres (100 feet). NAUI defines a repetitive dive as any dive made within between 10 minutes and 24 hours of a previous dive. NAUI also recommends a minimum of 1 hour for your surface interval time between dives and only dive when you feel well enough to do it safely. If involved in extended charters, it is always best to give yourself a "day off" diving and do some sight-seeing on land if possible. Consider all dives shallower than 12 metres (40 feet) as 12 metre dives when planning repetitive dives.
* When flying after diving, allow yourself at least 24 hours non-diving relaxing activity prior to the flight.
* Remember - the human error factor. We are all human and we do make mistakes at times. However, we can go a long way to minimize these. Know and understand your limitations - if it doesn't feel right - don't do it. Knowledge is strength and experience is a powerful teacher.

It is important to note that the most common symptom of decompression sickness is general weakness. lethargy and fatigue - not joint pain as was once believed !!! It is also important that if any Decompression Sickness symptoms are being experienced, that you should contact the Diving Emergency Service right away. Don't let ego get in the way of obtaining treatment early. Instructors must also be aware of the danger of too many multiple ascents during a single dive. For example, NAUI recommends Octopus Assisted Ascent training to be staggered to allow for example, one student to act as donor on one dive and recipient on another separate dive (and vice-versa). Most training activities which may involve repeated ascents during a single dive (e.g. Controlled Emergency Swimming Ascents, Buoyancy Control etc) can be planned to minimize these problems. Careful planning and common sense can go a long way to prevent problems.

I wish to extend a very special thanks to the people listed below. Their involvement and assistance in this project is greatly appreciated. A NAUI Certificate of Appreciation has been sent to: Dr Robyn Walker (Townsville General Hospital, Townsville, Queensland), Dr Ian Unsworth (Prince Henry Hospital, Sydney, New South Wales), Lieutenant Commander Michael Loxton (HMAS PENGUIN, Sydney, New South Wales), Dr Carlos Scheinkestel and Dr David Tuxen (Alfred Hospital, Melbourne, Victoria), Dr Peter McCartney (Royal Hobart Hospital, Hobart, Tasmania), Dr Chris Acott (Royal Adelaide Hospital, Adelaide, South Australia), Dr Dylan (H.M.A.S. STIRLING, Perth, Western Australia), Dr Harry Oxer (Fremantle Hospital, Fremantle, Western Australia), Surgeon Lieutenant. Chris Strack and Dr Des Gorman (RNZ Naval Hospital, Naval Base, Auckland, New Zealand).

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PANIC AS A CAUSE

Forty-two-year-old Fredrick Swatman and his wife Barbara Ann, of Redmond, Washington, got certified last June.

On November 19, the Swatmans and a family friend decided to dive near the Keystone Harbor ferry dock on Whidbey Island, in Puget Sound. Their first dive about 10 a.m. had them admiring octopi.

"Usually it's a safe area", Mrs Swatman said. "The first dive was mild. But when we went down a second time the current was very turbulent. We were trying to hold on to each other. I wasn't used to the turbulence, and I think I got a panic attack. My chest froze. I couldn't breathe."

"I bolted for the surface. I was drowning. My husband saw me and caught up to me. He got behind me and got my regulator in my mouth. Then the current pulled us apart."

Mr Swatman was pulled out of the water by a boater and taken to the ferry dock where he was treated by paramedics before being flown to Seattle. Mrs. Swatman was pulled out of the water by a boat crew from a nearby ferry. She, too, was flown to Seattle. Both Swatmans were placed in Virginia Mason hospital hyperbaric chamber. She survived. Her husband did not.

"He was a wonderful man", Mrs. Swatman said. "He was very special and he saved my life."

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GLEANINGS FROM MEDICAL JOURNALS

The following abstracts have come to the notice of the editorial staff. They are printed to bring them to the attention of members of SPUMS. They are listed under various headings of interest. Any reader who comes across an interesting article is requested to forward the reference to the Journal for inclusion in this column.

BAROTRAUMA

Sahni TK, Lamba PS and D'souza J.
Localized obstructive pulmonary emphysema during diving training. *Med J Armed Forces India* 1989; October

A case of localized obstructive emphysema in a 23-year-old diving trainee is reported. Clinical presentation and radiological features were the key to the diagnosis. The mechanism of development of this condition during diving due to pressure changes, along with its implications are discussed.

DECOMPRESSION SICKNESS

Weathersby PK, Survanshi SS and Nishi RY.
Relative decompression risk of dry and wet chamber air dives. *Undersea Biomed Res* 1990; 17(4): 333-352

The difference in risk of decompression sickness (DCS) between dry chamber subjects and wet, working divers is unknown and a direct test of the difference would be large and expensive. We used probabilistic models and maximum likelihood estimation to examine 797 dry (and generally resting and comfortable) and 244 wet (and generally working and cold) chamber dives from the Defence and Civil Institute of Environmental Medicine, supplemented with 483 wet (working, cold) dives from the Navy Experimental Diving Unit. Several analyses considered whether dry and wet data were distinguishable using several models, whether models obtained from one set of exposure conditions would correctly predict the occurrence of DCS in the other condition, and whether a single wet-dry risk difference parameter was different from zero. Although the two conditions may not produce identical risks, immersion appears to change relative risk of DCS by less than 30% and certainly involved less than a doubling of DCS risk. Uncontrolled differences in exercise and temperature stresses unavoidably complicate interpretation. Several methods are presented to extrapolate results from dry-test subjects in decompression trial to expected at-sea performance.

From

Naval Submarine Medical Research Laboratory, Box 900, Naval Submarine Base New London, Groton, Connecticut 06349-5900, Naval Medical Research Institute Bethesda, Maryland 20814-5055 and Defence and Civil Institute of Environmental Medicine Downsview, Ontario, Canada M3M 3B9.

Lee HC, Niu KC, Chen SH, Chang LP and Cho SH.
Therapeutic effect of type II decompression sickness. A comparative study between United States Navy treatment table 6A and modified treatment table 6A1. *J Hyper Med 1988*: 3(4): 235-242

Before 1982 the standard procedure at our facility was to treat type II decompression sickness (DCS) with United States Navy (USN) treatment table 6A rather than table 6. However, we were sometimes confronted with recurrences during ascent from 165 to 60 ft, which could necessitate shifting to the lengthy USN treatment table 4. Therefore we modified USN treatment table 6A (the modification we term table 6A1) by extending the bottom time up to 60 min and adding 3 more stops (120 ft for 1 min, 80 ft for 8 min, and 70 ft for 15 min) from 165 to 60 ft so as to minimize recurrences during treatment. Using data collected from 1982 through 1986, we conducted a retrospective study of 128 cases of type II DCS which received treatment on either table 6A or modified table 6A1, followed by several courses of hyperbaric oxygen (HBO) therapy if residual symptoms existed. The clinical outcome revealed a cure rate of 21 out of 31 (67.7%) in the 6A group and 74 out of 97 (76.3%) in the 6A1 group ($P > 0.05$). Among those cases responding completely to the first recompression, the cure rate was 8 out of 31 (25.8%) in the 6A group as opposed to 49 out of 97 (50%) in the 6A1 group ($P < 0.05$). The recurrence rates for 6A and 6A1 were 5 out of 31 (16.1%) and 4 out of 97 (4.1%), respectively ($P < 0.05$). This suggested that our modified table 6A1 not only improved the cure rate but reduced the possibility of recurrence during treatment travel from 165 to 60ft.

DROWNING

Simcock AD.
The resuscitation of immersion victims. *Appl Cardiopulmonary Pathophysiol* 1989; 2: 293-298

This paper reviews the outcome of 150 victims of drowning and near-drowning brought to a district general hospital close to the sea. The pathophysiology of the drowning process is reviewed. Patients were treated immediately on arrival by a resuscitation team. Respiratory difficulties were relieved as quickly as possible. Common problems were hypoxia, hypothermia, acidosis, and low blood pressure. The apparently dead were assessed very carefully. The results show an excellent prognosis for those patients who had not suffered cardiac arrest before arrival. There were, however, two survivors from the cardiac arrest group. Survival rates in this group will only improve if the hypoxia is relieved before cerebral damage occurs.

HEARING DETERIORATION IN PROFESSIONAL DIVERS

Molvaer OI and Albrektsen G.
Hearing deterioration in professional divers: an epidemiologic study. *Undersea Biomed Res* 1990; 17(3): 231-246

Hearing acuity was measured in 116 professional divers. After approximately 6 years they were retested. At most frequencies, the divers had higher hearing thresholds than otologically normal subjects at the same age, both at the first and at the final examination. The divers' hearing deteriorated faster than that of the otologically normal subjects. The young divers' hearing thresholds were lower than in unscreened non-divers at comparable age, but the gap closed gradually with increasing age. Accordingly, the divers' hearing deteriorated faster than that of unscreened non-divers. Some of the divers had suffered permanent hearing loss from acute barotrauma. Considering the regular noise exposure during commercial diving, this must have contributed significantly to the observed hearing deterioration.

From
Norwegian Underwater Technology Centre, Bergen, Norway and Section for Medical Informatics and Statistics, University of Bergen, Bergen, Norway.

NITROGEN BUBBLES

Hyldegaard O and Madsen J.
Influence of heliox, oxygen, and N_20-0_2 breathing on N_2 bubbles in adipose tissue. *Undersea Biomed Res* 1989; 16(3): 185-193

Bubbles in rat adipose tissue were studied at 1 bar after decompression from an exposure to air at 3.3 bars (absolute) for 4 h. During air breathing the bubbles grew throughout the observation period. During heliox (80:20) breathing they shrank and eventually disappeared from view. If the breathing gas was changed from heliox back to air or to N_2O-O_2 (80:20) while the bubbles still had an appreciable size, they started growing again. If the change to N_2O was done after or a few minutes before a bubble disappeared from view, it did not reappear. During breathing of 100% O_2, most bubbles containing N_2 initially grew and then maintained their size for a while before diminishing. However, some bubbles did not start shrinking during the 2-3 h observation period. The relevance of the findings to heliox treatment of CNS decompression sickness after air dives is discussed.

From
Instiute of Medical Physiology C, University of Copenhagen, Denmark.

NITROGEN NARCOSIS

Rogers WH and Moeller G.
Effect of brief, repeated hyperbaric exposures on susceptibility to nitrogen narcosis. *Undersea Biomed Res* 1989; 16(3): 227-232

We investigated the effect of brief, repetitive exposures to 5.5 ATA (148 fsw) in a hyperbaric chamber on adaptation to nitrogen narcosis. A standing-steadiness task, which measures body sway, was administered to 2 groups of 3 chamber-qualified men at 5.5 ATA and 1.3 ATA [10 fsw (control)] on each of 12 successive days to determine if an initial performance decrement at 5.5 ATA would be ameliorated with time. Standing steadiness was significantly worse at 5.5 ATA than at 1.3 ATA across all 12 exposures. There were also changes in standing steadiness from day to day, but these changes occurred in both the test and control depths. There was no day-x-depth interaction that would have indicated that the initial performance decrement at 5.5 ATA was reduced with repetitive exposures. These results are taken as evidence that there is little or no behavioral adaptation to nitrogen narcosis in response to brief, repetitive exposures to narcosis-inducing hyperbaric air.

SATURATION DIVING

Vaernes RJ, Klove H, and Ellertsen B.
Neuropsychologic effects of saturation diving. *Undersea Biomed Res* 1989; 16(3): 233-251

Neuropsychologic status of saturation divers was assessed before and after 300-500 msw dives (deep saturation diving -DSD group) and before and after 3.5 yr of ordinary saturation diving (saturation diving - SD group). Average baseline results showed the divers to be slightly superior to nondiving controls. Mild-to-moderate neuropsychologic changes (>10% impairment) were found in measures of tremor, spatial memory, vigilance, and automatic reactivity in 20% of the divers after deep dives (DSD group). One year postdive no recovery was observed except for a vigilance test. In the SD group, 20% of the divers showed>10% impairment after 3.5 yr of ordinary saturation diving. Significant reduction in autonomic reactivity was also found and there was a relationship between low autonomic reactivity before saturation diving and number of >10% impairments. For the whole group (DSD + SD divers), negative correlations were found between saturation experience and results on memory and complex visuomotor tests. Years of diving from first to last examination was positively correlated with number of >10% impairments and with reduction in autonomic reactivity. No similar correlations were found to dive variables after about 3 yr of air diving. The mild-to-moderate changes seen in some divers, therefore, seem to be the effects of saturation diving. Since one deep dive may cause an effect similar to the effect of 3.5 yr of ordinary saturation diving, there is reason to believe that repeated deep diving may lead to more pronounced neuropsychologic impairment.

From

The Norwegian Underwater Technology Centre (NUTEC) A/S and Department of Clinical Neuropsychology, University of Bergen, Bergen, Norway.

ABSTRACTS FROM THE UNDERSEA AND HYPERBARIC MEDICAL SOCIETY ANNUAL SCIENTIFIC MEETING 1989

GAS UPTAKE

Non-exponential uptake and elimination of inert gas in a dog model.

Ingle RM and Novotny JA. *Undersea Biomed Res* 1989; 16 (Supp): 98

Inert gas kinetics have been assumed to be exponential since 1900, though recent dive tables have dropped this requirement to better fit clinical experience. We present high quality tissue inert gas uptake and release measurements for Xe-133 in a dog model and show that a single hyperbolic equation provides a better fit to the data than multiple exponentials. We show then that the form of the Michaelis-Menten equation holds for inert gas kinetics, and discuss the significance of this finding for predicting decompression sickness.

Hyperbaric Medicine Division, School of Aerospace Medicine, Brooks AFB, Texas 78235, and Diving Medical Department, Naval Medical Research Institute, Bethesda, Maryland 20814, U.S.A.

DECOMPRESSION SICKNESS

Direct comparison of the effects of He, N_2, and wet or dry conditions on the 60 fsw no-decompression limit.

Thalmann ED, Survanshi SS and Flynn ET. *Undersea Biomed Res* 1989; 16 (Supp): 67

A series of 256 man-dives was done to a depth of 60 fsw to determine the no-decompression (no-D) times under four sets of conditions: Air-Dry, HeO_2-Dry, Air Wet, HeO_2-Wet. HeO_2 dives used 21% O_2 and on dry dives the chamber was compressed on breathing gas. Exercise was performed for half the time at depth (10 minutes work, 10 minutes rest) on a bicycle ergometer. Dry workload was 125 watts; wet was 100 watts where the divers wore quarter inch full wetsuits in 60°F water. Results are given as man-dives/cases of decompression sickness (DCS). Times are exclusive of the 2-3 minute descent times. Analysis of results using the method of maximum likelihood showed that dry HeO_2 dives had the highest chance of DCS of any condition, probably due to significant gas absorption through skin. Wet air dives had a significantly higher change of DCS than dry air dives. On wet dives no significant affect of He vs air was shown but the large confidence limits suggested insufficient data rather than absence of an affect. While wet exercise invokes a higher decompression stress than dry exercise on air, the advantage of HeO_2 over air for no-D dives remains to be demonstrated.

	Actual Time at 60 fsw (min)					
	70	**80**	**90**	**100**	**110**	**120**
Air-Wet		14/1	21/2	13/2		
Air-Dry	10/0	10/0	20/0	20/1		
HeO_2-Wet	18/1	9/0	17/0	10/0	9/0	12/2
HeO_2-Dry	18/1	20/0	10/3	20/5		5/3

Naval Medical Research Institute, Bethesda, Maryland 20814-5055, U.S.A.

Estimating risk in multi-level sport diving.

Wachhol CJ , Bensen CV and Vann RD. *Undersea Biomed Res* 1989; 16 (Supp): 36

Sport divers often dive a multi-level profile in the course of normal dive excursions. Although the U.S. Navy Standard Air Decompression Tables assume "square" profiles, new dive computers and tables allow for multi-level dive planning. During a recent DAN benefit trip, Suunto decompression meters with a retrievable 20 hour memory were used to monitor the profiles of 54 dives. No attempt was made to regulate the dive profiles and nearly all dives were observed to be multi-level. Doppler was used to measure precordial bubbles following each dive. Although many of the dives recorded exceeded the no-decompression depth/time limits, no divers reported DCS symptoms and bubbles were heard in only one diver. The potential DCS risk was estimated for each dive using a three-tissue bubble/diffusion barrier model with parameter values determined using maximum likelihood (Vann, UHP 9:165-182, 1987) from the decompression trials for the U.S. Navy Standard Air Trials (Des Granges, NEDU Report, 5-57). These risks are: mean risk: 4.7/10K dives, range: 0-7.2/1K. Repetitive dive profiles of a similar nature can have risks 10-100 times higher.

Divers Alert Network (DAN), Hyperbaric Center, Duke University Medical Centre, Durham, N.C. 27710, U.S.A.

DEEP DIVING

Long term neurological health effects of deep diving
Todnem K, Nyland H, Riise T, Skeidsvoll H and Aarli J.A.*Undersea Biomed Res* 1989; 16 (Supp): 38

Thirty four deep divers, mean age 32.6 (24 - 42) years were examined one to seven years after their last deep dive. Each had had one to four deep dives, mean depth 368 (190 - 500) msw. The breathing gas was heliox; in one dive heliox/trimix. In addition to the deep diving, their mean diving experience was 10 (0 - 20) years, with a mean of 482 (0 - 1610) days of air diving and 319 (0 - 700) days in saturation. The control group consisted of 74 men, mean age 32.8 (20 - 46) years, who never dived. The protocol included a clinical interview, a neurological examination and electroencephalography (EEG). Twenty divers had been treated for decompression sickness, seven had been unconscious in connection with diving, six had had focal cerebral symptoms, and five had had spinal symptoms. Twelve divers had quit diving. Nine divers reported previous neurological symptoms, as compared to three in the control group ($p<0.002$). Four divers had episodes of cerebral functional disturbances ($p<0.009$); two of them had seizures, one had transitory cerebral ischemia and one had had an episode of transitory global amnesia. In addition, the divers reported more symptoms from the central nervous system ($p<0.003$), the autonomic nervous system ($p<0.007$), and the peripheral nervous system ($p<0.007$). They also have more abnormal findings from the sensory system ($p<0.045$) and co-ordination disturbances ($p<0.038$). There was no significant difference in the findings from cranial nerves ($p=0.4$) and the motor system ($p=0.4$). 17.5 per cent ($p=0.69$) of the divers and 5.4% of the controls had an abnormal EEG, which is not statistically significant.

Department of Neurology and Section for Medical Informatics and Statistics, University Hospital of Bergen, 5021 Haukeland Hospital, Bergen, Norway.

HYPERBARIC OXYGEN THERAPY

Predictive value of TCPO$_2$ measurements in HBO for prescribing HBO therapy in chronic vascular wound.
Wattel FE, Mathieu D and Coget JM. *Undersea Biomed Res* 1989; 16 (Supp): 23

Many non healing tissues are hypoxic. In such an environment, the normal wound healing sequence is disrupted. The adjunctive use of HBO can provide the substrate necessary to initiate and sustain the healing process. But unfortunately, specific oxygen dose requirements for individual patients have not been defined. We undertook a study to evaluate the usefulness of transcutaneous oxygen measurements (TcPO2) at different oxygen pressures in chronic vascular wound management.

During a twelve month period, 20 patients were included (chronic arterial insufficiency ulcers in 9 cases, diabetic foot lesions in 11 cases). TcPO2 measurements were taken in three succcessive conditions: patients breathing at first normal air, then normobaric pure oxygen and, at last, 2.5 ATA hyperbaric pure oxygen. HBO thereapy, initiated twice a day, consisted of pure oxygen 2.5 ATA, 90 min. Complete healing was observed in 15 of 20 cases (average length of HBO sessions: 46).

The distal TcPO$_2$ value at 2.5 ATA pure oxygen is a reliable test to predict final outcome (healing or no change), when these values were not different in normal air and in normobaric oxygen.

Distal TcPO$_2$	**Healing**		**No Change**
Air	32 ± 31	NS	12 ± 4
1 ATA O$_2$	75 ± 70	NS	18 ± 10
2.5 ATA O$_2$	635 ± 388	p = 0,003	45 ± 20

In hyperbaric oxygen when the distal TcPO$_2$ value is less than 100 mm Hg, all patients showed either improvement or aggravation, and when the value is higher than 100 mm Hg, wound healing is achieved with all patients.

C.R.O.H.B. Hôpital Calmette, Centre Hospitalo-Universitaire, Bd du Professeur Leclercq, 59037 Lille Cédex, France.

The use of hyperbaric oxygen for the treatment of aseptic bone necrosis: a case study.
Neubauer RA , Kagan RL and Gottlieb SF. *Undersea Biomed Res* 1989; 16 (Supp): 23

Although indigenous to divers as a late sequel of decompression illness with no apparent temporal relationship, aseptic bone necrosis (ABN) also has been reported as an idiopathic condition, a consequence of various diseases, and a complication of various physical and chemical therapeutic procedures. The case presentation is that of a white male, age 41, with aseptic necrosis of the right hip and pain in the hips and right shoulder. Pain began in April 1986, and disability progressed to the need for crutches. Ten years previously he had Type I DCI resulting from a 65-70 foot dive. As a teenager he had large doses of steroids for a platelet dysfunction. Diagnosis was corroborated by orthopedic evaluation, x-rays, bone scans, and magnetic resonance imaging (MRI). Hip replacement was imminent, but the patient selected hyperbaric oxygen therapy in lieu of surgery. He received 108 treatments (2.2-2.4 ATA, 90 minutes each). All symptomatic evidence of the disease disappeared and has not returned to date, approximately one year after the last treatment. The patient is back jogging, scuba diving, and coaching track while still practicing law. This is the first case when evidence of clinical improvement was substantiated by MRI. It is recommended that prolonged and intensive HBOT be considered as a logical, safe, effective, non-invasive, and cost saving approach to the treatment of ABN.

Clinical Baromedical Center, Lauderdale-by-the-Sea, Florida 33308, and Department of Biological Sciences, University of South Alabama, Mobile, AL 36688, U.S.A.

Hyperbaric oxygen as an adjuvant in penile re-implantation: a case report.

McGough EK, Gallagher TJ, Hart J and Plumley D. *Undersea Biomed Res* 1989; 16 (Supp): 80

Hyperbaric oxygen therapy (HBO) has been recommended for the treatment of ischemic tissue and various grafts. The use of HBO as an adjuvant therapy for surgical re-implantation of an amputated penis has not been previously described. A 29 year old man with a self-inflicted, penile amputation was transferred to the University of Florida. The penis had been amputated, with a pocket knife, approximately 2 cm from the base. Five hours after the amputation, a microvascular re-anastomosis was started. At the completion of surgery, the penis was dusky and viability was considered marginal. A continuous epidural anesthetic was maintained for three days to provide a sympathectomy and to increase blood flow, which had a minimal affect on the appearance of the penis. On the first post-operative day, HBO, using a modified US Navy Table 5 twice a day, was started for a total of ten treatments. After two days, the tip of the penis became pink and sensation to light touch developed. Over the next several days, the skin on the shaft of the penis necrosed, which required two skin grafts, but the remainder of the penis remained viable. Five months after treatment, the patient had normal voiding and erection. Because of the reported poor survival of penile grafts and the importance of re-attachment, any therapy that increases graft survival is indicated. Of 47 reports of penile re-implantation in the English literature, none have reported the use of HBO or sympathectomy as adjuvant therapy. Continuous epidural sympathetic block improves arterial profusion and HBO improves oxygenation, reduces, edema, and enhances vascular regeneration.

Depts of Anesthesiology (Div. of Critical. Care Med.), Surgery, and Urology, University of Florida, College of Medicine, and Jerome Johns Hyperbaric Facility, Shands Teaching Hospital at University of Florida, Gainesville, FL 32610-0254, U.S.A.

Hyperbaric oxygen therapy in burn patients with adult respiratory distress syndrome.

Ray Carolyn S, Green B and Cianci P. *Undersea Biomed Res* 1989; 16 (Supp): 81

Hyperbaric oxygen (HBO) is currently utilized as adjunctive therapy for thermal burns. Pulmonary capillary endothelial and alveolar epithelial damage can be toxic manifestations of high inspired oxygen pressures. In inhalation injuries with an associated capillary leak syndrome, HBO could enhance lung tissue injury.

Of 18 patients with a mean burn of 55%, 14 survived. Ten patients received HBO, eight did not. Five HBO and 5 non-HBO treated patients were on ventilators. There were no significant differences in the treated vs. non-treated group in age, per cent of burn, number of days hospitalized, maximum oxygen concentration, average FIO2 or outcome. Nine of the 18 patients developed ARDS. Four of these 9 patients received hyperbaric therapy with only one death. Of the five patients not treated with hyperbaric therapy, two died.

HBO did not adversely affect either the total group or the higher risk group of patients with ARDS. HBO may have improved survival and decreased the length of mechanical ventilation in the group with ARDS.

Departments of Pulmonary Medicine, Hyperbaric Medicine, and Burn Center, Brookside Hospital, San Pablo, CA, U.S.A.

RECALL BULLETIN

US DIVERS REGULATORS AND ORCA DELPHI

US Divers has extended the recall of their SE2 and Conshelf Sea Supreme, 21 Supreme and Pro Diver regulators to those sold, serviced or overhauled since July 1, 1988.

Orca Industries has announced the voluntary recall of their Delphi models using the 3.0 software. While testing the Pro model at Duke University they noticed that in the decompression mode the depth indication was "off by up to 17 feet shallow or 25 feet deep." *Version 3.0 should not be used in decompression diving.*

"Version 3.0 falls in the serial number range 6500 to 8785, and some lower mumbers which were dated August 9 to November 16, 1990. To determine if your Delphi has version 3.0, turn the unit on and wait for the second display screen to appear. The depth display area in the center will show the software number." If your unit has 3.0 return it to Department 30, Orca Industires, Inc., 10 Airport Way, Toughkenamon, PA 19374 for a free correction. Please include your present shipping address and phone number in the package.

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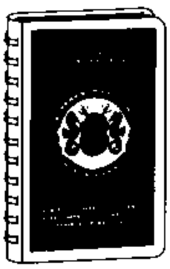

MEETINGS AND COURSES

NEW ZEALAND CHAPTER OF SPUMS CONFERENCE AND ANNUAL GENERAL MEETING WHITIANGA , FRIDAY APRIL 19th TO SUNDAY APRIL 21st 1991

Plans are well underway for this meeting. There is a wide range of accommodation available and plety of alternative activities, sailing, fishing, golf and sightseeing. Diving will be at the Mercuries and Goat Island.

The conference organiser is
Dr Carol McAllum,
Postal Delivery Centre, Ngunguru, Via Whangarei.
Telephone (089) 434 3202

SPUMS ANNUAL SCIENTIFIC MEETING AND ANNUAL GENERAL MEETING 1991

WILL BE HELD AT THE
KARUMBA VILLAGE RESORT, MALDIVES
FROM JUNE 1ST TO 8TH.

The guest speaker will be Dr Glen Egstrom, who was the first SPUMS ASM guest speaker in 1978. The theme will be

"DIVER EQUIPMENT AND
THE DIVER-EQUIPMENT INTERFACE".

The programme for the meeting appears on pages 42 and 43.

The ASM convener is Dr Des Gorman, RNZN Hyperbaric Medicine Unit, HMNZS PHILOMEL, Devonport, Auckland, New Zealand.

Prices for travel and seven nights, share twin, at Kurumba Village Resort are $1,880.00 from Adelaide, Brisbane, Melbourne and Sydney and $1,750 from Perth. Breakfast and dinner daily is included in the price. Diving, two dives a day for five days, will be available for $385.00 which includes hire of boats, tanks and weights.

Ttravel arrangements are in the hands of
Allways Travel,
168 High Street,
Ashburton,
Victoria 3147, Australia.
Phone (03) 885 8818
Fax (03) 885 1164

THE UNDERSEA AND HYPERBARIC MEDICAL SOCIETY ANNUAL SCIENTIFIC MEETING
19-23 June 1991.
San Diego, California

The Undersea and Hyperbaric Medical Society (UHMS) will hold its 1991 Annual Scientific Meeting at the San Diego Princess Hotel, San Diego, California from 19-23 June 1991.

In addition, there will be a one day "Cardiovascular fitness to Dive" course on 19 June for the particular benefit of HSE approved doctors who are not resident in the United Kingdom. Dr. David Elliott of Biomedical Seminars, London, England will be the director of the course.

THE FIRST WORLD CONGRESS ON WILDERNESS MEDICINE
July 14th-19th 1991
MEDICINE AND THE SPIRIT OF ADVENTURE

Seventh Annual Scientific Meeting of the Wilderness Medical Society
Whistler, British Columbia, Canada

There will be three sessions on the World status of Wilderness medicine
Monday July 15th
Mountaineering and environmental stresses
Tuesday July 16th
Aquatic Medicine and environmental stresses
Thursday July 18th
Delivery of services including Search and Rescue and Emergency Care

For further information contact
Wilderness Medical Society
PO Box 460635,
Aurora, CO 80046,
U.S.A.

The Journal has two copies of the brochure and application form.

PROPOSED CIRIA INTERNATIONAL CONFERENCE: ENGINEERING AND HEALTH IN COMPRESSED AIR WORK

Provisional date September 1992

For further information contact

Mr F M Jardine, Research Manager, CIRIA
6 Storey's Gate, London, SWLP 3AU, U.K.

DIVING MEDICAL CENTRE COURSES
SCUBA DIVING MEDICAL EXAMINATIONS

A course will be conducted to instruct medical practitioner in diving Medicine, sufficient to meet the new Queensland Government requirements for **Recreational** Scuba Diver assessments, at

Sunshine Coast, Queensland
April 26th to 28th 1991.

For further details contact
DIVING MEDICAL CENTRE,
132 Yallambee Road,
Jindalee, Queensland 4047
Phone (07) 376 1414

ROYAL ADELAIDE HOSPITAL HYPERBARIC MEDICINE UNIT

COURSES IN DIVING AND HYPERBARIC MEDICINE

November 1991

Basic Course in Diving Medicine

Content

Concentrates on the assessment of fitness of candidates for diving. HSE-approved course.

Venue

Royal Adelaide Hospital

Date

11th to 15th November 1991

Cost

$A 500.00

Advanced Course in Diving and Hyperbaric Medicine

Content

Discusses the diving-related, and other emergency indications for hyperbaric therapy.

Venue

Royal Adelaide Hospital

Date

18th to 22nd November 1991

Cost

$A 500.00
$A 800.00 for both courses

For further information or to enrol contact

Royal Adelaide Hospital Courses,
Dr John Williamson, Director, HMU,
Royal Adelaide Hospital, North Terrace
South Australia, 5000.

Telephone Australia 08-224 5116
Overseas 61-8-224 5116