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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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Abbreviations do not mean the same to all readers. To avoid confusion they should only be used after they have appeared in brackets after the complete expression, e.g. decompression sickness (DCS) can thereafter be referred to as DCS.

Original articles should include a title page, giving the title of the paper and the first names and surnames of the authors, an abstract of no more than 200 words and be subdivided into Introduction, Methods, Results, Discussion and References. After the references the authors should provide their initials and surnames, their qualifications, and the positions held when doing the work being reported. One author should be identified as correspondent for the Editor and for readers of the Journal. The full current postal address of each author, with the telephone and facsimile numbers of the corresponding author, should be supplied with the contribution. No more than 20 references per major article will be accepted. Acknowledgements should be brief. Preferred length is 2500 words or less. Inclusion of more than 5 authors requires justification.

Abstracts are also required for all case reports and reviews. Letters to the Editor should not exceed 400 words (including references which should be limited to 5 per letter). Accuracy of the references is the responsibility of authors.

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

Computer compatibility

The SPUMS Journal is composed on a Macintosh using Microsoft Word and PageMaker. Contributions on Macintosh discs, 400 or 800 k, preferably in Microsoft Word 3, or in any programme which can be read as "text" by Microsoft Word 3, save typing time. They must be accompanied by hard copy set out as in **Minimum Requirements for Manuscripts** above.

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Any report of experimental investigation on human subjects must contain evidence of informed consent by the subjects and of approval by the relevant institutional ethical committee.

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GLEANINGS FROM MEDICAL JOURNALS

COURSES AND CONFERENCES

THE MARINE STINGER HOTLINE

AUSTRALIA WIDE TOLL FREE NUMBER 008-079-909

For advice about the treatment of marine stinger injuries dial **008-079-909**.

DIVER EMERGENCY SERVICE
008-088200

The DES number **008-088-200** can only be used in Australia.
For access to the same service from outside Australia ring ISD **61-8-223-2855**.

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

We publish our first leading article in this issue. It is of course a moot point whether a guest editorial should be called a leading article. Either is a good way of drawing attention to a subject of importance, in this case the continued well being of the Diving Emergency Service (DES). The origins of DES go back many years before it became reality. The service based in the Royal Adelaide Hospital, with its dedicated toll free line and its mobile telephone and beeper for the duty doctor, providing almost instantaneous contact is a vast improvement on the early DES which was hampered by lack of funds and lack of equipment. It is up to the diving community, and almost all SPUMS members belong to that, to see that funds are raised for, and paid over to, DES. A first class service cannot be provided without sufficient money, suitable equipment and the time of committed workers.

In the original articles we get an insight into the equipment that Queensland divers own and do not own. By the standards of divers in the colder States they seem to manage without many of the items that are taken for granted in the South. Diving tables are in again, this time the DCIEM tables and their development. According to one UHMS member presenting a paper at the UHMS 1989 meeting there had not been one case of decompression sickness (DCS) in 40,000 Canadian dives where the tables had been properly used. That claim, if confirmed, would put them at the top of the league of tables. Diving accidents reported to the Queensland Dive Tourism Association association of Australia (QDTAA) are given a brief airing. QDTAA deserves great credit for being willing to collect accident statistics and even more for actually persuading dive shops and dive boats to pass on the incidents. There is an air of unreality in the classification system used by QDTAA, for, regardless of the outcome which in some cases was death, non-scuba accidents are all classified as minor !

Two diving lawyers present a paper on what divers should be told about foramen ovale. They promise another paper on the doctor's duty to the budding diver. So it is time to read up on the literature and have your arguments ready to support whatever view you take of the need to explain the risks to the diver candidate. While patent foramen ovale may make decompression sickness worse by letting bubbles into the arterial system and producing cerebral symptoms, would it matter if there were no bubbles to let through ? Probably not, so it is only a problem for those who generate bubbles. While people write about "unexpected DCS" meaning being inside safe depth/time envelopes they never mention the really major stress that makes divers bubble, rapid ascent rates. We will have to work out an adequate explanation for trainee divers to assess the risks for themselves, which means we have to know the risks. At present much more is unknown than is known about the risks to the intelligent, sensible, reasonable diver so what are we, who are all such divers, to say ? One might say "You tell me".

The Executive Committee has taken to the telephone conference (teleconference) like divers to the water. Readers can have an insight into how the Society is run and to its problems by reading the minutes of the last two meetings. A society is only as good as the efforts put into running it and producing its services. There have been very few new faces on the committee over the years, people come and go, but most of the comers have also been goers. One does not have to be an expert in underwater medicine to serve SPUMS. But one does need to be willing to work and learn. With this issue is the nomination form for next year's committee. Seldom are there more than enough candidates for the vacancy. While this holds costs down, by avoiding a postal ballot, it means that the Executive becomes a self-perpetuating oligarchy with only the old boy network for recruiting replacements. Will 1991 be the year of the ballots ?

For those who are interested in resuscitation in emergencies, and that should be every reader, we publish an index of the Australian Resuscitation Council's policy statements. When it comes to teaching resuscitation it is sensible to teach the official Australian method in Australia.

The papers from the AGM owe their choice to being ready for publication rather than deliberatedesign. However accident has produced an interesting blend of present, past, clinical discussion, doubts and finally there is a boost for the DCIEM tables in the treatment statistics of dysbaric illness from New Zealand.

From other journals we get a practical view of the problems of the British Sub-Aqua Club divers in 1989 who provided some of the stimulus for the DMAC report published earlier this year. After a break we again have letters to the Editor to stir the blood and have the fur flying about the DMAC report. Given the appalling stories from "Diver" reminding divers about basic safety seems sensible, even if it did offend some British divers. We also get information on how to achieve a neutrally buoyant ascent, on when to fly after diving, and a consensus on ascents from the USA. "Diver" magazine provides the story of a diving demand valve patented in 1838. From the 1988 EUBS meeting we have a paper on Danish trainee divers' ear barotrauma. An American paper draws attention to the amazing ability of divers to ignore the evidence and believe that they do not have DCS. Interesting abstracts from the UHMS 1989 meeting round off an intellectual meal.

As we go to press the decision has been made that the costs of the Science Centre Foundation's services are beyond the Society's pocket and that SPUMS' permanent address will be C/o The Australian College of Occupational Medicine. This is a logical choice as diving medicine is a part of occupational medicine. The address is P.O.Box 2090, St Kilda West, Victoria 3182, Australia.

LEADING ARTICLE

DIVING EMERGENCY SERVICE

Introduction

The Diving Emergency Service (DES) is a telephone advice service available to divers in Australia (toll-free) and the South Pacific region (costs borne by the caller), in the event of a diving accident. A similar system, the Divers Alert Network (DAN), has been operating in the United States of America for several years. Both provide advice over the telephone and both advise on transport to a hyperbaric facility if this is needed.

There are more problems in organising help for divers in Australia and the South Pacific than there are in North America and Europe because of the distance between hyperbaric facilities in Australia and the remoteness of many of the diving localities in the South Pacific.

Origins

DES began as an Australian Underwater Federation (AUF) initiative during 1984. At their request the Minister of Defence committed the Royal Australian Navy (RAN) School of Underwater Medicine (SUM), at HMAS PENGUIN, to providing a 24 hour contact point for diving accident advice which was given by the duty medical officers of RAN SUM. SPUMS publicised this service with a poster, distributed to all hospitals and ambulance services in Australia, giving adviceon first-aid for diving accidents and the number to ring for expert advice.

The initial DES was not toll-free and consequently it ended up serving mainly the Sydney metropolitan area.

The Present

Problems with contacting the RAN SUM medical officers, due to changes in the Navy's telephone exchange manning, the establishment of the Royal Adelaide Hospital (RAH) Hyperbaric Medicine Unit with financial support from the National Safety Council of Australia (Victorian Division) and the support of the Federal Ministers of Defence and Health, enabled the establishment of a truly national DES providing a toll-free number (008-088-200). This is manned 24 hours a day and gives divers access to expert advice from doctors experienced in diving medicine.

The financial collapse of the National Safety Council of Australia (Victorian Division) threatened the survival of DES but the recreational diving industry (including FAUI, NAUI, PADI and SSI) rallied to its support and provided money to keep it going. SPUMS contributed $ 500 when it was most needed, and various SPUMS members also contributed individual donations. The AUF and the Commonwealth Department of Health also contribute to the running costs. The Diving Industry Travel Association of Australia (DITAA) assists DES by providing a promotional stand at its yearly exhibition, SCUBA EXPO. Telecom Australia has also supported DES in a most practical way by donating a mobile telephone.

Besides providing telephone advice DES is now involved in collecting accident and incident statistics and publishes a newsletter. "Divesafe" is available for an annual subscription of $ 5.00. Write to "Divesafe", C/o PO Box 400, GPO Adelaide, South Australia 5001.

Contacting DES

DES is based at the Royal Adelaide Hospital Hyperbaric Medicine Unit. Originally the toll-free telephone rang in the RAH Intensive Care Unit (ICU). Now the toll-free telephone contact is located at the St John's Ambulance Communications Centre in Adelaide. This has enabled DES to increase the efficiency of its service and reduce delays in contacting the duty DES doctor, who carries a special beeper and a mobile phone. Calls on the toll-free number (008-088-200) are diverted to the mobile phone and the duty DES doctor can immediately speak to the caller and give advice. Emergency advice on diving accident management includes the likely diagnosis, the necessary first-aid and, when necessary, how to arrange retrieval to a hyperbaric facility.

Calls from outside Australia (user pays number 61-8-223 2855) are still answered by the nursing staff in the RAH Intensive Care Unit. This is an international medical retrieval number for South Australia. There is a set protocol for diving emergencies which allows the staff of the ICU to provide first-aid advice while they contact the DES duty doctor. If the situation can be handled by advice alone this is done, otherwise the DES duty doctor arranges retrieval for the diving casualty. This is not a cheap procedure and appropriate insurance is advised for all divers.

While DES is available 24 hours a day for emergency calls on the toll-free number, information of a non-urgent nature may be obtained from the Hyperbaric Medicine Unit, Royal Adelaide Hospital by telephoning 08-224 5116 during business hours. Advice is also available from the caller's local hyperbaric medicine unit.

Workload

In the year following its official launch, on July 4th 1986, by the then Federal Minister of Health, Dr Neal Blewett, DES was involved in the management of more than 120 diving accidents. This doubled in 1987-88 and in 1989 more than 1,000 contacts were made. Calls came from as far away as the Sultanate of Oman and from Brazil. During this time the Commonwealth Department of Health has increased the efficiency of the service by funding an up-grade of the telephone system and by supplying pamphlets advertising DES in different languages.

There is a seasonal variation in the number of phone calls received. The winter sees a marked reduction in calls from the southern States. A record of calls has been published.[1] Some of the urgent incoming calls require several outgoing calls before the matter is successfully resolved. Approximately 40% of the incoming telephone calls are non-urgent.

Retrievals

Medical retrieval networks are co-ordinated by the ambulance or retrieval services in each State. In general, retrieval for diving accidents consist of what are known as "hospital to hospital transfers". Unless the casualty is within a short distance of a hyperbaric unit the casualty is taken to the nearest hospital for primary treatment before retrieval to a hyperbaric unit.

When a diving casualty, who requires recompression treatment, is remote from a hyperbaric unit road ambulance transport is not acceptable where distances are great or the road rises to 300 m above sea level (this will involve decompression of the casualty and is very likely to worsen his condition). In these circumstances pressure controlled retrieval by aircraft is indicated.

The overall service

The service available to Australian diving casualties consist of DES as an emergency advisory service, the various ambulance or retrieval services which organise and control the retrievals and the various participating hyperbaric units which provide the treatment.

These combined resources have, in Australia and elsewhere, already significantly reduced the morbidity and mortality arising from diving accidents.

How does DES benefit the diver ?

The present national system ensures that a diving casualty is only a free phone call away from advice and help 24 hours a day, seven days a week, every day of the year.

There have been recent suggestions that the States should set up their own diving emergency service to provide services for each State. Duplication of the existing national, and international, DES in the States would be be counter-productive, economically unsound (splitting the available resources) and, as a result of under-funding, detrimental to the diving community. Although the hyperbaric units in Australia are among the best in the world, obtaining adequate expert staff is a problem for all of them. Doctors appropriately trained in treating divers, who also have expertise in intensive care, resuscitation, anaesthesia, medical evacuation and retrieval are few in Australia. This is the expertise needed to run a successful DES.

The essential part of DES is the 24 hour, seven days a week, 365 days a year medical cover provided by doctors trained in diving and hyperbaric medicine. Without this medical cover for emergencies the service would be inadequate and not offer the essential rapid access to expert advice. At present the Royal Adelaide Hospital Hyperbaric Medicine Unit is the only unit that has sufficient appropriately trained staff to be able to provide such cover for a diving emergencies.

The Future

It is proposed to link DES with the New Zealand equivalent in the near future and it is hoped that this international co-operation will soon include DAN in the United States. The first result of this will be a shared, and vastly enlarged, data base of diving accident reports and of treatments and their results. From this should come improved treatment protocols as the results ofvarious treatments will be easier to identify in a large series. At present no one unit is treating enough decompression illness for its results to be statistically valid in a reasonable length of time.

Chris Acott,
FFARACS, DD&HM,
Hyperbaric Medicine Unit,
Department of Anaesthesia and Intensive Care,
Royal Adelaide Hospital.

Reference

1 Diver Emergency Service calls received by the Royal Adelaide Hospital. *SPUMS J* 1989; 19 (4): 196-7

ORIGINAL ARTICLES

KITTING UP: AN EQUIPMENT PROFILE OF QUEENSLAND DIVERS

Jeffrey Wilks

Abstract

Under new Queensland legislation divers are now required to have certain pieces of equipment before they are permitted to dive in commercial settings. To gain some idea of how this legislation might impact on current diving practices the present study asked certified divers to report on the equipment they currently owned and also equipment they would like to own. Results showed that a majority of divers own what could be described as the basics, mask, snorkel, fins. Less than 50% of the sample owned the main safety items specified under the new legislation. There were also considerable sex differences within the sample, with male divers owning significantly more equipment than females. Possible implications of these findings for continuing education, retail marketing and diver dropout are discussed.

Introduction

Recent government legislation in Queensland has attempted to formalise some aspects of diver safety by insisting that divers possess certain pieces of equipment.[1] On commercial charters dive supervisors now have a legal responsibility to ensure that divers have the following, mask, snorkel, fins, regulator fitted with an alternate air source, submersible pressure gauge (SPG), depth gauge and timer, buoyancy control device (BCD), power inflator, and tank (Regulation 262(c), p. 98).

While many commercial operators have quickly complied with these new regulations and purchased additional equipment (especially octopus regulators, contents gauges and timing devices), there is still no baseline information available to assess the implication of these safety measures for recreational divers.

To address this problem the present study asked certified divers to report on the equipment they currently owned, and the types of equipment they would like to own. Of particular interest was the ownership (or intended purchase) of equipment legally required under the new Queensland legislation.

Information on equipment ownership is also important to manufacturers for planning market strategies. One specific item of gear, the dive computer, is not legally required but was included in the present study to assess its popularity. Pilot studies had revealed that many certified divers are unable to use their dive tables correctly[2] so the possibility that significant numbers might be changing to computers was examined. Overseas studies have identified lack of equipment as a factor in diver dropout.[3] A similar situation appears to exist in Australia, with just over a third of certified divers who have dropped out of the sport citing lack of equipment as a contributing factor.

The intention of the present study was to obtain an accurate profile of the equipment owned by "active" divers so that relationships between safety, marketing and scuba promotion could be addressed. Active divers are defined as those who dive at least once a year. The definition follows those used in the most recent international studies. For example, "at least once a year" by McCarthy[3] and "have been diving in the preceding 12 months" by Diagnostic Research.[4]

Sampling

A random sample of 1,500 certified divers (900 males, 600 females) 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 1,373 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.

A total of 1,565 questionnaires was mailed to certified divers throughout Queensland in September 1989. 287 were returned unopened as divers had left their previous address. From the 1,275 remaining, 380 completed questionnaires were returned. This represents a 29.7% return rate for the study. This return rate compares favourably with other recreational diving studies. For example, Somers[5] mailed 7,546 questionnaires to divers in the United States and received only a 16.5% return. Australian industry studies have also experienced low return rates, 40% by the Centre for Studies in Travel and Tourism[6] and 25% from the Diving Industry and Travel Association of Australia.[7] Without extensive, and expensive, mail and telephone follow-ups[8] the present rate of return appears robust, especially as the study was designed to investigate relationships between variables and not estimate population parameters.

Subjects

Of the 380 completed returns in the study, 285 were from active divers and 95 were from subjects who reported

TABLE 1.

DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLE: PERCENTAGE OF RESPONDENTS BY SEX

Characteristic	**Males**	**Females**	**All Respondents**
Mean Age (in years)	28.7	27.8	28.4
Age Range (in years)	14-60	15-58	14-60
Occupation			
Professional	21	38	28
Managerial	9	3	7
White Collar	12	19	15
Skilled Manual	23	1	14
Semi-skilled Manual	10	4	7
Unskilled Manual	9	7	8
Tertiary Students	7	13	9
High School Students	8	6	7
Home Duties	0	9	4
Unemployed	1	1	1
Family Status			
Single (not married)	65	69	66
Parents	24	25	25
Time Since Certification (months)			
0-12	5	6	6
13-24	25	29	26
25-36	34	31	33
37-48	15	15	15
>49	20	19	20
Amount of diving done from commercial charter boats			
None	14	9	12
Less than half	29	23	26
More than 90%	54	63	60
Total number of divers	**177**	**108**	**285**

that they had not dived since gaining their open water certification. Details of the "diving dropouts" are to be presented in a separate report. Characteristics of the active divers in this study are presented in Table 1.

As can be seen from Table 1, subjects had an average age of 28 years, with a range from 14 to 60 years. Based on scales of occupational status developed at the Australian National University[9] the sample represents a full range of employment categories. Sixty-six percent of the sample were single and 25% were parents. Overall, the characteristics of this sample compare well with profiles of active divers in other studies. For example, a 1979 national profile in the United States showed divers to have a median age of 28 years and to be predominantly employed in management, technical and professional positions.[10]

Table 1 also presents details of time periods since subjects received their openwater certification. Most subjects (74%) had been certified for between one and four years. The proportions for males and females are very similar. Finally, Table 1 shows that the majority of divers surveyed do most of their diving from commercial charter boats and therefore would be subject to the equipment requirements set out under Queensland legislation.

Questionnaire

The questionnaire used in this study was developed from international literature[3,5], NAUI and PADI openwater training manuals[11,12], and through extensive consultation with local instructors. A draft schedule was pilot tested with

TABLE 2.

DIVING EQUIPMENT CURRENTLY OWNED: PERCENTAGE OF RESPONDENTS BY SEX

Equipment	Males	Females	All Respondents	
Mask	94	95	94	
Snorkel	93	95	94	
Log book	90	92	91	
Fins	92	87	90	
Dive tables	89	85	87	
Boots	79	67	74	+
Gloves	77	69	74	
Wet suit	82	59	73	**
Underwater watch	75	58	69	*
Weight belt	75	57	68	*
Gear bag	74	54	66	**
Dive knife	72	35	58	**
Buoyancy compensator	55	44	51	
Regulator	54	41	49	+
Depth guage	54	38	48	+
Underwater torch	53	39	48	+
Submersible pressure guage	50	41	46	
Tank	42	30	37	+
Power inflator	42	29	37	+
Octopus regulator	41	28	36	+
Compass	41	27	35	+
Slate and pencil	34	21	29	+
Hood	37	10	27	**
Diver's flag	27	19	24	
Underwater camera	17	14	16	
Dive computer	6	4	5	

** $p < .001$; * $p < .01$; + $p < .05$

four instructors, four divemasters, four advanced divers and four open water divers. Some questions were deleted and others rewritten for clarification following the pilot study.

The final nine page questionnaire examined diving activities under the headings of history, travel, training, equipment, dive tables and personal experiences. For the equipment questions subjects were presented with a 26 item check-list. They were asked to indicate the kind of diving equipment they currently owned by placing a tick in the box next to the piece of equipment. They were then asked to examine the list again and to circle any of the items they would like to own.

Results

Table 2 presents the results for diving equipment currently owned. Most divers reported that they had their own mask, snorkel, fins, log book and dive tables. Just under three quarters of the sample had boots, gloves and a wet suit. Two thirds of the sample owned an underwater watch, weight belt and gear bag; while 58% of respondents reported having a dive knife and 51% a buoyancy compensator. Slightly less than half the sample owned their own regulator, depth gauge, torch or SPG. Just over a third of the respondents owned a tank, power inflator, octopus regulator and compass. Toward the bottom of the list, around a quarter of the sample had a slate and pencil, hood and diver's flag; while 16% reported owning an underwater camera. Finally, only five percent of these certified divers owned a dive computer.

Examination of the equipment owned by males and females reveals some interesting sex differences. Males were significantly more likely than females to have their own boots, wet suit , watch, weight belt, gear bag, knife, regulator, depth gauge, torch, tank, power inflator, octopus regulator, compass, slate and pencil and hood.

Having reported on the equipment they currently owned, subjects then nominated the gear they would like to

TABLE 3.

DIVING EQUIPMENT DESIRED: PERCENTAGE OF RESPONDENTS BY SEX

Equipment	Males	Females	All Respondents	
Underwater camera	52	57	54	
Octopus regulator	33	46	38	+
Buoyancy compensator	34	42	37	
Depth guage	32	45	37	+
Tank	36	35	35	
Regulator	29	38	33	
Submersible pressure guage	25	35	29	
Compass	23	34	27	+
Underwater torch	19	26	21	
Wet suit	14	33	21	**
Dive computer	28	9	21	**
Weight belt	15	28	20	+
Underwater watch	10	30	18	**
Dive knife	14	23	17	+
Power inflator	17	17	17	
Diver's flag	19	12	16	
Slate and pencil	14	17	15	
Boots	7	18	11	*
Gloves	8	15	11	
Gear bag	5	20	11	**
Fins	8	11	9	
Hood	6	6	6	
Mask	6	4	5	
Dive tables	5	6	5	
Snorkel	5	4	5	
Log book	1	1	1	

** $p < .001$; * $p < .01$; + $p < .05$

own. As can be seen in Table 3, the most popular item for intended purchase was an underwater camera. Over half the sample indicated that they would like to own one. Over one third of the divers expressed an interest in having an octopus regulator, a BCD, depth gauge and tank. One third also indicated that they would like a primary regulator. Just over one quarter of the sample showed interest in owning a submersible pressure gauge and compass. Some respondents even wrote on the questionnaire that they intended to buy a combination gauge which included a compass and bottom timer.

Less than one quarter of the respondents indicated a desire to purchase a torch, wet suit, computer, weight belt, watch or dive knife. Of course these figures, and the proportions toward the bottom of the list, are smaller because the majority of divers already own the equipment discussed. However, some of the sex differences that emerged are interesting. Female divers reported owning less equipment than males (see Table 2) and therefore are likely to require gear. Females were significantly more likely than males to express interest in owning a wet suit, watch, gear bag, boots, compass, knife, weight belt, depth gauge and octopus regulator. Males, on the other hand, were more likely to express interest in owning a dive computer.

Discussion

Similar to the findings of overseas studies[3] most Queensland divers surveyed owned basic snorkeling gear (mask, snorkel and fins). Around three quarters of the sample also owned boots, gloves and a wet suit. Even in tropical waters the possibility of hypothermia must be recognised, so it reassuring to note that 94% of the sample either own or are interested to own a wet suit.

Ownership of equipment required by divers under the new Queensland legislation[1] varied considerably. Only half the sample owned a buoyancy compensator (51%) and only slightly more than a third (37%) owned the mandatory power inflator. Similar low rates of ownership were reported for regulators (49%) and octopus regulators (36%). The latter is the most common alternate air source available and meets the new legislative requirements. Interestingly, it became clear from the question on equipment subjects would like to own (and later discussions with divers) that many divers believe an "octopus" to be all the hoses running from the first stage. This is why some divers who do not own a regulator did not express any interest in owning one, but instead indicated that they would like an octopus. A similar misunderstanding seems to exist with the power inflator. Subjects either did not realise it was important (they may have had a vest which did not require one) or they believed it was part of the BCD. Alternatively, some divers may not be familiar with this piece of equipment. While both NAUI and PADI open water manuals discuss equipment in depth, it is clear from these results that some divers are still a little confused.

A majority of the divers in this study reported owning dive tables (87%). In a separate exercise they were asked to use their tables to complete two basic dive profiles. Preliminary analyses showed that most could not correctly complete the profiles.[2] These findings, together with the fact that less than half the sample own a depth gauge (48%) or submersible pressure gauge (46%), raise serious concerns about the possibility of risk for decompression sickness[13] or at least out-of-air emergencies.[14] Admittedly, 69% of the sample do have a timing device (underwater watch) and most dive on charters where a supervisor is available. Even so, analyses of accident reports consistently point to the importance of regular maintenance and familiarity with all equipment as central components of diving safety.[15,16] One way to achieve this is for divers to have their own gear and not rely on rented or borrowed equipment.

One positive finding which relates to the new Queensland legislation[1] is that most divers (91%) owned a log book. Admittedly, most receive a log book automatically with their certification. Regulation 264 (3)(c) requires that each diver keep a record of their dives in a prescribed form (a dive profile) and that these records are signed by the dive supervisor. This provision appear useful in alerting the dive supervisor to potential problems with"pushing the limits" during repetitive dives. As a final point on safety however, it is disappointing to note that only slightly more than one third of the sample owned a compass (35%) and less than one quarter (24%) owned a diver's flag. Again these results may reflect the fact that the sample predominantly dive on commercial vessels where supervision and gear hire are readily available.

Significant sex differences were identified on 15 of the 26 items of equipment owned by divers. In all cases, males owned more equipment than did females. The implication of this finding is that manufacturers and retailers might consider specific marketing strategies directed at the female market. In the United States, for example, the Diving Equipment Manufacturers Association (DEMA) currently run national media campaigns aimed at encouraging women to learn to dive.[17] These campaigns appear to be very successful. The industry as a whole should also be aware of the need to encourage the purchase of gear by both men and women since overseas[3] and unpublished Australian studies have found lack of equipment to be a significant factor in diver dropout. What is not clear , however is whether divers drop out because they cannot afford to purchase or hire equipment, or whether they drop out for other reasons and in retrospect rationalise that they did not have the gear to keep diving anyway. If we wish to retain divers, then this should be one of the priority areas for further research.

When given the option of nominating the type of gear they would like to own, over half the sample chose an underwater camera. This particular interest in underwater photography also emerged in other parts of the research project. Divers were asked to nominate any training courses they would be interested in taking. Underwater photography was a popular choice, in front of the more safety-oriented training programs. In terms of equipment desired, however, safety items such as an octopus regulator, BCD and depth gauge were high on the shopping list of divers in this study (see Table 2). Interestingly, only 21% of the sample expressed interest in owning a dive computer (5% already owned one). Despite the amount of advertising by manufacturers, divers appear hesitant to try this new technology.

When figures from Tables 1 and 2 are combined it becomes clear that divers either own or would like to own most of the equipment discussed. There are, however, pieces of equipment that some divers do not consider are important to own. These include: power inflator (46% of the sample did not own one or express interest in owning one), compass (38%), octopus regulator (26%), SPG (25%), regulator (18%), depth gauge (15%), underwater watch (13%), BCD (12%), dive tables and log book (8% each). Divers were not asked specifically why they did not consider these items important to own. Based on other questions in the study the issue of cost must be given serious consideration. At the same time, divers may not believe that their safety will suffer by not owning this equipment. Another study will address this issue in greater depth.

As previously mentioned, many divers are probably not aware of the new Queensland legislation and the requirements set down for diving in a commercial environment. Hire gear is usually available for divers, but as stressed earlier, there is no substitute for owning and being familiar with one's own equipment. The results of this study point to a need for the industry to emphasise safety aspects of equipment use and maintenance. Preliminary research shows that many certified divers would willingly take a general refresher course if one was offered by their local instructor.[2] While certifying agencies will quickly point out that these refresher courses are currently available, the real need is to market them actively.

Acknowledgements

This study was initiated through a grant from the University College of Central Queensland and supported by Downunder Research. I would like to thank NAUI Australia for access to their confidential records from which the major sample was drawn. Special thanks go to Robert Freitag and his staff at Capricorn Reef Diving, Rockhampton, for their professional assistance throughout the project.

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THE DCIEM SPORT DIVING TABLES

John Lippmann

Historical background

Canadian decompression research began in 1962 in what is now named the Defence and Civil Institute of Environmental Medicine (DCIEM). Kidd and Stubbs set out to develop an instrument which would monitor the diver's depth-time profile, and provide instantaneous decompression information when complicated dive profiles were undertaken, or where wide variations of gas mixtures were used. In these situations, the traditional tabular approach to determine decompression was inadequate.

Initially, their decompression computer was based on the traditional Haldane model in order to duplicate the U.S. Navy 1958 Standard Air Tables. However, parameters were changed and the model was modified until a low incidence of decompression sickness was achieved.

A variety of dives were tested, ranging from fixed depth dives, random depth dives and repetitive dives. Within five years they had developed a fairly successful computer based on 5,000 man-dives.

The final configuration of the computer utilized a "serial model", in which tissue compartments are connected in series instead of the parallel arrangement used by Haldane. The model was again modified in 1970, in order to increase its safety in the 60-90 msw range. The result became known as the KS 1971 Model.

The model was used for some time at DCIEM but a few deficiencies became apparent. One of the problems was that the No-Decompression Limits were much too conservative, in some cases (at shallower depths) being half that of the Royal Navy and U.S. Navy Tables. In other areas the model lacked conservatism so, consequently, more research and modifications became necessary.

The DCIEM model

A very large data-base of decompression information had been accumulated by DCIEM over the years and in order to utilize this information the KS model was chosen as the basis for a new set of air decompression tables. Modifications were made to the KS decompression model and the earlier problems and anomalies existing in the KS model were overcome. This modified model became known as the DCIEM 1983 Decompression Model.

The serial model assumes that the tissue compartments are connected in series. Only the first compartment is exposed to ambient pressure and, as gas builds up in this compartment, it bleeds into the next compartment. In Haldane's model each compartment is exposed to ambient pressure and loads up simultaneously. Each of the four tissue compartments in the DCIEM model has the same half-time, which is approximately 21 minutes. The model utilizes the concept of allowable surfacing supersaturation ratios. Critical ratios of 1.92 and 1.73 are used in the initial two compartments, while the pressure levels in the other compartments are not used to calculate the depth from which a diver can safely ascend.

Features of the DCIEM 1983 model

The DCIEM Model produces decompression times which are more conservative than the U.S. Navy Tables and the decompression profiles have deeper first stops. These tables have been rigorously tested during working dives in cold water. For strenuous dives in cold water, the U.S. Navy procedure is to decompress according to the next longer bottom time. The resulting times are comparable to the DCIEM 1983 times.

The model has been used to generate a complete set of tables, including standard air decompression, repetitive dive procedures, corrections for diving at altitude, in-water oxygen decompression and surface decompression with oxygen.

Testing

The new tables have been extensively tested using the Doppler ultrasonic bubble detector and bends incidence as safety criteria. About 900 man-dives were performed during the validation dive series over a two year period. Because the model was continuous, and because of the large database of both safe and unsafe dives done on the original K.S. model, it seemed unnecessary to test a larger number of depth and bottom time combinations.

During the tests the divers were monitored for bubbles at the precordial site (right ventricle and/or pulmonary artery) and the subclavian sites (both left and right shoulders). At the precordial site, a reading was first taken when the diver stood at rest, and another reading was taken when he performed a deep knee-bend. At the subclavian site, the diver was initially monitored while at rest and then again after clenching his fist on the side being monitored. The Doppler signals were recorded on audio magnetic tape as well as being assessed aurally by experienced technicians.

The bubble signals were classified according to the Kisman-Masurel (KM) code which utilizes three criteria, each on a scale from 0 to 4. (Other systems only use 2 criteria to establish bubble grades). The criteria used were the number of bubbles per cardiac cycle, the percentage of cardiac cycles with bubble signals and the amplitude of the bubble signals relative to the background sounds. The resulting 3-digit code is converted to bubble grades from 0 to 4, resulting in a similar bubble grade to that developed by Spencer (and used to assess the PADI Recreational Dive Planner).

The divers were monitored before the dive(s) and at half-hour intervals for at least two hours after diving. When repetitive dives were undertaken, the divers were monitored between the dives as well as after the second dive.

The test dives were conducted in a hyperbaric chamber, with wet-working divers in cold water at 5-10^{o} C, as well as with dry-resting divers. All dives were done using a real-time on-line decompression computer, following the exact decompression profile as specified by the DCIEM 1983 Decompression Model. The Standard Air Table was tested by 267 man-dives. Fifty-five dives had decompression times shorter than 30 minutes, and 90% of these subjects showed no, or few, detectable bubbles.

Eighty-four no-decompression stop dives were tested with no detectable bubbles resulting. No cases of bends were observed. The remaining 128 dives (66 single dives and 62 repetitive dive pairs) were near, or at, the normal air diving limit with decompression times between 48 and 88 minutes. Eight cases of bends occurred after single dives, and 4 cases occurred after the second dive of a repetitive dive pair. However, some of these incidents were thought to have other contributing causes and may not have been attributable to the dive profiles alone.

No diving tables can be expected to totally eliminate the occurrence of decompression sickness, but the DCIEM Tables are considered by many experts to be much safer than most other published tables. In the period from October 1987, when the DCIEM Sport Diving Tables were first released, to the time of writing, no cases of decompression sickness were reported in divers who had used the tables. They appear to be sound, well-tested tables (i.e. on "rectangular" dives) which should generally be quite suitable for the recreational diver.* However, a diver's individual susceptibility to bends must still be considered when planning the bottom time for a dive.

In the Instructions for Using The DCIEM Sport Diving Tables © 1990, it states:

"The DCIEM air decompression model was tested empirically using a relatively diverse group of human subjects. This takes into consideration certain assumptions about the fitness of the subject. These same considerations apply to divers who use the DCIEM Sport Diving Tables.

It is assumed that:

1 The diver is physically fit, with a good exercise tolerance.
2 The diver is free of any acute or delayed effects of alcohol or drugs of any kind.
3 The diver is not overly fatigued, dehydrated, motion sick, sunburned or otherwise affected in a detrimental way.
4 The diver has no acute illness, especially of a respiratory or musculo-skeletal nature, has had no recent physical trauma and has not recently undergone surgery.
5 The diver has no chronic illnesses such as asthma, high blood pressure, diabetes, epilepsy, inner ear barotrauma or spontaneous pneumothorax.
6 The diver is free of any decompression debt, other than that allowed for or calculated in the DCIEM Sport Diving Tables.

If any of the above apply, or if there is any doubt, do no scuba dive. Seek advice from a physician experienced in hyperbaric medicine.

Acknowledgements

Much of the text of this paper has been taken directly from the literature and reports accompanying the DCIEM Sport Diving Tables (written by Ron Nishi and Gain Wong). The author wishes to thank DCIEM and UDT Inc. for their co-operation and assistance with the preparation of this paper.

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* It is important to realise that no testing was conducted to determine their validity for multi-level diving.

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The above paper is taken from a larger chapter about the DCIEM Tables in a recently released book titled "Deeper Into Diving" by John Lippmann. "Deeper Into Diving" provides an in-depth review of various decompression procedures and of the physiological aspects of deeper diving. It contains more than 600 pages of detailed information and can be obtained from J.L. Publications, P.O. Box 381, Carnegie, Victoria 3163, Australia.

For book review see page 230.

QUEENSLAND DIVING ACCIDENTS

John Knight

July 1988 to June 1989

The Queensland Dive Tourism Association of Australia (QDTAA) has published a Dive Tourism Accident Bulletin which appeared in Neville Coleman's "Underwater Geographic" (ISSN 1032-5212) No 28, pages 72 and 73.

The QDTAA is to be congratulated on providing such a report. Unlike other diving accident reports there is a mention of the number of dives involved (250,000) but unfortunately this is just an estimate of dives carried out in Queensland in the time covered by the report, not a record of the number of dives performed under the auspices of the reporting companies. Minor injuries were probably under reported as 74.1% of the injuries were classified as serious.

In twelve months there were 27 accidents reported by members of the QDTAA, three of which were fatal. Two of these were attributed to drowning (one not on scuba and so classified as a minor accident) and one to cerebral arterial gas embolism (CAGE). The minor accidents reported were divided into non-scuba and minor injuries. Non-scuba included a death (mentioned above) while swimming, facial laceration from a trigger fish, an exploding scuba tank in a dive shop and a person reported lost and later found alive. At least three of these were very major problems for those involved and difficult to classify as minor incidents. Minor injuries were salt water aspiration, a bleeding ear and reverse ear squeeze.

Of the 20 serious accidents while using scuba 80% were decompression sickness (DCS). However the pie chart of major scuba-related accidents shows 10% were drownings and 10% CAGE so presumably one drowning was resuscitated and one CAGE victim survived leaving 16 cases of DCS.

Nearly 50% of the serious diving related accidents occurred off Cairns and over 35% off Townsville. These two centres provide the bases for most dives in Queensland.

Of interest is the fact that females outnumbered males in the ages groups 15-24 (M 2, F 5) and 25-34 (M 2, F 3) but in the age group 35-54 it was the other way round (M 3, F1). But as the numbers are small it is quite possibly due to chance.

July 1989 to June 1990

The QDTAA report for July 1989 to June 1990 is now available. In this year there were 34 accidents, three fatal. One was attributed to drowning while the other two were cardiac, which were classified as minor accidents as they were not related to scuba diving.. 21 of the accidents (62%) were classified as serious.(13 DCS, 3 CAGE and 5 scuba related drowning or near-drowning). Besides the two cardiac deaths there were 11 other minor accidents, mostly salt water aspiration.

The estimate of recreational scuba dives, from regional membership and certification surveys, was about 884,000 dives in the twelve months. There were no statistical differences between the incidence of accidents between the two years.

Young (aged 15-24) and older (35-54) females outnumbered males in the accident statistics, but in the 25-34 age groups males predominated. However with 9 females (43%) to 12 males (57%) females, who are estimated to be about 25% of the Queensland diving population, are over-represented. The report draws attention to the fact that if the two years are combined it seems that females are three times as likely to have a major diving accident (usually DCS) than males. The QDTA is to be congratulated for drawing attention to this and recommending that there is a need for improved diving training for females.

This year the accident winner, if one can use the term, is Townsville with 10 accidents per 100,000 dives, up from just over six last year. This may be due to the fact that the boats that visit the Yongala wreck, which is in deep water, are mostly based in Townsville. Unfortunately no absolute figures for accidents by area are provided this year.

These reports, and an interesting table of the 1989 accidents are available from the Mr David Windsor, Secretary of the Queensland Dive Tourism Association of Australia (Inc.), PO Box 122, Chermside, Queensland 4032, Australia.

Dr John Knight's address is 80 Wellington Parade, East Melbourne, Victoria 3002, Australia

THE DILEMMA OF THE PATENT FORAMEN OVALE

Michael Gatehouse and Tom Wodak

The SPUMS Journal, (Vol 19, No 4) contained two papers dealing with the latent condition, patent foramen ovale, (PFO), one by D.F.Gorman and S.C.Helps[1], and the other by D.Davies.[2] In addition a thought provoking editorial[3] on the subject has prompted the writers to address the legal issues which PFO raises.

First, by way of introduction, we are both practising lawyers and diving instructors, who derive knowledge, inspiration and enjoyment from each edition of the SPUMS Journal.

Several years ago, a group of Victorian lawyers with an interest in diving, formed a group for diving lawyers under the umbrella of the doubtful acronym of CODS. The inspiration for the name of our organization was derived from a passage in one of the early judgments in English law in which the concept of the reasonable man was formulated. In that judgment, the reasonable man was thought to be the man on the Clapham Omnibus. One of the founders of our organization, himself a reasonable man with great perspicacity and an understanding that all diving lawyers were reasonable men, made the inspired suggestion that our organization should be named “Clapham Omnibus Diving Society”. The dual advantage of the title of our organization can be seen from the acronym which if it does not immediately conjure up an image of diving lawyers, at least provokes some association with the water. Without apology, CODS was modeled on, and sought to draw upon the success of, SPUMS although to date its accomplishments have been rather modest.

Both writers were active in the formation of CODS, and have been and remain on its executive. One of the aims in establishing CODS was to provide a forum through which members of the legal profession with an interest in diving could exchange knowledge and discuss issues raising medico-legal aspects of diving and hyperbaric medicine with the SPUMS membership.

PFO presents as a topic of great relevance to diving instructors, the diving industry and those interested in hyperbaric medicine.

An issue which needs to be addressed is the duty owed by the examining doctor to candidates wishing to undertake entry level diving courses. It appears that up to 30% of the population have a PFO and most have no symptoms. Recent studies suggest that individuals with demonstrable interatrial shunts compromise a high proportion of divers exhibiting early neurological decompression sickness (DCS). They also said to constitute a majority of the divers who have DCS of unexpected onset, that is the time/pressure profile of the dive was well within the limits of the table being used.

Our understanding is that the vast majority of persons with PFO are asymptomatic, and exhibit no clinical signs of the condition, which accordingly is likely to go undiagnosed. We understand that diagnosis of an asymptomatic PFO requires performance of a specialised form of echocardiogram which can show blood passing through the patent foramen ovale into the left side of the heart. This is an expensive procedure which, in any event, may identify no greater than 50% of divers with a PFO.

Should a doctor performing a diving medical within the requirements of a particular instructor agency remain silent about the risks associated with PFO? Or should the doctor advise the candidate sufficiently concerning the latent condition to enable him or her to decide whether to undergo echocardiography? Indeed should the diving doctor recommend that the candidate undergo echocardiography?

In the event of a diving fatality following severe DCS complicated by a previously undiagnosed PFO, the diving doctor, who certified the deceased as medically fit to dive, is exposed to the risk of criminal prosecution, disciplinary proceedings before a Medical Board and civil action for damages brought by the deceased’s dependents. The same risks apply if the diver survives.

It is a measure of contemporary social values that the professions are increasingly subject to legal scrutiny including claims for damages whenever and wherever there is a prospect of success. This form of litigation is gaining in popularity in Australia, the trend having drifted, with some encouragement from the legal profession, across the Pacific. Although our legal system has declined to adopt the American standard of “informed consent”, which requires doctors to advise their patients fully and comprehensively of all risks, the Australian medical profession owes a duty of care to its patients. This includes providing advice commensurate with that which a reasonably prudent medical practitioner would give in the particular circumstances.

We do not believe that a diving doctor is under an obligation to recommend that prospective divers undergo echocardiography. However it is our view, having regard to what is now known about PFO, and its potential complications in cases of severe cases of DCS, that the reasonably prudent medical practitioner should, at the very least, alert the prospective diver to the existence of the latent condition, its possible consequences, the diagnostic option and its attendant risks.

It is acknowledged that there are likely to be commercial pressures upon diving doctors, not to provide such advice, or to understate the problem in order not to deter potential divers from embarking upon diving courses. Clearly the issue must be kept in prospective and scare-mongering is inappropriate.

At present it is impracticable, and clearly undesirable, to require all qualified and potential divers to undergo investigation for PFO. However, to do or say nothing will not, in our view, equate with the proper discharge of the diving doctor’s professional duty to exercise the due care, skill and diligence when assessing the medical fitness of the diver or potential diver.

We advocate inclusion in the preamble to the standard diving medical form, or the handing by doctors to candidates for diving medicals, of a notice containing a warning setting out the potential risks of diving with a PFO, and of the difficulties and risks associated with its diagnosis.

The medical knowledge against which the actions of the diving doctor will be measured by the deliberations of a court asked to determine whether a diving doctor acted with due care, skill and diligence, contains sufficient reputable and responsible research and discussion on PFO for the issues we have raised to be given urgent consideration by the medical profession and for appropriate measures to be instituted. We have prepared a further paper about the responsibilitties of doctors who do diving medicals and their duties towards their patients in warning them of the risks involved which we hope will be presented in a later issue of the SPUMS Journal.

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3 Editorial. *SPUMS J* 1989; 19 (4): 149 and 154

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SPUMS NOTICES

MINUTES OF SPUMS EXECUTIVE MEETING (TELECONFERENCE) MONDAY JULY 30, 1990 AT 1800 HOURS EST.

1 **Apologies**

Drs John Knight and Tony Slark.

2 **Minutes of the previous meeting**

The Minutes of the AGM and of the Executive Meetings in Palau were taken to be a true record of those meetings. Proposer Dr C Acott, seconder Dr D Davies.

3 **Business arising from the minutes**

3.1 Future AGM venues.

It was agreed that the Society is committed to The Maldives in 1991, and should return to Palau in 1993.

Discussion regarding the venue for 1992 centred on Port Douglas and in particular the Mirage Resort which would make an excellent venue. The advantage of holding a conference on the Australian mainland was noted. Provided Allways Travel can provide a costing competitive with other venues, it was decided Port Douglas should be the venue for the 1992 AGM.

3.2 Future AGM speakers

Dr Gorman informed the Executive that Dr Glen Egstrom had accepted the Society's invitation to be the Keynote Speaker at the 1991 AGM. Regrettably, the other invited speaker, Dr Peter Bennett, had to decline due to other commitments. It was felt, however, that Glen Egstrom was a speaker of sufficient calibre to ensure an excellent meeting and that his presentations will be well complemented by papers from other recognized authorities attending the conference. The subject is to be "Diving Equipment and the Diver-Equipment Interface".

Discussion turned to the Port Douglas meeting and it was agreed the subject should be"Barrier Reef Marine Ecology". Dr John Williamson was suggested as a Keynote Speaker. Dr Williamson spoke and indicated there is a large number of experts relevant to this topic in North Queensland. Dr Peter Fenner, Dr King, Dr Joe Baker of AIMS and Bob Hartwick were all mentioned. Further, it was suggested that the people of the Great Barrier Reef Marine Park Authority (GBRMPA) would be most interested in having input to the meeting.

Dr Williamson agreed to research the theme and further inform the Executive of developments.

Discussion turned to the 1993 meeting in Palau. It was quickly agreed that an excellent subject would be "Comparative Physiology", and that we should invite Dr Runciman and Dr Russell Baudinette as Keynote Speakers because of their pre-eminence in this field and the great success of previous presentations by Dr Runciman at the 1988 AGM.

With regard to venues for 1994 and 1995, it was decided to await the result of Geoff Skinner's investigations of more exotic venues.

Opinion was sought by the President of each executive member about speakers we should consider for further meetings.

Dr Davies proposed Richard Moon and re-inviting Dr Peter Bennett.

Dr Williamson added Dusty Rhodes of Thailand.

Dr Gorman proposed the Diving Inspector in

Queensland should be amongst the possible list for Port Douglas.

It was resolved that Dr John Williamson will submit a theme to Dr Des Gorman and this will be circularized to the Executive. Dr Gorman will subsequently arrange the meeting as convener.

3.3. Progress of database.

The new application form designed by Mr Des Ireland of the Science Centre Foundation was discussed at length. Most speakers were critical of the form. However, it was agreed that the Science Centre Foundation should be our Society's contact point and that they should keep a complete record of the Society's members on computer. To this end, Dr David Davies and Dr Grahame Barry agreed to redesign the application form which is to be forwarded to the Secretary who will then circularize the Executive before the next meeting.

3.4 Policy statement regarding diving medical examinations.

This was discussed and Dr John Williamson pointed out the importance of the Society making such a statement. Dr Davies agreed, saying we had undertaken to make such a statement and we should do so. He went on to inform the Executive he had written to Dr John Archdeacon of Cairns, asking what he felt should be in such a statement. This followed Dr. Archdeacon's statements at the A.G.M. and the necessity he felt for the matter to be dealt with. Dr Archdeacon has not yet replied to Dr Davies' letter. It was agreed that Dr Des Gorman will draft a statement which will be forwarded to the Secretary to circularize the Executive before the next meeting.

The Executive Committee felt many of Dr Archdeacon's comments at the AGM related to the doctor-patient relationship and were outside the role of the Society.

3.5 Budget and forward planning.

Due to suggestions regarding statutory requirements of South Pacific Underwater Medicine Society Incorporated (SPUMS) following incorporation, Dr Grahame Barry and the Public Officer, Dr John Knight, made enquiries in Victoria. It was found all budgetary and financial planning was being carried out in accordance with such requirements.

The Committee unanimously expressed their appreciation to Dr Grahame Barry for his continued management of the Society's financial affairs, and noted the healthy position SPUMS enjoyed.

3.6 New Letterhead.

The Committee was advised by the Secretary that a new letterhead had been printed with the Society's address as the Science Centre Foundation.

4 **General business**

4.1 Indonesian Joint Meeting.

There had been no further correspondence and it was decided to defer consideration of such a meeting till 1994 or 1995.

4.2 AIDAB.

4.3. Anthony Newly's widow.

After discussion, it was agreed that SPUMS had already written expressing great regret. It was further agreed at this stage not to seek funds on Linda Newly's behalf.

4.4. Constitution.

The Secretary advised under the rules regional branches may only be established in the South Pacific Area. The President was strongly in favour of a North American Chapter. The Committee agreed to do everything possible to encourage Dr Raymond Rogers in the matter. In view of the unanimous support by the Committee for a North American Chapter, it was decided to seek a change of rules, as outlined under Section 37 "Changes of Purpose and Rules" at the next AGM. Pending ratification of the necessary constitutional changes the Secretary was instructed to write conveying the Committee's thoughts, and to suggest a North American Chapter could proceed in an informal manner.

Having already decided to include the office of Education Officer on the Executive Committee, it was decided a ballot on both matters will be conducted at the 1991 AGM. The Editor of the Journal will be asked to give the necessary notices in the SPUMS Journal.

4.5 AGM registration fees.

The Secretary recorded that a number of non-financial people attended the Palau AGM. It seemed unusual practice to allow this, compared with similar scientific meetings. It was agreed that at any future AGM non-members will be required to pay an additional $75.00 registration fee which is to be forwarded to the Treasurer immediately upon receipt by the Society's appointed travel agent.

4.6 Coral Sea Marine Park

The Secretary spoke about the proposal by Valerie Taylor that the North Horn of Osprey and Bougainville Reefs in the Coral Sea should become a marine park. Dr Gorman and the other members of the Executivethought this was a worthy project. The Secretary was instructed to write to Professor J.D. Ovington, Director Australian National Parks And Wildlife Service, G.P.O. Box 636, Canberra ACT, 2601, expressing our support for this concept. A letter of encouragement will also be sent to Valerie Taylor.

The Secretary shall place a letter in the SPUMS Journal, indicating the Committee's support and inviting interested members to write to Professor Ovington expressing their views.

5 **Correspondence**

5.1 A letter has been received from Dr Raymond Rogers expressing his desire to form a North American Chapter.

This matter had already been dealt with.

6 **Other business**

6.1 SPUMS Journal.

Dr John Williamson spoke concerning peer review of papers presented for publication. He indicated his willingness to assist in this. The Committee discussed this and agreed it was time for peer review. Dr Gorman suggested Dr Williamson go ahead and further, co-opt whoever he felt necessary.

6.2 Future Australian Hyperbaric Medicine Society

Dr Williamson spoke of the need for physicians, being actively involved in running hyperbaric facilities, to meet on a regular basis. They represent a very small percentage of the SPUMS membership. He expressed a strong desire not to conflict with SPUMS. Amongst topics needing pursuit were an accident and mortality register in Australia and New Zealand, a consensus on which conditions hyperbaric medicine has a role, and the place of research in hyperbaric medicine, particularly with regard to multicentre trials.

After discussion, the President summarised that the Executive felt this was a good idea, that it should be under the auspices of SPUMS, perhaps as a subcommittee, and that in the meantime, the Executive be kept informed regarding progress.

6.3 New PADI medical format

A request has been received from Ms Brigid Roach, College Programme Co-ordinator, PADI College, Sydney, seeking the opinion of SPUMS, of PADI's new Medical Statement, Participant Record. At the moment, not all members have received a copy of the statement, so discussion was deferred to the next meeting.

6.4 Questionnaire results.

A questionnaire was distributed in Palau by Mrs Inall. It was felt that it had offered no useful information.

6.5 New Queensland Health and Safety Act.

After discussion, it was decided the Secretary should supply, upon request, a list of doctors who are members of SPUMS, who are duly qualified to do diving medical examinations, and do such medical examinations. It is to be noted there are some similarly qualified doctors who do diving medicals who are not members of our Society.

Dr Williamson spoke about the standards SPUMS should provide for diving doctors in Australia and New Zealand, and strongly supported the notion that such doctors should be involved with on-going education, membership of SPUMS being one way of achieving this.

7 **Other business**

7.1 Dr Darryl Wallner advised the Committee of his intention to run a course, under the auspices of SPUMS, at Coffs Harbour, NSW, in February 1991. The Committee supported this initiative. Dr Davies spoke regarding the need for a full statement of accounts. After discussion, it was decided a weekend format would be best, and it was emphasized the meeting should be self-funding.

7.2 Letters from Dr J. Wilks and Dr Peter Sullivan were read and will be dealt with by the Secretary.

There being no further business, the meeting closed at 2115 hrs EST.

John M.P. Robinson
Secretary of SPUMS

MINUTES OF SPUMS EXECUTIVE MEETING (TELECONFERENCE) SUNDAY, SEPTEMBER 23, 1990 AT 1000 HOURS EST.

Present

Drs Acott, Barry, Chapman-Smith, Davies, Gorman, Knight, Robinson, Slark, Wallner and Williamson,.

1 **Minutes of the previous meeting**

Following clarification of correspondence previously dealt with, these minutes were read and taken as a true record.

2 **Business arising from the minutes**

2.1 A.G.M. 1991

A report was received from Allways Travel. The Venue is Karumba Village Resort, Republic of Maldives, June 1-8 1991. Tour costs were discussed and considered excellent value. Singapore Airlines was preferred to Air Lanka as it offered a fixed price. The Executive agreed to accept the price and package as presented.

Partial funding for speakers by AIDAB is still under review and any further developments will be presented by Dr Gorman at the next meeting.

2.2 A.G.M. 1992

The Meeting discussed the proposed Port Douglas Meeting at length. A tentative scientific programme has been presented by Dr John Williamson titled "Australia's Wondrous Reef". The Committee considered the programme looked outstanding. Dr Williamson stressed the people involved from AIMS were all world authorities in their field and very enthusiastic about the meeting.

It was agreed that expenses of the speakers would be met but that in view of the proximity to Townsville, these will not be great.

Dr Chapman-Smith suggested Dr Richard Willans of Brisbane University was an authority on invertebrates, and in particular nudibranchs and should be approached regarding a presentation. Dr Williamson took note of this.

A statement from Allways Travel was discussed. The venue at Port Douglas was costed using the Radison Royal Palms. The Mirage Resort had been investigated but no worthwhile discount could be negotiated. The cost on a daily basis of over $250.00 per head was considered too great. Radison Royal Palms was thought an acceptable alternative and priced competitively compared to previous conferences.

The problem with a North Queensland venue is availability of diving at a satisfactory cost. At Port Douglas, The Quicksilver is priced at $13,000.00 per day, or an estimated $210.00 per diver per day. This price was thought too high. Dr Williamson suggested it would be cheaper not to have exclusive use of the boat. While this is true, it was pointed out the usual reef trip returns to Port Douglas too late to attend lectures.

Some discussion occurred as to whether Townsville or Cairns would be a better venue than Port Douglas, but the same diving problems remained.

In response to an enquiry by Dr Davies, Dr Gorman advised there would be 2 sessions of the Conference devoted to Diving Medicine.

Dr Wallner suggested dividing the Meeting into blocks of days conference and days diving to overcome the problems mentioned. Dr Knight and Dr Chapman-Smith both indicated the necessity of some scientific programme each day to ensure acceptability by the Taxation Office.

Dr Williamson thought Dr King of Mossman may be able to get better rates for diving in Port Douglas than those quoted by Allways Travel. It was agreed Dr Williamson should pursue this with Dr King.

Concluding, Dr Gorman summed up the feeling of the Executive that the programme presented by Dr Williamson was outstanding and of sufficient merit to warrant changing the previously accepted format of SPUMS meetings. John Williamson and John Robinson were to informally discuss a different meeting format after Dr Williamson had spoken to Dr King.

Dr Knight spoke about the management of the Palau Conference, specifically, no covers on the dive boats, no snorkel trips, wives confined to the beach and not enough free wine at the final dinner despite this being advertised. The Secretary was instructed to draw Allways Travel's attention to these matters and ensure what is advertised is produced.

2.3 DATABASE

A number of revised forms were circulated and discussed. Most comments were directed towards simplifying the form. There was discussion about having a separate application form for associates but this failed to attract majority support.

Dr Davies' final plan was thought acceptable with some minor changes. Dr Davies noted these and will produce a revised form for the next meeting.

2.4 POLICY STATEMENT RE DIVING MEDICAL EXAMINATIONS

Dr Davies advised this has now been completed, edited and accepted for the next issue of the Journal. The contents of the statement had been circulated previously. It was agreed no further discussion was required.

2.5 PADI MEDICAL FORM

Dr Acott and Dr Williamson spoke noting this form was against SPUMS philosophy. The statement appeared to get away from a qualified underwater doctor doing examinations. Further, it allowed diving by minors and discretion as to whether there should even be a medical examination.

All members of the Committee spoke and were critical of the PADI statement.

Dr Gorman noted Andy Veale had already written a critical comment of the statement in New Zealand. Further, the statement pre-empted the forthcoming Australian Standard.

Dr. Slark felt the concept of, in effect, offering advice to unqualified doctors had some merit.

Dr Gorman observed PADI was doing the right thing asking our opinion before circularizing the statement. He felt PADI deserved a detailed reply. Having already written a draft, this and Andy Veale's critique will be circularized before the next meeting.

2.6 FUTURE MEETING

The Secretary advised that as well as Western Samoa and Tonga, Allways Travel were now able to organise a New Guinea meeting in 1994 or 1995.

2.7 STATEMENT ACCOMPANYING LIST OF DIVING-DOCTORS

John Knight advised a disclaimer would appear in the Journal noting that the list of diving-doctors provided with the Journal only included members of SPUMS and that SPUMS policy was that doctors doing diving medicals should have training in underwater medicine.

2.8 HYPERBARIC SOCIETY

John Williamson spoke and advised there are 12 people involved in this fledgling group. Discussion followed concerning the group's relationship to SPUMS and the Executive thought a Standing Committee would be best. The Committee decided that the Society should offer full financial support. Dr Williamson mentioned that some of the Clinical Directors were not enthusiastic about being associated with SPUMS but the Committee felt that it would be appreciated in due course, that a group of only 12 would have difficulty self-funding and would therefore find it easier to operate under the SPUMS umbrella.

3 Other business

3.1 JOURNALS FOR NEW MEMBERS

Grahame Barry spoke and after discussions, the Executive felt that upon election to the Society, a new member is entitled to received a full complement of Journals for the year in which they join.

3.2 ENTRANCE FEE

Grahame Barry spoke suggesting it is usual practice to have an entrance fee, and that it would encourage people to keep membership fees up to date if the possibility of paying to rejoin existed.

John Knight advised the Constitution allows an entrance fee.

Discussion showed most members felt an entrance fee was appropriate. The feeling was it should be of the order of $20.00 Australian, and apply to future applicants. It would be introduced after the next AGM as the introduction of this fee requires endorsement at the AGM.

3.3 SCIENCE CENTRE FOUNDATION

John Knight spoke expressing dissatisfaction with the Centre. He thought there was some doubt as to its efficiency and worried about intrusion into the role of the Treasurer and Editor of the Journal. Further, he thought typing by the Centre was very expensive.

Grahame Barry spoke indicating the bills from the Science Centre were getting larger, not smaller as expected, and was concerned that the Society would not be able to fund this service at the current rate of growth.

John Knight felt our needs would be satisfactorily met by keeping a list of members on the Editor's computer. We now have two hard disks and two floppy disks and there appeared no need for a further list of member at the Science Centre.

After discussion, it was thought the performance of the Science Centre should be closely watched and the Secretary should write expressing our concern at mounting costs, duplication and efficient distribution of documents. John Knight added that photocopying should be on both sides of the paper.

3.4 1st. AUSTRALIAN-CANADIAN MEETING, SYDNEY

This meeting was discussed and a suggested letter to Carl Edmonds read. The Executive uniformly felt disappointed at not being notified of the meeting. Dr Gorman raised the possibility the meeting was entirely organized from overseas. In view of this, Dr Gorman was requested to raise the matter with Dr Edmonds on an informal basis before any further action is taken.

3.5 COFFS HARBOUR MEETING

Dr Wallner spoke. A problem with accommodation and dates was discussed. The meeting will be reallocated to March 2 and 3 and a correction inserted in the next Journal by the Editor.

4 Correspondence

4.1 RAY ROGERS

The North American Chapter was discussed. Much correspondence has been received. The question of free membership to the President of UHMS and EUBS was raised. The feeling was that as the UHMS President had already been offered this, it should be allowed to go for one year, but there should be no extension of this practice other than SPUMS past practice of free membership for one year to our guest speakers.

The question of annual fees was raised. After discussion consensus was that the North American Chapter should have an annual fee of US$50.00 and collected in Australia. Any surplus due to currency differences will be returned to the North American Chapter. Grahame Barry was asked to draft a letter to Ray Rogers which the Secretary will forward, accompanied by the Executive's congratulations on the work already done by the North American Chapter.

4.2 REPUBLIC OF MALDIVES

A letter expressing the Ministry of Health and Welfare, Republic of Maldives' support for the 1991 meeting was received.

After discussion, it was decided to invite the Minister to open the meeting, to advertise of the meeting within The Maldives, aimed at the local medical community and offer a half-day workshop conducted by selected people from our group.

4.3 QUEENSLAND REGULATIONS

Dr Gorman had written to Brian Marfleet, Inspector, Division of Accident Prevention, Department of Employment, Vocational, Educational Training and Relations, expressing concern that the standards proposed in Queensland, in particular regarding long bone surveys for recreational dive instructors were excessive. This is particularly so as there is no evidence that dysbaric osteonecrosis is a problem in the recreational dive industry, even in those treated for DCS.

As the current mood is to move away from long bone surveys, the Executive strongly supported this approach by Dr Gorman.

5 Other Business

5.1 LETTERHEAD

John Knight raised the question of letterhead and retention of the SPUMS Logo. Advice from the Corporate Affairs Commission indicated we could continue using the old letterhead, and a future letterhead may retain the Logo. Incorporated or Inc. need only be added after the full name of the Society in one place.

Discussion followed, many members expressing their distaste for SPUMS INC. and their preference to retain our description as SPUMS only.

As the question of continued use of the Science Centre was unresolved, it was decided to retain the present stationery until we have a more settled address.

5.2 STANDARDS SUB-COMMITTEE

Dr Knight spoke of discussions with Dr Carl Edmonds concerning a Standards Association meeting due December 13th. At a previous meeting, it had been decided that doctors trained in diving medicals should do the medicals. It was strongly felt that a subcommittee of experienced diving doctors should be formed to draft a diving medical of adequate standard acceptable to SPUMS

Discussion followed about Carl Edmonds' offer to host a sub-committee of 5. It was decided appropriate to form such a committee, preferably at an alternative site such as Adelaide, and that SPUMS should finance the meeting. Dr Barry observed that at our current rate of expenditure to the Science Centre we may not be able to finance the meeting.

The final committee will be decided when it is known where and when the meeting will be held. However, it should be composed of Dr Carl Edmonds representing NSW and Dr Bob Thomas representing Queensland, Dr John Knight and 2 other SPUMS members with a strong history of diving medicals, .

Dr Knight was asked to communicate with Dr Edmonds concerning such a committee.

5.3 WHITIANGA

Dr Chapman-Smith informed the Committee the New Zealand Chapter will conduct a meeting at Whitianga from April 12-14, 1991.

There being no other business, the Meeting closed at 1345 EST.

John M.P.Robinson
Secretary of SPUMS.

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 is enclosed with this 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.

John M.P.Robinson
Secretary of SPUMS.

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

AUSTRALIAN RESUSCITATION COUNCIL INDEX OF POLICY STATEMENTS

SPUMS is an associate member of the Australian Resuscitation Council and is supplied with information about their publications.

We reproduce below the index of policy statements and the dates of publication, as of July 1990, for the information of members. Copies of the policy statements are available from the

Australian Resuscitation Council Inc.
C/- Royal Australasian College of Surgeons
Spring Street, Melbourne, Victoria 3000
Telephone: (03) 663 3831, 662 1033

Section 1 Aims and objectives

1.1 Aims and Objectives of the Australian Resuscitation Council — March 1983
1.2 Policy Decisions of the Australian Resuscitation Council — April 1984
1.3 Protocol for Policy Decisions — March 1987
Addendum Principles for Policy Statements — November 1986
1.4 Objective of Modern Resuscitation Techniques — March 1988

Section 2 Assessment

2.1 Priorities in an Emergency — March 1988
2.2 General Principles of Management of the Collapsed Person — March 1988
2.3 When to Move an Injured Victim — March 1989

Section 3 The Unconscious State

3.1 Causes of Unconsciousness — March 1988
3.2 Recognition of Unconsciousness — March 1987
3.3 Positioning an Unconscious Victim — March 1988

Section 4 Airway

4.1 Causes of Airway Obstruction — March 1988
4.2 Recognition of Airway Obstruction — March 1988
4.3 Airway Management
4.3.1 General Principles — March 1988
4.3.2 Backward Head Tilt — March 1988
4.3.3 Jaw Support — March 1988
4.3.4 Jaw Thrust — November 1986
4.3.5 Manual Clearance of the Airway — March 1988
4.3.6 Management of Choking — March 1988
4.3.7 Laryngeal Spasm — November 1988
4.3.8 Fractured Lower Jaw — March 1987
4.4 Airway Management in Children and Infants — July 1988

Section 5 Breathing

5.1 Causes of Ineffective Breathing — March 1988
5.2 Recognition of Breathing — March 1987
5.3 Expired Air Resuscitation
5.3.1 Mouth to Mouth Method — November 1989
5.3.2 Mouth to Nose Method — July 1988
5.3.3 Mouth to Mask Method — July 1990
5.3.4 Mouth to Stoma Method — March 1988
5.4 Expired Air Resuscitation in Children and Infants — March 1988

Section 6 Circulation

6.1 Causes of Cardiac Arrest — March 1987
6.2.1 Recognition of Cardiac Arrest — March 1988
6.2.2 Method of Checking the Carotid Pulse — March 1988
6.3 Managementof Cardiac Arrrest
6.3.1 Locating the Compression Point for External Cardiac Compression — March 1988
6.3.2 External Cardiac Compression Technique - Adults — March 1988
6.3.3 Rate of External Cardiac Compression — July 1988
6.3.4 Use of the Precordial Thump — July 1988

Section 7 Cardiopulmonary Resuscitation

7.1.1 Cardiopulmonary Resuscitation — March 1988
7.1.2 Cardiopulmonary Resuscitation in Children and Infants — July 1988
7.1.3 Recovery Checks — March 1988
7.1.4 Change from One Rescuer to Two Rescuers During CPR — March 1988
7.2 Basic Life Support Flow Chart — March 1988
7.3 Summary of CPR Management Steps — March 1988

Section 8 - Specific Emergencies

8.1 Principles of Control of Bleeding for First Aiders — March 1985
8.2 Heart Attack — July 1989
8.3 Electric Shock — July 1989
8.4 Shock — August 1984
Addendum Emergency Management of a Crushed Victim — November 1986
8.5 Burns — November 1989
8.6 Priorities at the Scene of a Road Accident — March 1989
8.7 Special Problems in Resuscitation of the Near-Drowned — March 1989
8.8 Cold Injury — November 1982
8.9 The Management of Envenomation — March 1989
8.10 First Aid Management of a Seizure — July 1988
8.11 Head Injury — July 1988
8.12 Emergency Management of a Victim who has Ingested Poisons — November 1988

8.13	Emergency Management of Victims of Inhalational Incidents	March 1989
8.15	Asthma Attack: First Aid Management	July 1990

Section 9 Instruction

9.1	Cardiopulmonary Resuscitation Training, Course Objectives, Content and Criteria for Evaluation	July 1988
9.2	Training in Cardio-Pulmonary Resuscitation	March 1987
9.3	Training Programmes for Groups	
9.3.1	Teaching of Resuscitation in Schools	July 1990
9.3.2	Resuscitation and First Aid in Schools	July 1981
9.3.3	Children Aged 10-14 Years	March 1987
9.3.4	Adults and Children Aged Over 14 Years	March 1987
9.3.5	Special Groups - Occasional Users	March 1987
9.3.6	Special Groups - Regular Users	March 1987
9.3.7	Ambulance Officers	March 1987
9.3.8	Nurses	March 1987
9.3.9	Dentists	March 1987
9.3.10	Medical Practitioners	March 1987
9.4	Teaching Aids	
9.4.1	Audiovisual (Posters)	March 1985
9.4.2	Manikins	July 1986
9.4.3	Cross Infection Risks and Manikin Disinfection	May 1989
	Addendum Aids Precautions in Resuscitation	November 1987

Section 10 Resuscitation Devices

10.1.1	Ancillary Devices for EAR	
10.1.2	Use of Oxygen by First Aiders	November 1986
10.1.3	Pharyngeal Airways	November 1988
10.2	Life Detection Devices	August 1984
10.3	Protocol for Evaluation of Equipment	July 1988
	Appendix Referral Form	July 1986
10.4	Guidelines for Evaluation of Artificial Airways	March 1979

LETTERS TO THE EDITOR

DMAC REPORT BIASED

The British Sub-Aqua Club
National Diving Committee
16 Upper Woburn Place
London WC1H 0QW

13th June 1990

Sir,

I read with interest and concern the statement on Sport Diving from the Diving Medical Advisory Committee (DMAC) published in the October-December 1989 issue.[1] The statement was prompted by recent events in the UK.

I think your readers should be aware of the identity of DMAC and their authority to issue statements on Sport Diving. DMAC do not represent UK Sport Divers in any capacity. The UK government recognises the British Sub-Aqua Club (BS-AC) as the sport's governing body and BS-AC has its own medical committee which is unconnected with DMAC. In fact DMAC is not a UK organisation although its secretariat is in London. DMAC is a self-appointed body consisting of individuals involved in commercial diving in connection with the North Sea oil industry. There are represtatives from industry and government bodies of many countries (e.g. Netherlands, Norway and UK) involved in North Sea oil exploration. DMAC is funded by the Association of Offshore Diving Contractors (AODC) and Tom Hollobone is secretary of both DMAC and AODC. A couple of members of DMAC (less than 10% of the committee) are involved in recompression chamber operation in UK and as such are called on to treat bent amateur divers from time to time. There is no other involvement with recreational diving and none of the committee members takes part in recreational diving in the UK itself.

On June 28th 1989 I attended a meeting of DMAC in Aberdeen to present my observations on the relation between intracardiac shunts and decompression sickness. I was only an observer during the remainder of the meeting, since I am unconnected with the Committee. I was not present in my capacity as the Medical Adviser to the British Sub-Aqua Club.

Commander Greg Adkisson MC USN (on exchange at the RN Institute of Naval Medicine) introduced a draft of the DMAC statement. I was somewhat surprised at this for two reasons. Firstly, it did not appear on the agenda (and agenda items dealing with professional diver safety were deleted to make room for it). Secondly, DMAC had previously only concerned itself with professional diving.

The reason given for producing this document was concern about "the increased numbers of cases of decompression sickness treated in the UK". It was therefore my impression that the document was directed at British divers.

There are a number of points which concern me. Some of these I subsequently expressed to the Chairman of

DMAC in writing. The committee was presented with incorrect and inflated data on the number of cases of decompression sickness treated by the Royal Navy. The analysis of these statistics did not take into account important factors, such as the record good weather in the UK in 1989 which surveys have shown caused an increase of almost 100% in the number of dives conducted. Those who discussed British recreational diving practices seemed singularly ill-informed about those practices.

During the discussion, many members remained silent throughout, whilst the document was largely drafted by a few individuals, each of whom appeared to me to have vested interests in exaggerating the amount of amateur diving accidents.

Whilst I am in favour of any genuine attempt to improve amateur diver safety, I do not believe that is the purpose of the statement from DMAC. I believe that it is no coincidence that this document was released less than one month before the UK Department of Energy report on decompression sickness from commercial offshore air-diving operations on the UK continental shelf during 1982 to 1988 was released. This data clearly shows that professional divers were subjected to an unacceptable incidence of decompression sickness as a result of relaxation of Diving Safety Memorandum 7/86 by the Department of Energy when pressure to do so was applied by the diving and oil industries. Since those most in favour of producing the DMAC statement were aware of the conclusions of that report, I believe that the DMAC statement on sport diving is merely a diversion. DMAC might have spent its time more usefully producing a statement on the report by the Department of Energy.

Peter Wilmshurst
Medical Adviser to BS-AC

Reference

1 Diving Medical Advisory Committee. Statement on Sports Diving. *SPUMS J* 1990; 20 (1): 57-58

The above letter has been shown to Dr Adkisson whose reply appears below.

4170 Jackdaw Street,
San Diego,
California 92103,
USA

23 October 1990

Sir,

Dr Wilmshurst's letter is inaccurate and misleading. It would not be worth my time in replying except that divers reading the SPUMS Journal[1] may be adversely affected if the statements he made are left unchallenged.

DMAC (Diving Medical Advisory Committee) is a group made up of physicians and diving industry personnel who meet on a voluntary, unpaid basis to review and comment on safety aspects in any part of the diving industry and this includes the sports diving industry. DMAC is not funded by the AODC or any other organization that I am aware of. While Tom Hollobone acted as our secretary and worked for the AODC, most of the members work within the diving field in some capacity or they would not have the expertise or interest to be on the committee. I collected my pay cheque from the Navy but to extend that connection and state that DMAC was therefore funded by the Navy is ludicrous.

The physician members of DMAC represent virtually all major recompression centres in and around the UK as well as some in other parts of Europe. Their chambers treat the vast majority of all diving accidents that occur in the UK including military, commercial and sport divers. They have treated hundreds of divers over the last few years. If this is what Dr Wilmshurst means by "called on to treat bent amateur divers from time to time" I have the following question: How many divers with decompression sickness have you recompressed in the last few years Peter? I am amazed that Dr Wilmshurst alleges those of us who treat sport diving injuries are not involved.

Dr Wilmshurst was indeed present for DMAC's meeting in June of 1989 but he misquotes events and conversations. DMAC as a committee had discussed their concerns about events within the sports diving industry for the previous year. The draft presented at this meeting, while not on the agenda, was not a new idea. I had been assigned back to the United States and this was my final opportunity to finish any DMAC work I had in progress. The DMAC Statement on Sport Diving was completed early and presented. The draft was actively discussed by the entire committee and a final version approved. As a courtesy, Dr Wilmshurst was asked for his remarks and he expressed no negative comments about any aspect of the statement.

The DMAC statement on Sport Diving is simply a reminder of basic safety rules and concepts and was addressed to divers in all parts of the world. Dr Wilmshurst has now expressed concern about the statement but has discussed only unrelated issues. I ask him now, publicly, to be specific regarding which portions of the statement he objects to.

G H Adkisson, MD

Reference

1 Diving Medical Advisory Committee. Statement on Sports Diving. *SPUMS J* 1990; 20 (1): 57-58

SPUMS ANNUAL SCIENTIFIC MEETING 1990

THE SCIENCE CENTRE FOUNDATION

Ruth Inall

What is a professional organization? Why does it exist and what is its purpose?

All associations, societies and institutes should ask themselves these questions periodically. Basically an organization comes into being because a number of people have found that they share a common interest which cannot be met by any existing group. In the case of "interest" groups this may arise because of new and/or compelling ideas develop which focus on a particular aspect, e.g. conservation concepts. In professional groups it generally occurs when the parent body is perceived, for whatever reason, as not meeting the needs of a new sub-speciality, e.g. the many engineering speciality institutes which have derived from the original institutions of engineering.

The development of a new organization is a bit like human growth and development. There is the conceptual stage, very exciting and full of enthusiasm; next comes the birth with all the usual traumas followed by the toddler stage, teething troubles, etc. The analogy can cover all the stages of human existence. Except for one. For centuries mankind has looked for the elixir of life, to extend human existence past the three score and ten, with minimal success. On the other hand our research can prove more successful when we look for the magic ingredients that enable some organizations to remain valid and active for centuries while others spring up, flower and then die away.

What are these magic ingredients? We do not need to do a great deal of research to answer this riddle. They are leadership, relevance and good management.

There is very little the Science Centre Foundation (SCF) can do about the first to help our organizations. Quite rightly it would be termed "interference" and "meddling" by our member bodies. We can sometimes help with the second by acting as a catalyst, working with a group that is trying to translate its original objectives to meet to-day's demands. However, we can always help the group to achieve better management.

To ensure that the activities of the Science Centre were developed both in depth and in scope to meet more fully the needs of the professional and semi-professional community, the Science Centre Foundation was established and incorporated in New South Wales on 27 May 1981.

However, the benefits to be derived from the provision of a common core of services and facilities for scientific, technical and other professional societies was recognized as far back as 1928. In that year the NSW Government passed legislation granting a parcel of land in Gloucester Street, Sydney, to the Royal Society of New South Wales, the Linnean Society of New South Wales and the Institution of Engineers, Australia. Those bodies were charged with the responsibilities of erecting a suitable building to house the scientific and professional societies of the state.

The building was completed in 1931 but was resumed in the 1970's for the Rocks development scheme. At that time a review was made of the needs of professional and semi-professional organizations. This revealed that while the very few large organizations would no doubt continue to manage their affairs independently, the numerous middle-size and smaller bodies were finding it extremely difficult to administer their affairs efficiently, and to play a significant part in Australia's professional life, without increasing their members' fees to the level where such increase would become counter-productive. The Royal Society of NSW and the Linnean Society of NSW therefore undertook the task of setting up a secretariat to provide these bodies with the facilities whereby operating costs could be shared and management improved. Since the withdrawal of the two societies from this task the SCF has taken over these activities and has been operating independently since 1983.

The Governor-General of Australia is the patron of the Foundation and takes a keen interest in its activities.

The aims and objectives of the Foundation can be summarized briefly as being to assist scientific and technological development by aiding professional and semi-professional bodies to function and develop, to provide liaison within and between the professions both nationally and internationally, to assist individuals in the development of their scientific and technical abilities by appropriate grants, and to encourage the application and dissemination of knowledge in the scientific and technological fields.

It should be stressed that the Foundation does not intend to usurp in any way the activities of the larger well-established professional organizations; it is concerned with the welfare of that large group of medium to small organizations which are of very real importance to the community as a whole.

It has always been intended that the SCF shall have a broad base with a membership drawn from a wide variety of societies and organizations (both professional and industrial) together with interested individuals.

The methods we use to translate these objectives into action are as varied as the member organizations we service. The common denominators are that we explore with each committee where the greatest need for assistance lies and that we encourage the organization to realize that by joining the Foundation that they have acquired staff varying in skills from executive director to office junior, and to develop a relationship with the secretariat accordingly.

For example, in 1988 the SCF created an award which recognizes that many members put an enormous amount of effort into the development of their organization. Since the development of professional and scientific organizations is the main reason for the Foundation's existence, the board of Governors resolved to mark the bicentenary year with the establishment of the Science Centre Foundation award. This was such a success that it was decided to make this award an annual event.

The award is presented to the elected officer, member or official of an organization which is a member of the SCF, in recognition of dedication and outstanding service to that organization and to the fostering of cooperative relations between organization and the Foundation.

If SPUMS decided to join the Foundation and establish a secretariat the following might happen:

1 We can provide a registered office with mail address and telephone. Routine matters can be handled by the staff while the rest is sent on to the Secretary. Files and records can be maintained at the office.
2 We can provide assistance with the preparation and attendance at committee meetings.
3 We can create a data base and keep it up-to-date.
4 We can send out subscription notices, record payments, and send out reminders. We can bank, prepare monthly financial statements, leaving the Treasurer responsible for budgeting and forward planning.
5 We can assist the Editors at the word-processing stage, then return the disc for editing and lay-out. We could undertake the sales and advertising tasks.

The tasks I have outlined are basic administrative procedures. However, it is perhaps in helping the Society to look at its objectives and translate these into programmes that we could be most helpful. Relieving executive members of most of their clerical chores will allow available time to be spent on developmental projects. From discussions and reading background material provided, it would appear that a number of areas could be explored:

1 An expansion of educational activities such as providing more scientific meetings including those catering for members other than doctors.
2 Establish hyperbaric medicine as a recognized part of medical education.
3 Establish contact with other medical organizations such as the Postgraduate Federation in Medicine.
4 Develop projects in developing countries such as making a video suitable for a teaching aid.

To give some idea as to how to implement for example the first suggestion of educational activities it might be possible to select a small group to put material together for a two-day seminar, then take this to each State and appropriate centres. This would enable wider participation by both members and associates, thus helping them to become more involved with the Society.

My talk to-day has been an attempt to demonstrate how the SCF functions and what we could achieve together. I hope that the opportunity you have given me to-day is not the last time I shall be talking to members of this Society.

Mrs Ruth Inall is the Executive Director of the Science Centre Foundation, the address of which is Private Bag No 1 Darlinghurst, New South Wales 2010, Australia.

SUBMARINE ESCAPE AND RESCUE

Greg Adkisson

Submarine escape and rescue of the 1990's is a complex evolution involving a variety of different craft, both surface and submersible, and often the co-ordinated efforts of many nations. To appreciate what we are able to accomplish today, it is worth looking back through time to appreciate the work of those that passed before us.

History

The first successful submarine escape on record occurred in 1851. The *Brandtaucher* or *Sea Devil* was a German vessel commanded by Wilhelm Bauer, a corporal in the Bavarian artillery. She was a stubby, narrow beamed vessel of some 35 tons with a very deep draft and motored by a hand turned propeller. She was first sent into action against the Danish fleet which was blockading the harbour at Kiel. The Danish fleet stayed at sea and Bauer's first day consisted of moving about the harbour without seeing enemy action.

Not one to give up easily, Wilhelm set out to sea on the second day determined to sink a ship. Unfortunately, his determination would prove successful but not in the way he imagined. The *Brandtaucher*, on its second submergence, ran out of control and sank in 18 metres of water. Unsure of quite how to handle the situation he discussed it with his shipmates. They were all for staying put, having no idea of how to leave. Wilhelm, however, felt that it was time to return to the artillery and came up with the idea that, by pumping water into the vessel, pressure could be equalized, the hatch opened, and they could all swim to the surface. It took five hours and a large hammer to convince his men but the plan succeeded and the first successful escape became a reality.

The *Brandtaucher* was salvaged in 1887 and placed at the Naval College at Kiel. In 1906 she was taken to the Naval Museum in Berlin but deteriorated over time and is no longer in existence.

During the war between the North and the South in the United States, the need for submarine escape became all too painfully apparent. The Confederate States of the South began building a series of semi-submersibles, not true submarines but of a similar design and concept. The year was 1861 and these small hand powered submersibles, called "Davids", were designed to do battle against the overwhelmingly superior Northern fleet. It was billed as the battle between David and Goliath. In 1863, one of the first of these was constructed in Mobile, Alabama. 50 feet long with a 9 foot diameter, it was powered with steam and was capable of 7 knots. It was equipped with a single spar torpedo in front and reverted to hand power when submerged. Lieutenant Glassell commanded but the engineer was a man named Tombs.

She was sent to sea against the northern vessel *New Ironsides*. She rammed the *New Ironsides* but caused only superficial damage. The crew expected the David to sink and abandoned the submersible. Mr Tombs, however, belying his name, stayed aboard and escaped with the vessel into the night.

The next vessel in the line became somewhat more infamous. Designed by Hunley and McClintock, she was 60 feet long, hand powered by a crew of 8, with an additional man on board as the pilot, and was equipped with a spar torpedo. In her initial trials off Charleston, a paddle-wheeler came along, flooded the boat and sent her to the bottom. Lieutenant Paine was the sole survivor, managing to escape through an open hatch. She was raised and refurbished, only to be sunk during her second trial by a storm. On this occasion Lieutenant Paine and 2 of the crank turners escaped. She was salvaged and refitted. Proving herself to be a true submarine, she promptly sank a third time. Lieutenant Paine and 3 others escaped setting, by Lieutenant Paine, what appears to be a world record of 3 actual escapes from a sunken submarine.

She was raised again and given a new crew. Lieutenant Paine was no longer in command, a bad omen perhaps, for she sank this time taking all nine men aboard to their deaths. She was salvaged again and sank again. This time 7 men died. She was raised again and was finally to do battle. She damaged a frigate but the frigate was repaired while the sub sank again with all but the pilot being drowned.

She was raised a final time and dried out. She was sent into battle again against a selected target, the Northern corvette *Housatonic*. A call for volunteers had gone out but was promptly ignored. The South finally managed to put a partial crew on board with Lt Dixon in command from the 21st infantry. On the 17th of February, 1864, she set to sea. The *Housatonic* expected the attack and was keeping a sharp eye towards land. The valiant vessel, however, went around and approached from seaward. She was sighted about 100 yards off and the *Housatonic* attempted to manoeuvre. The attempt was unsuccessful and the *Housatonic* was struck just forward of the mainmast at the magazine. The sub earned a place in history as the first to sink an enemy vessel but, unfortunately, she sank with the *Housatonic* and the entire crew perished with her. There were no further attempts to use submersibles by the South but the North continued building a series of semi-submersibles, similar in design to the Davids, known as Cigar boats.

Of the ill-fated Davids, one man was quoted as saying the "David lost so many Confederate lives it must have been designed by a Yank". 35 men lost their lives before even going into battle.

Other submarines and other crews were lost in the following years.

In 1916 HMS E-41 collided with another submarine and sank in 30 feet of water. Stoker Petty Officer Brown made British history as the first man to successfully escape from a British submarine and survive to tell the tale. With the development of the Davis Escape Lung, Britain began to move towards the concept of escape as the primary method of leaving a disabled submarine. In 1933 the advent of modern submarine rescue occurred when the USS Squalus sank in 234 feet of water and the entire crew was rescued using a relatively new device called the McCann Bell. The McCann Bell was a submersible rescue chamber designed to go to 250 m and attach to the hatch of a disabled submarine. It was capable of doing this only if the submarine remained at 1 atmosphere of pressure.

In the years to follow, the United States, while maintaining an escape capability in the form on the Momsen lung, and later the Steinke Hood, would move towards rescue, bringing men out of a submarine by means of a rescue chamber or rescue vehicle, as the primary means of saving lives in a submarine accident. The United Kingdom would continue to concentrate on escape, maximizing a man's ability to exit from a disabled submarine and get back to the surface. Today, the United Kingdom has combined these methods to maximize success.

General Considerations

Should a submarine become disabled and sink, several variables come into play. There are four general scenarios. The submarine may be dry and unpressurized, wet (partially flooded) and unpressurized, dry and pressurized or wet and pressurized. The optimum state for survival is dry and unpressurized. Each scenario presents unique challenges to would be rescuers.

There are two methods of leaving a disabled submarine. Escape is when the survivors make their own way to the surface. Rescue is when the survivors are transferred by means of some type of submersible.

Methods of escape

Generally, survivors are encouraged to wait until surface forces are on hand to assist with recovery. If escape is forced due to deteriorating conditions, the Submarine Parachute Assistance Group (SPAG) may be air dropped in to assist. Two methods are available:

Tower escape, with hooded ascent, is the primary means of escape with one or two survivors being pressurized and exiting at a time.

Rush escape is a secondary method when the entire compartment is flooded and all escapees are pressurized together. As they can only escape from the compartment singly the majority are exposed to raised pressures for some time, increasing the risk of decompression sickness.

Methods of rescue

Rescue is the preferred method of recovering survivors and should be utilized unless conditions are optimum for escape or if deteriorating conditions force escape. Several methods are available.

The US Navy maintains two Deep Submergence Rescue Vessels (DSRV) for world-wide assistance in submarine disasters. They are capable of mating to any submarine with standardized mating hatches with a maximum depth capability of 1500 metres. They can rescue survivors from boats pressurized up to 5 ATA.

The LR5 is a civilian submersible under contract to the Ministry of Defence. Like the DSRV, it can mate to compatible submarines at pressures greater than 1 ATA.

The USN McCann Bell is surface deployed and is capable of rescuing men from a non-pressurized submarine at depths up to 250 m.

Other nations have developed rescue capabilities and NATO is investigating the possibility of a European DSRV.

Medical Concerns

Men escaping from a disabled submarine are faced with a wide variety of potential problems. These are compounded in the submarine is at an increased pressure to before the escape. Various conditions that may present include:

Pulmonary barotrauma.
Other barotrauma, especially ears.
Decompression sickness.
Exposure, including hypothermia or sunburn.
Drowning and near drowning.
Traumatic injury.
Exposure to toxic gases, oxygen, carbon monoxide, chlorine, carbon dioxide.
Radiation injury.
Dehydration from limited water supplies.

Recent Highlights

Exercise Sedgemoor was a joint US-UK submarine escape and rescue exercise designed to test all phases of a rescue operation. Of particular note was the fact that it was the first time that submariners were taken from one pressurized submarine to another pressurized submarine in a simulation, start to finish, of a pressurized rescue scenario. This proved the pressurized rescue capabilities of the DSRV, the LR5 and the British Mother Submarine (MOSUB) system.

Summary

Submarine accidents can and do occur. A high standard of readiness and training on the part of rescue forces is necessary to insure optimum success in rescuing survivors of such disasters. Once the sinking occurs, tremendous problems face the survivors and their would be rescuers. Proper planning and preparation can optimise the possibility of a smooth, co-ordinated rescue.

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WHAT IS AN ADEQUATE DIVING MEDICAL ?

Martin Sher

Introduction

The problem of what constitutes an adequate dive medical is not a new one, and has been discussed at SPUMS meetings before.[1] This talk is concerned more with the attitude and philosophy of diving medicine. Doctors practicing diving medicine seem to be becoming more remote from their clients, the divers. This cannot be a good thing, and can lead to problems.

The diving medical

It is possibly inappropriate that I am giving this talk, as I do no diving medicals and practice very little diving medicine. However I have done a lot of diving and I come from Cairns, a town with a population of just under 100,000.

A lot of diving happens in Cairns (54% of the diver-days in Queensland, where conservative estimates place the number of dives per year at over 250,000).[2] I have many discussions with medical practitioners, those in the dive industry, and the divers themselves, and possibly see things from a different angle to the usual diving medicine doctor.

While I believe that problems occur at all levels of diving medicine, I have chosen the dive medical to illustrate the problem. I must stress that I acknowledge the great work being done by people, like Des Gorman, who are helping to improve our understanding of the patho-physiology of diving problems. I also feel that the training of GPs in diving medicine is essential. This talk is limited to medicals for sport diving. Professional diving is a separate issue, and I do not believe the two can be equated.

As I have said before much of the problem with dive medicals is with the attitude toward them. Is it not rather strange that other hazardous pastimes, such as hang-gliding, mountaineering, parachuting, snorkelling require no medical, while scuba-diving requires an extremely stringent one? The only other activity requiring a similar "pass or fail" medical is a pilot's licence. I do not believe the two are at all comparable, as a pilot in trouble is likely to injure others, whereas a diver is only likely to injure himself or herself. It is interesting to note that the pilot of an ultra-light aircraft is only required to state that he or she is fit to drive a car.

Having said that, I do recognize that because of the unique nature of diving, that a dive medical is essential. However it is relevant that we are prepared to allow people to undertake other hazardous pastimes without a medical.

Most of the medical conditions relevant to diving are detectable by taking a good history (e.g. spontaneous pneumothorax, epilepsy, diabetes, asthma, medications). In fact without an honest and accurate history many of these can be undetectable.

Even with the best dive medical on Earth it is impossible to predict who may have a spontaneous pneumothorax in the future. Until it occurs one is fit to dive but afterwards no more diving. Stories of people having thorough medicals and then having a spontaneous pneumothorax abound.[1] Recently patent foramen ovale has been linked to an increase in neurological decompression sickness (DCS).[3,4] This condition is extremely difficult to pick up, even with expensive and potentially hazardous tests. Yet the Editorial in a recent SPUMS journal (Oct 1989) the suggestion is made that testing for patent foramen ovale should be part of the dive medical of the future. If present the person should be declared Unfit to Dive.[5] What of the 60,000-120,000 current divers who are expected to have this condition, which occurs in 15% - 30% of the population ?[6,7] Are they retrospectively unfit to dive ? How will they react when told ?

I think it is high time we admitted to ourselves, and our clients, that we do not really know who is fit, or is not fit, for sport scuba diving. We can provide valuable advice, but unfortunately there are still more grey areas, than black and white. The speciality of diving medicine is in its infancy, and very little of what we practice and preach is scientifically proven. We seem particularly keen to find bandwagons to jump on.

The question of asthma in divers illustrates this very well. Asthma has long been an absolute contraindication to diving. However where does one draw the line. To quote from the SPUMS Journal "anyone who has a history of asthma, even if it is only a suspicion, now bears the burden of proving he does not have asthma."[8] From the same journal there was an article reprinted from Diver where asthmatics are allowed to dive if wheeze free. The author stated that "our more lenient policy has proved itself over the years by the absence of any recorded serious incidents involving asthmatics".[9]

In January 1990 an article appeared in the British Medical Journal on the diving practices of scuba divers with asthma. The authors circulated a questionnaire for divers with asthma in the magazine *Diver*, which has a circulation of 38,000. They received 104 replies from asthmatics who between them had logged 12,864 dives. Most took b_2 agonists before diving. 22 wheezed daily. Most of the asthma was induced by cold air, exercise and allergy. Their conclusions, "Our study suggests that the British Sub-Aqua Club's recommendation to divers.....not to dive within 48 hours of wheezing is safe".[10] This is the closest thing I can find to a study paper on asthma. Who is right ? I certainly do not know, and I suggest no-one does. Also many respiratory physicians feel smoking is worse than asthma, as it affects small airway closure, yet we do not ban all smokers from diving.

I believe that I have shown that there are problems with diving medicals for sports divers. Another problem I believe is on the increase is diver dishonesty. Divers conveniently forget they are asthmatic, epileptic, or whatever, for fear of failing the medical. I believe the reason for this is lack of confidence in their doctors.

Suggestions

Do I have any solution to these problems ? Not really, but I can offer some suggestions:-

1 Honesty on the part of the doctor! Let us be frank and admit we do not really know all the answers. This can be done in the form of an explanatory note given to every intending diver. It might read something like this:

> "The sport of scuba-diving takes place in an environment entirely foreign to humans. The human body is not designed to function, and especially not to breathe, whilst underwater. The normal body copes remarkably well with these conditions. However the reaction to certain medical conditions can be much more marked than when on land.
>
> This is why it is extremely important to fill out your medical questionnaire, and answer any questions the doctor might ask, accurately. If you have any doubts *ask the doctor*. It is only with all the relevant information that the doctor can give you valid advice on whether you should, or should not, take up scuba-diving. The medical is not strictly a "Pass" or "Fail" test, rather it is to give you advice as to any increase in the risk of diving in your case.
>
> It is obviously in your best interest to mention any pre-existing condition(s) you may have, or have had in the past. Without this knowledge your doctor may not warn you of any risk factors and give advice on how to minimize them.
>
> It is also important to note that even a thorough medical may not detect several conditions that increase the risk of diving, and that diving related illnesses can occur in people with no pre-existing problems. The only way to be certain you will not have a diving related illness is not to dive.
>
> Should you take up diving it is extremely important that if you develop some change in health status, e.g. become asthmatic, you should contact a doctor *experienced in diving medicine* for a further medical before diving again. In any case it is a good idea to have a dive medical every five years or so.
>
> Remember the aim of a diving medical is to make sure you are aware of any risk factors that you may have, and to give advice on how to minimize them. The only one put at risk by inaccurate or incomplete information is YOU.
>
> If your doctor warns against scuba diving, listen carefully to the reasons given, as they are NOT in any way related to general fitness. e.g. you may be a fit triathlete and still have risk factors that make scuba-diving a hazardous pastime. Make sure you understand why you have been warned not to dive, if you do not, ask the doctor to explain again".

2 A standard dive medical questionnaire for history taking. (Both these items should be available in several languages).

3 An appropriate physical examination. For instance should it include spirometry ?

4 I would do no further testing if the questionnaire and examination are both negative.

5 We should think before ordering further tests. In my opinion audiograms have no relevance in a sport diving medical. If the client would like a baseline that would be an acceptable reason.

Chest X-Rays have been shown to be of little value in asymptomatic healthy preoperative patients and pregnant women.[11,12]

6 Get rid of the paternalistic attitude towards divers. If risk factors are present, explain what they are and why. We should offer further testing as required, and suggest a course of action. Most choices should be up to the diver e.g. if there is a vague history of asthma as a child, the diver should not "bear the burden of proving that he does not have asthma". Rather the doctor should explain that there is *some* increased risk while diving, and that more information could be obtained by other tests e.g. histamine challenge test. If he wishes to dive a note can be given, stating that there might be some increased risk, specifically while ascending, that the maximum ascent rate should be below 6 m/minute and that out of air situations are likely to have dire consequences. A person who has some understanding of his or her risk factors is a far safer diver than one who does not.

In some cases it is necessary to declare a person Unfit to Dive. Then spending time explaining to that person exactly why they are at risk, and the likely consequences if they do dive, is essential. If this is not done the person often goes to another doctor and develops selective amnesia.

Changes over the years

In conclusion I would like to note changes that have occurred since I took up scuba diving in the mid 70's.

Then we did not have octopus regulators, buoyancy compensators and contents gauges were a rarity as were dive medicals. Neither portable recompression chambers.nor the DES network was available.

As part of the training we had to do free ascents from 40, 60 and 100 feet.

Theoretically this should be a recipe for disaster, but the accident rate did not seem any higher. In fact air embolism seemed less common. Is the increase due to the use of buoyancy compensators ?

I am not recommending a return to the bad good old days, but it is important to realize that here are a lot of divers, and dive instructors, who trained in that era. Many of them have medical conditions that would not be acceptable in today's diving medical. These people are highly sceptical and may advise friends not to mention certain conditions, e.g. asthma, when going for a medical. This is a real recipe for disaster. Articles by people who are sick of over-regulation, and not convinced of the benefits of it, are appearing in the diving press, and even in the SPUMS Journal.

The other change has been in the doctors practicing diving medicine. Then it was the Navy, and some doctors who were scuba divers. Now many doctors are being trained to do dive medicals who have little or no experience in diving. While I think it is wonderful that more people are being trained in diving medicine, I do not think it is necessary to instil the "pass and fail" mentality. There are so many grey areas in diving medicine, that to rigidly enforce opinions on these doctors cannot be right.

I have mentioned diver dishonesty a few times, and I believe it is on the increase, certainly in Cairns and I would imagine elsewhere. The cause is, I believe, the paternalistic attitude encouraged by the pass or fail approach to dive medicals. There really is seldom need to fail people, if risks are adequately explained, and problems emphasized they will make the decision not to dive anyway. This does not cover the grey areas, but there the decision should be left to the diver after a full explanation by the doctor.

If we adopt this attitude it will lead to increased confidence in the medical profession, and those people with some increased risk will at least have insight into their problem and how to minimize risks. This must be better than people "forgetting" to mention that they are epileptic, or being scared to take a puff of Ventolin before diving, which is sadly what we are seeing now.

The argument that this attitude will lead to people suing their doctors does not seem logical. How can one be sued if one informs the client of the risks and the client makes the decision to dive? I would have thought that someone would be more likely to sue if he had been passed fit to dive and then developed a dive-related problem. This group would include the 100,000 odd divers with a patent foramen-ovale. Alternatively what if an overseas person is failed, and then sues for the cost of the trip plus psychological damage, quoting the BMJ article on asthma?[10]

A major benefit of my suggested approach is that some valid studies could be done. At present some people considered unfit to dive are by-passing the system (by changing their history) and diving. We do not know how many. By and large these are the same people who would dive even after the risks are pointed out. Yet in these cases we could attempt to document figures, and have some follow up. Valid studies would no doubt prove the correctness of the stricter medical attitudes. These would then be based on studies done on sport divers, and be of far more relevance to sport diving than studies on military divers or submariners.

Conclusion

As with other hazardous pastimes the decision to participate in diving should be left to the diver.

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THE OUTCOME OF 125 DIVERS WITH DYSBARIC ILLNESS TREATED BY RECOMPRESSION AT HMNZS PHILOMEL

Stefan Brew, Courtenay Kenny, Robert Webb and Des Gorman

Summary

125 civilian sport scuba divers with dysbaric illness have been treated with recompression at HMNZS PHILOMEL over a 23 year period. A retrospective factorial analysis of the case records was carried out to identify the factors influencing outcome.

A significantly better outcome was noted in those divers who kept within conservative tables and in those whose dive profiles resulted in a low repetitive dive group.

The study also demonstrated the importance of obtaining adequate information at the time of treatment in order to facilitate prospective study.

Introduction

Decompression sickness (DCS) and arterial gas embolism (AGE) are dysbaric illnesses amenable to treatment with hyperbaric oxygen (HBO). The clinical features of both include significant neurological abnormalities and the morbidity following treatment is unsatisfactorily high. In addition to obvious sequelae such as weakness, sensory deficit and cerebellar dysfunction, there may also be more subtle neuropsychologic abnormalities.[1,2] Such sequelae may nevertheless be distressing to the patient and highlight the need for early and adequate treatment.

The recompression chamber (RCC) at NMNZS PHILOMEL was established in 1959 to support Naval diving. However therapeutic recompressions have been predominantly for civilian sport scuba divers.

We report here a factorial analysis of all those divers treated by recompression and have used this to identify those factors associated with a poor outcome.

Patients and Methods

The study includes all patients with a diagnosis of DCS or AGE and who were treated with recompression. Recompression includes all treatments undertaken in the RCC regardless of their duration or number.

Those patients who presented with a history and clinical features indicative of AGE but who also had dive profiles predisposing them to DCS were classified as AGE.

The data fields considered are listed in Table 1 with the proportion of data available for each field indicated.

This data was then entered on computer using the database programme dBase III plus. Programmes were designed to generate the descriptive data presented in Tables 1 to 4.

A further programme was developed to construct 2 x 2 contingency tables of outcome (complete or incomplete recovery) against the other factors in Table 1. This process was performed for outcome after first recompression, at discharge from hospital and at follow-up after one month. Complete recovery was considered to be the absence of any detectable neurological or other abnormality as indicated in the case notes. Incomplete recovery was taken as any comment in the case notes describing residual symptoms or signs related to the most recent episode of dysbaric illness. If the status of the patient was unclear, no outcome was assigned.

Patients with a diagnosis of AGE were considered separately from those with DCS.

Where a factor was not binomial, a range of values, including the mean, were used to divide the DCS and AGE populations into groups for comparison.

Although the original population consisted of 125 cases, when considered as two populations by diagnosis and excluding those cases of unknown outcome, some cells of the contingency tables were of such small size that Chi-square analysis was inappropriate. Therefore, Fisher's Exact test was performed and a p value of < 0.01 was considered significant.

Adjunctive treatment, if any, included combinations of aspirin, anti-coagulants, intravenous fluid, lignocaine, non-steroidal anti-inflammatory agents and steroids. Any treatment with one of these agents was recorded, regardless of its dose, frequency or duration.

Results

A total of 125 patients were treated over a 23 year period. From 1967 until 1983 the average number of patients was less than 2 annually, but from 1984 onwards this increased to 15 per year.

The mean values and standard deviations of numerical data fields for DCS and AGE are shown in Table 2.

The ages of patients ranged from 16 to 58 years, with the average age for both groups being approximately 33 years. The average overall level of diving experience was 6.7 years. For DCS the average level of formal diver training was to the equivalent of PADI Advanced Open Water Diver

TABLE 1

DATE FIELDS AND PERCENTAGE OF DATA AVAILABLE

Data Fields	Data Available %
Surname	100
Date of admission	100
Duration of stay	96
Sex	100
Age	99
Occupation	71
Diagnosis	99
Previous DCS or AGE	56
Diving experience in years.	39
Level of training	38
Training organisation	20
Diving activity	76
Number of divers	46
Maximum depth	96
Time underwater	86
Type of tables used	27
Complies with tables?	?
Complies with DCIEM?	86
DCIEM repetitive group	86
Number of dives	90
Number of ascents	90
Number of days	90
Equipment failure	?
Equipment misuse	?
Ran out of air	?
Alcohol/drugs use	17
Aggravated by altitude?	98
DES referral used	98
Retrieved or self-presentation	98
Retrieved in RCC	100
Cardiopulmonary symptomss	98
General symtoms	98
Musculoskeletal symptoms	98
Neurological symptoms	98
Dermatological symptoms	98
Time to symptom onset	90
Delay to recompression	91
Number of recompressions	95
Aspirin	78
Anticoagulants	75
Crystalloids	76
Colloids	77
Lignocaine	78
NSAID's	78
Steroids	77
Outcome after first recompression	97
Outcome at discharge	94
Outcome at one month	47

while for AGE this was only to the equivalent of Basic Open Water Diver.

All cases were civilian divers and 80% were diving recreationally. 8 divers were undergoing diving training, and 4 were diving instructors. A further 8 were diving commercially, although not necessarily holding commercial diver qualifications.

There was a significant difference in mean time to onset of symptoms (10.5 hours for DCS, 0.1 hours for AGE, $p < 0.01$) and in average delay to recompression treatment (57 hours for DCS, 12.7 hours for AGE, $p < 0.01$) between the two groups.

Of those patients who ran out of air or experienced a failure of their air supply, 44% were diagnosed as having DCS and 56% as having AGE. In those reporting more than one ascent during their diving, 87% were diagnosed as having DCS and 13% as having AGE.

20% of those patients with DCS were considered from the case notes to have made a complete recovery after one recompression, compared with 28% of those with AGE. At the time of discharge, 40% of those with DCS were considered to be completely recovered, compared with 58% of those with AGE. Of those whose condition at one month after treatment was recorded (47% of the total), 49% of those with DCS and 50% of those with AGE were considered to have made a full recovery.

Presenting symptoms are listed in Table 3 and adjunctive treatment in Table 4.

Neurological symptoms were present in approximately 90% of patients in both groups. Nearly 50% of patients with AGE had cardiopulmonary symptoms (12% in DCS). In DCS, nearly half of patients had musculoskeletal symptoms, and a similar number had general symptoms including malaise, tiredness and aching or fullness in the head. Dermatological symptoms were present in 11% of those with DCS but not reported in any of those with AGE.

80% of those patients with AGE received intravenous crystalloid solutions as compared to 50% of those with DCS. Half those with AGE received at least one dose of steroids, as did one-third of those with DCS.

The significant factors influencing treatment outcome, together with their respective p values, are listed in Table 5.

Divers with DCS maintaining a DCIEM repetitive group less than or equal to group G was associated with a significantly better outcome at all times. Group F was associated with a better outcome at discharge and one month later.

TABLE 2

AVERAGES AND STANDARD DEVIATIONS OF NUMERICAL DATA FIELDS

DATA FIELDS	DCS			AGE		
	Cases	Average	Standard Deviation	Cases	Average	Standard Deviation
Age	92	33.7	7.8	32	32.7	9.9
Duration of stay (days)	89	4.8	6.4	31	6.3	10.1
Diving experience (years)	35	7.4	6.8	7	9.9	5.9
Level of diving training*	34	1.9	1.2	10	0.9	0.5
Maximum depth (M)	89	28.0	13.0	31	23.4	10.0
Time underwater (MIN)	81	34.0	17.0	26	33.2	11.4
Number of dives	85	3.8	6.8	26	1.4	1.0
Number of ascents	84	5.6	13.0	26	1.9	1.5
Number of days diving	85	2.0	2.5	26	1.2	0.6
Time to onset (hours)	90	10.5	41.0	32	0.1	0.5
Delay to recompress (hours)	86	57.0	87.0	28	12.7	17.2
Number of recompressions	88	3.3	3.5	30	3.1	5.0

* level 1 equivalent to PADI basic open water diver
* level 2 equivalent to PADI advanced open water diver

TABLE 3

PRESENTING SYMPTOMS AS PERCENTAGE OF CASES

Diagnosis	General	Dermatalogical	Musculoskeletal	Cardiopulmonary	Neurological
DCS	41	11	48	12	88
AGE	13	0	9	47	91

TABLE 4

ADJUNCTIVE THERAPY
(PERCENTAGES OF CASES WHERE DATA WAS AVAILABLE)

Diagnosis	Aspirin	Anti-coagulant	Crystalloid	Colloids	Lignocaine	NSAID	Steroids	Other
DCS	32	1	54	0	8	40	37	39
AGE	21	17	80	21	13	24	54	58

TABLE 5

SIGNIFICANT OUTCOMES OF 2 X 2 CONTINGENCY TABLES FOR 125 CASES

Decompression Sickness

FACTOR	POOR OUTCOME after 1st RCC	at time of discharge	at 1 month follow-up
Repetitive DCIEM Group greater than F	0.054	0.010	0.008
Repetitive DCIEM Group greaterthan G	0.008	0.00006	0.002
Non-Adherence to DCIEM Tables	0.014	0.005	0.006

Arterial Gas Embolism

FACTOR	POOR OUTCOME After 1st RCC	at time of discharge	at 1 month follow-up
Non-Adherence to DCIEM Tables	0.008	0.011	0.012

Adherence to DCIEM tables was associated with a significantly better outcome in both DCS and AGE. Compliance with the diver's own tables or computer did not appear to be a significant factor, nor did the number of dives or ascents.

The time to onset of symptoms and the delay to recompression did not appear to have any significant influence on outcome.

Discussion

As in most retrospective studies absent or incomplete records led to many data fields being inadequate for analysis.

The epidemiology of these civilian diving accidents is similar to other regional experience.[3] While the preponderant neurological involvement is different from early studies of DCS,[4,5] it supports many other recent surveys.[3,6]

The most interesting finding is, however, the significantly better outcome in those divers who kept within conservative tables such as the DCIEM tables and those whose diving profiles resulted in a DCIEM repetitive group lower than group G. Adherence to DCIEM tables was also shown to be a significant outcome factor in those patients with AGE and this may be explained by the likelihood of their having concurrent DCS.

The lack of any correlation between time to onset of symptoms and outcome may be due to those with mild symptoms failing to recognise them and presenting relatively late for treatment. Animal studies have shown that there is an inverse relationship between latency of onset and the severity of disease.[7] The delay to recompression was not shown to be a significant factor. Since mild disease tends to be treated less urgently any difference in outcome may have been obscured.

Given the findings of previous surveys of this type[3] it is surprising that the number of ascents is not a significant outcome factor. It may be the result of divers in this series under-reporting the number of ascents which occurred.

This study strongly suggests that divers should both keep within conservative tables, such as the DCIEM tables, and ensure that repetitive diving is conservative.

It also demonstrates the need to elicit adequate and appropriate information from the patient during the hospital admission so as to facilitate subsequent prospective study.

The widely varying HBO schedules and adjunctive treatment used resulted from changing ideas about the treatment of dysbaric illness since 1967 and the differing preferences of individual practitioners. Nevertheless, the prevalence of incomplete recovery is in keeping with other reports [3,6] and shows that there is little room for complacency in the current treatment of divers with either DCS or AGE.

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Key Words; Decompression Sickness, Arterial Gas Embolism, Hyperbaric Treatment.

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BOOK REVIEW

DEEPER INTO DIVING. John Lippmann
1990. Illustrated, 610 pages. J.L.Publications, P.O.Box 381, Carnegie, Victoria 3163, Australia.
Price $ 45.00 (including postage)

John Lippmann is an enthusiastic diver and writer and consequently his two previous books on diving have been successful. This book will have a similar fate as it is well researched and written and will satisfy the needs of many involved in diving activities.

The book is divided into sections of physics and physiology, decompression tables, altitude diving, multilevel diving, decompression diving, administration of oxygen and a miscellaneous final section. There are also several appendices. The strength of this book is the simple translation and practical examples given to explain extremely difficult and confusing phenomena. Such explanations are necessary to an increasingly better informed recreational diving community and essential given the active marketing of new decompression tables and decompression computers. A healthy cynicism needed in reviewing these products and this is apparent in John Lippmann's writing.

Purists may object to the frequency of personal communications and unpublished observations cited in this book, but this is the cost of trying to describe what medical practitioners think and believe rather than what they have written. The nature of these citations then is a reflection on both diving and those involved and on the recent changes in understanding of the diving illnesses.

"Deeper into diving" is a logical progression from John Lippmann's earlier books and, although it is written primarily for dive masters and diving instructors, it would be a useful addition to the diving library of serious recreational divers, navy divers, commercial divers and general medical practitioners interested in learning more about decompression and diving medicine.

Des Gorman.

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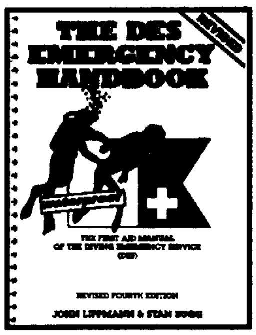

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ARTICLES OF INTEREST REPRINTED FROM OTHER JOURNALS

WATCH YOUR AIR!
1989 British Sub-Aqua Club accident statistics show too many divers running short of air.

Chris Allen

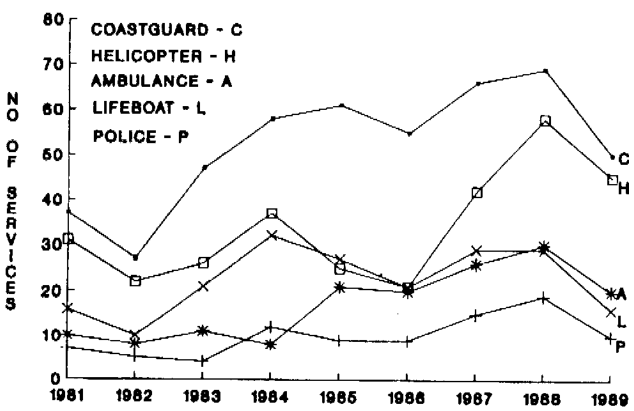
As anyone who deals regularly with statistics knows, it is very easy to draw the wrong conclusions from a given set of figures unless they are interpreted against a proper background. For example, if more road accidents are recorded, there could be a number of causes; more cars on the road, the same number of cars doing more journeys, a longer than usual period of adverse weather conditions, people driving less carefully, or possibly a combination of several of these factors.

In analysing our own accident and incident statistics for 1989 I am very conscious that this year, more than ever, we must take care not to jump to simple and possibly incorrect conclusions. For this year, quite apart from any underlying trends, three quite separate additional factors have influenced the statistics.

First of all, in 1989 we had a record breaking summer with many more dives being carried out as a result. Though it is always difficult to put an exact figure on the numbers of dives done, in recent years we estimate it to be well over one million man dives per year. This year that figure may well have been doubled. Certainly, informal surveys made of compressor stations on the South Coast suggest that air consumption in that area has increased by around 100 per cent this year.

The second factor which has affected the statistics is the change we have experienced in the quality of information we get from third parties such as HM Coastguard and recompression chambers.

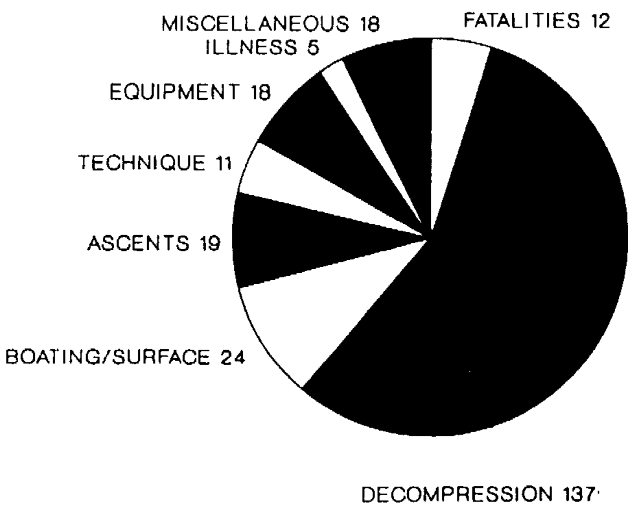
DIVERS' USE OF EMERGENCY SERVICES



This year we have received far fewer Coastguard (CG) reports of incidents involving divers. Normally I would regard that as good news. Unfortunately, I am aware that part of the reason is that there has been a hiccup in the system for distributing CG reports to interested third parties, such as ourselves. This has now been sorted out, we hope, but my feeling is that we have inevitably missed out on some relevant information which would normally have been included in our statistics, and that this is at least part of the reason why the number of incidents with Coastguard involvement and helicopter and lifeboat call-outs appears to be quite a lot lower this year.

On the other hand, this year we have had many more reports direct from recompression chambers. In particular, we are very grateful to have received from the Institute of Naval Medicine a brief summary of each incident which was either treated by a MOD facility or on which they gave advice. This information is invaluable and will in the future help us to identify trends much more accurately. However, in this, the first year in which we have received such reports, it has resulted in an apparent large increase in the number of cases of decompression sickness (DCS).

DIVING INCIDENTS BREAKDOWN - 1989



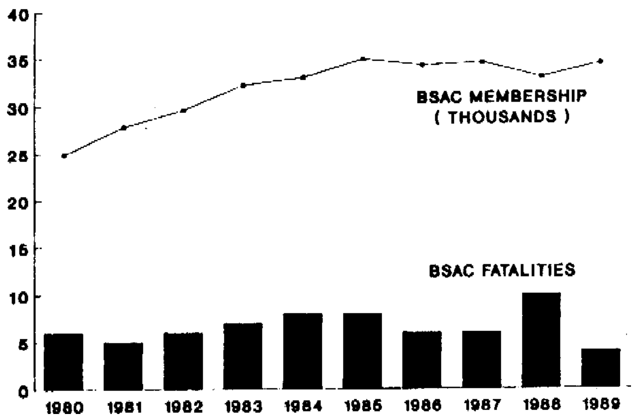
And on the subject of DCS, I have been disappointed to see from these reports that in a surprisingly large number of cases involving BS-AC members, no report has been received from the Branch or individuals concerned. If you are involved in an incident, we will undoubtedly get to hear of it from one direction or another. The BS-AC Incidents Reporting Scheme does not set out to apportion blame, and all reports are treated as confidential. However, the success and value of the scheme are dependent on the quality of the information received. If we do not have your side of the story and those essential details that perhaps complete or even alter the picture, we will not be able to draw the correct lessons for everyone's benefit.

The third factor is what might be termed the "goalpost factor". There is absolutely no doubt that a greater awareness of decompression sickness and improvements in our knowledge and the quality of diagnosis, have led to the reporting and the treatment of symptoms which a few years ago would have gone unnoticed or unreported. We have effectively "moved the goalposts". This in itself is a good thing, but we must be careful not to confuse better detection and reporting with an increase in the size of the problem.

So with that as the background of my 1989 Report, what do the figures show?

First of all, I am happy to say there has been a reduction in the number of fatalities recorded, from 16 to 12, and that in only 4 of those 12 cases were BS-AC members the victims. This compares with 10 cases involving BS-AC members last year.

BSAC FATALITIES AND MEMBERSHIP 1980-1989



When we look at the details of this year's fatalities once again, the single biggest factor is running out of air.

Last year running out of air and a subsequent failure to share properly resulted in six deaths. This year four divers died in similar circumstances.

In one case a pair of divers ran low on air during a wreck dive to 36 m. They had to work hard against the current to regain the shot-line and they both ran out of air on the bottom. After trying vainly to help his buddy, one of the pair successfully made a buoyant ascent to the surface. His partner drowned.

When we look at other less serious incidents we see a similar trend, with a large number of cases of decompression sickness or problems on ascent also occurring because divers had run short of air.

The lessons are clear: always plan to finish your dives with an adequate reserve of air; and check your air supply regularly during the dive. Remember that your air consumption increases dramatically with hard work, depth and cold, and that if you are leading someone who is less experienced, their air consumption is likely to be very much higher than your own. No-one ought to run out of air on a dive, but, just in case, the BS-AC recommends that everyone should carry a suitable secondary breathing system, such as an octopus, to ensure that both parties have the best possible chance of ascending safely to the surface if one of them does have an air supply failure.

While on the subject of equipment, it is clear from the reports I receive that it is essential for divers to consider their equipment as a complete package of component parts which must work well together, rather than as simply a collection of individual items. Change one piece of equipment and you may influence the performance of the whole.

Take, for example, the case of the diver who replaced the cuffs of his drysuit with new heavy-duty seals. A simple enough change you might think, except that his suit was not fitted with a dump valve and he normally vented via his cuff. During the first dive with the repaired suit he found that the new seals, being longer, folded over preventing venting, and as a result he lost control of his buoyancy and made a buoyant ascent from 25 m.

Another diver almost died when she got into similar difficulties with her drysuit. Once again the suit had no dump valve and quite tight wrist and neck seals. On this occasion the problem was a borrowed ABLJ which was inflated on the surface. Unlike her own ABLJ, once the borrowed ABLJ was inflated it accidently and continuously pressed on the suit direct feed, inflating the suit. The diver quickly became unconscious due to the constriction of the neck seal. Fortunately, quick thinking rescuers cut the suit open to vent it and she was successfully resuscitated.

Once again clear lessons not to underestimate the possible effects of even small changes in your equipment. Perhaps a lesson too, that some form of dump valve in a dry suit is a necessity.

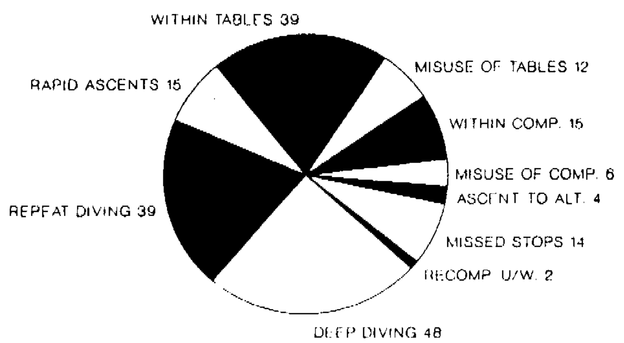
As you will see from the graph shown the breakdown of 1989 Diving Incident Reports, decompression sickness and boating/surface incidents lead the way as usual. Although the reduced number of CG reports means that the number of lost-diver cases and helicopter rescues appears to be down this year, this is still an area where a significant improvement can be made and where the resulting publicity can be most damaging. Once again the majority of lost divers were diving without surface marker buoys (SMBs). The remedy is obvious.

The most spectacular boating incident came, in fact, from one of our overseas branches in the Middle East, and involved a 17 foot dory with twin 50 hp engines and five divers on board, moored above the dive site. In the distance, a large landing craft was seen to be approaching and after initially seeming to be about to pass by, it altered course sharply and headed straight for the dory, ignoring all warning signals. At the time, two divers were underwater ant the three in the boat were forced to leap clear as the landing craft drove straight over the top of the dory! Fortunately there were no injuries; but the boat was written off and a substantial amount of diving gear was lost.

As far as decompression sickness reports are concerned, the statistics show that too many divers are still diving deeper than indicated by their abilities, ignoring common sense depth recommendations, or simply failing to plan their dives properly. A number of the cases of decompression sickness have resulted after required decompression stops have been missed due to divers running out of air towards the end of their dive as a result of inadequate preparation and planning. This seems to be a particular problem with divers who are carrying out extended periods of decompression using dive computers which do not indicate the total time of stops required in advance. These instruments alone are not adequate for such dives. Dives requiring long periods of decompression stops need to be thoroughly planned in advance. If you are to have any chance of managing your air supply properly, you need to know how long your stops are going to be - and that means working it out in advance.

As I have said before, no-one should in any case be doing more than 20 minutes of in-water decompression at the end of a dive. Remember that, with 30 minutes of stops, which evidently some divers consider only a modest amount of decompression, you would be off the BS-AC '88 Tables, off the RNPL/BSAC Tables, and beyond the limiting line of the RN Table 11.

DECOMPRESSION SICKNESS ANALYSIS - 1989



TOTAL NO. OF CASES - 137

We already know that your chances of being hit are much higher if you conduct prolonged spells of deep dives involving significant decompression stops. Confirming that this is indeed the case will aid no-one, least of all yourself.

In this category, the year's best example of sheer lunacy came form Northern Ireland and involved a group of visiting divers from England. During a wreck dive to 68 m a diver's contents gauge hose burst and he ran out of air without being able to perform the required decompression stops. Experiencing the symptoms of decompression sickness on the boat journey back to shore, he twice attempted re-entry recompression before finally being recompressed properly ashore. After such an exposure he was extremely fortunate that all symptoms were resolved completely.

Perhaps people still need to be reminded that re-entry recompression in UK waters should never be considered. There is very little chance of success and a very good chance that you will actually make things worse. The only course of action is to arrange transfer to the nearest recompression facility without delay and to administer oxygen in the meantime.

And on the subject of oxygen, it is extremely heartening to see the number of occasions on which oxygen has been promptly administered during rescues this year. We have also had feedback from recompression facilities that they have seen marked differences in the condition of arriving patients where oxygen has been administered on site and during transfer.

So does your branch have an oxygen set available on site with sufficient trained people able to use it? If not, maybe it is time to have a fund raising drive and make some bookings on the next Oxygen Administration Course in your area.

In conclusion, remember that many of the incidents and accidents which occurred this year were, as always, preventable if only the divers involved had planned their dives properly.

Safety is no accident! So let us all plan for safety in 1990. Safe Diving!

Chris Allen is the British Sub-Aqua Club (BS-AC)Incidents Adviser.

The offices of the BS-AC are at 16 Upper Woburn Place, London WC1H 0QW, United Kingdom.

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COMPUTING THE ODDS

Conclusions from the British Sub-Aqua Club 1989 incident figures

Chris Allen and Deric Ellerby

In analysing the 1989 incident statistics we looked in detail at reports of decompression sickness (DCS) where dive computers were involved, and also kept a close eye on the performance of the BS-AC '88 Tables in their first full season of use.

Compared with previous years, for 1989 we received much better information from chamber operators, particularly the Institute of Naval Medicine which, while continuing of course to respect the rules of medical confidentiality, gave us brief details of each of the sports diving cases they have treated or advised on. We are very grateful for that information and we hope not only to maintain this improvement in data collection in the future, but also to improve its quality. And talking of quality, it is also worth explaining that the quality of diagnosis of DCS has improved in recent years, both by divers and by doctors. There is no doubt that minor symptoms which previously went unreported or untreated are now being picked up. If you like, we have moved the goalposts. That in itself is no bad thing, but we must take care not to confuse increased reporting with an increase in the size of the problem.

The other information which has been very useful is the results of our Diving Officers Conferences (DOC) '89 survey. At DOC '88 attendees were asked to complete a questionnaire on their diving "habits". These were subsequently analysed. Last year we sent out the questionnaire in advance with DOC application forms, which has resulted in a larger number of replies, in fact more than 800.

DOC '89 SURVEY
METHODS USED BY DIVERS FOR CALCULATING DECOMPRESSION REQUIREMENTS

Dive Computers	390
BS-AC '88	379
RN.11	57
RNPL/BS-AC	47
USN	12
Buhlmann	4
DCIEM	0

Some people use both tables and a computer. In simple terms, the majority of people surveyed were using either BS-AC '88 Tables or dive computers.

As far as computers are concerned, 45 of the 137 cases of DCS occurred with computer users. As always a

INCIDENCE OF DCS IN 1989 RELATED TO METHODS OF DETERMINING DECOMPRESSION REQUIREMENTS

Dive Computers	45
BS-AC '88	41
RN 11	2
RNPL/BS-AC	9
USN	8
Buhlmann	9
Unknown	23
Total	**137**

As far as computers are concerned, 45 of the 137 cases of DCS occurred with computer users. As always number of those cases were clear misuse (i.e. missed stops or buoyant ascents), and in some cases the information we have is insufficient to make a judgement, we know only that a diver wearing a dive computer suffered DCS. However in 15 cases we know from the information we have that the divers were "inside" the computer. We also have a bit more information because 6 of those 15 have been examined by the NDC Medical Adviser, Dr Peter Wilmshurst. Although Peter is unable to pass on details of individual cases, we do know that 5 of those 6 were found to have Patent Foramen Ovale (PFO) and that the sixth had other relevant medical problems.

To try and put the whole thing in perspective, researches with computer suppliers in Britain suggest there are now 7,500-8,000 computers in use. This compares with our estimate of 5,000 at this time last year, so the use of computers has apparently increased by about 50 per cent in 1989. Interestingly, the increase in the number of cases of DCS among computer users is also 50 per cent.

One of the interesting things that came out of both the 1988 and 1989 surveys is that computer users generally do more dives than table users. However the gap appears to have narrowed somewhat with the introduction of BS-AC '88 Tables which are obviously more flexible.

If we consider 8,000 machines in use, and take a figure of say 50 dives per user on average (less than both years' survey results, but a nice round number), remembering a proportion of them were probably with a non-wearing buddy, we have around 500,000 person-dives on computers in 1989 which, even including the cases where known misuse was a factor, gives an incidence rate of better than 1 in 10,000. This is better than reported in 1988 when we appear to have under-estimated the number of dives done.

Turning to the BS-AC '88 Tables we have recorded 41 cases of DCS among people using '88 Tables.

In terms of usage, we have sold 18,000 copies of the tables so far. It is not easy to say how many dives have been done on each set, doubtless some sets are owned by people who make little or no use of them, while other sets have whole branches diving on them. But it is clear that the majority of BS-AC members are using '88 tables. In recent years we would estimate that sports divers in the UK have been performing about 1,250,000 person-dives a year. With the excellent weather experienced last year that could well be more than 2,000,000 dives. Of these, we estimate close to 1,000,000 were carried out on BS-AC '88 Tables. Even if that is too optimistic and the number of dive**S WAS ONLY HALF THAT FIGURE, THE INCIDENCE RATE** on BS-AC '88 would still be better than 1 in 10,000.

Breakdown of DCS in
uses of bs-ac 1988 tables
Insufficient information
8
Misuse
11
'Within' Tables
22
Total 41

It is interesting to look back over the past couple of years at the percentage of **DCS CASES WHICH DO OCCUR "WITHIN"** tables or computers. It is probably higher than you would think.

dcs Cases Within Tables/Computers
1987 42%
1988 47%
1989 39%

If either dive computers or the BS-AC '88 Tables had fundamental flaws we would expect this percentage to be increasing.

It would seem that as far as decompression incidents are concerned we can usefully divide them into three main categories.

Firstly, there are incidents that occur following a dive or series of dives which are clearly outside normally accepted risk parameters. In these cases the increased risk is not difficult to identify and a rather simple remedy is also pretty obvious. However, as diving is an adventure sport it will always attract adventurous characters, so just counselling "Don't do it" will not always work. In such cases we have always believed that education is far more likely to succeed than legislation and that Diving Officers and Instructors have an important role to play in providing that education. What is totally unacceptable is the situation where divers are engaged in such dives with anything less than a full understanding of the risk they are taking.

Secondly, there are incidents where the dive does not seem to be stretching any limits, and typically does not demand any in-water decompression stops. Here, what must be understood is that dives up to a no-stop limit are dives to a limit and need only a small deviation from the plan to become DCS provocative. There can be a much greater degree of provocation in a dive that includes a direct ascent to the surface when in fact a small stop was required, than in a dive that included a stop but a small part of the stop was omitted. So this group would include all dives that missed a stop due to lack of air or lack of buoyancy control, and dives that went right up to the no-stop limit and then suffered a rapid ascent. Also in this category would be dives that taken in isolation seem innocent but that look rather different when viewed alongside the series they belong to. These incidents all have either planning or training implications.

The final group, "innocent dives", holds the rest of our incidents. From Dr Wilmshurst's work on cardiac shunting (PFOs) it would seem that many of these have a medical explanation today and others may eventually also be explained medically, as our knowledge improves. The difficulty now is that there is a world of difference between medical explanation and solution. There seems no simple way of screening for PFO now or in the near future. Advice in this area is going to be difficult as it will lack scientific support, but knowledge and understanding are going to be important factors in risk assessment.

We must remember also that not all our underwater incidents have a decompression element. Fatalities through drowning are obviously a concern and while these are fortunately even rarer than decompression incidents, we still must learn the maximum from each case. The key factors that emerge from analysis again point **t**o **t*he need for better pl***anning or training, or both!

So how do these observations affect our advice?

1
Check dive fitness.

Do not put divers into situations for which they have not had appropriate experience. Too many incidents show an almost selfish approach from Dive Organisers or Dive Leaders in putting others into inappropriate situations so that the Organiser/Leader can have a dive they enjoy. Many of the incidents that occur around Easter/early summer show relatively novice divers getting into trouble because they are doing dives they are clearly not ready for. Similarly, we see experienced divers engaging in dives they are not fit for follo***wing a winter break.*** Frequently these dives lead to decompression incidents in the second category.

2
Check skill level.

Make sure that divers have a full understanding of the responsibilities they are accepting. Do they understand how to use their dive computer or the t**ab*les they are usi***ng? Have they properly mastered the techniques of in-water decompression stops?

3

Plan your dive.

Make sure dive plans are made; make sure they are checked. Make sure they are sensible and achievable by the divers planning to carry them out. Make sure their equipment is both appropriate and adequate. Do you have a system that evaluates dive plans? Paradoxically modern tables and computers can only offer flexibility if more rigorous planning takes place before the dive. Air consumption planning is even more significant. Plan your dive and dive your plan is still our best advice. This means careful monitoring of the dive **as *it progresses. The*** flexibility mentioned earlier soon disappears when someone runs short of air.

4

Control the ascent.

Pay careful attention to the ascent phase of the dive. Many divers still do not seem to appreciate that most of their dive is spent absorbing gas and only a small amount of time is allocated to getting rid of that gas. There must be a better appreciation that the ascent is a major opportunity for the fast tissues such as the brain to off-load gas. If it is not correctly managed the potential for serious problems is high. The analogy of tearing up to a red traffic light and screeching to a halt is quite appropriate, and an equally dangerous operation.

It would seem that besides not fizzing on the ascent there are other forbidden delights. Certainly the concerned diver should refrain from the traditional method of wetsuit warming during an ascent, and also avoid baked beans for breakfast. Coughing is to be avoided; indeed anything that might cause a pressure reversal across a PFO is bad news.

There has long been a respected body of opinion that has recommended making precautionary stops during an ascent. The difficulty we have had has been in reconciling such a procedure with existing tables which used the concept of bottom time followed by a fixed-rate ascent to the surface. With both the BS-AC '88 Tables and dive computers such stops are now simple to incorporate, remembering of course that any such stops must be properly planned and carried out.

Although not strictly part of the ascent, we all recognise that the surface interval following a dive is part of the decompression process. Just as a pressure reversal across a PFO is bad news during an ascent, so it is in the period immediately after the dive. That means avoid strenu***ous activities, s***o if you want an excuse to get out of hauling the anchor up, be the last pair in.

5

Control the risk.

Accept that diving is an adventure sport and a certain degree of risk will always attach to it. But in all situations minimise this risk. Do not push yourself out of the sport you love by pushing the limits too far. Do not lose diving through carelessness when a little planning is all that is needed.

Dr Wilmshurst's work on PFOs has raised concern, but we must remember that it is unlikely that the risk has changed at all. What has changed is our awareness of the risk. With this particular risk not diving at all is one solution, a solution unlikely to be acceptable to most divers until their individual PFO risk level is ascertained. Another alternative is to limit maximum depth to, say, 15 m. Again, this is unlikely to be very popular when the degree of personal risk is unclear. The most likely approach will be to accept it as part of the general risk that accompanies immersing your respiratory orifices in a liquid. Attempting risk control would suggest even at this early stage that we can do a little better. Avoid the ascent provocations mentioned earlier. Be prepared should the worst happen, with immediate oxygen therapy and radio to contact the emergency services.

So what can we learn about DCS from the 1989 statistics? Well, its not so much what has been learnt as what has been reinforced, it is clear that the biggest influence on your risk of DCS is not whether you use computer or table, nor w*hich computer or table you use, but how you go about organising and carrying* out your dive pr*ac*tice!

Reprinted, by kind permission of the Editor from DIVER , June 1990; 33-34.

Editor's comment

These two papers discuss the BS-AC's contribution to the acci*dent statistics which led to the DMAC statement referred to in Letters to the Editor on pages 217-218.*

NEUTRALLY BUOYANT ASCENTS

Dennis Graver

If we can maintain neutral buoyancy throughout our ascents, we can control how fast we go up. But suit expansion, expanding air in the buoyancy compensator (BC), and breathing patterns and currents attempt to thwart a diver's efforts to maintain control of the rate of ascent.

If a diver is carrying too much weight, then more air than necessary must be maintained in the BC at depth (the correct amount of weight is that which will enable a diver to hover at a depth of 15 feet with 300 psi of air remaining and not one pound more). The more air in the BC, the more that must be vented during ascent.

For decades the procedure to vent excess air has been periodic venting. But with this method, maintaining neutral buoyancy is a hit-and-miss process.

Not too many years ago, Lou Fead introduced an easy, effective BC venting technique at NAUI's annual International Conference on Underwater Education. The concept is very simple, but not many divers seem to be aware of the procedure.

The Technique

To maintain a given amount of air in the BC, assume an upright position, hold the vent valve of the BC open with the mouthpiece pointed downward at chest level.

Next, slowly raise the mouthpiece until air begins to bubble out of the BC, about shoulder level. The inverted mouthpiece forms an air trap, while the open valve allows any expanding air in the BC to escape. This creates a constant volume of air in the BC, which equals constant buoyancy.

The level of the mouthpiece is the diver's accelerator, raising the valve slightly allows more air to escape from the BC and slows the ascent rate, while lowering the valve allows more air to be maintained in the BC and increases the rate of ascent.

If you're wearing wet suit and its expansion begins moving you faster through the water column, simply raise the mouthpiece an inch or two and regain control.

GSD, an Italian equipment manufacturer, has installed a constant-volume valve, similar to the automatic vent valves for dry suits, into a line of buoyancy compensators. The diver determines the amount of buoyancy to be retained in the BC by turning the valve, which increases or reduces the amount of force needed to cause the valve to vent. Any increase in pressure is automatically vented by the valve, so volume remains constant throughout ascents.

One model of the GSD BC does not even have an oral inflation hose. The "Shuttle Valve" BC has a low-pressure inflation valve and an automatic exhaust valve. It takes a few dives to adjust to the new techniques for controlling buoyancy with this BC, but control is excellent. As a couple of bonuses, no water gets inside the bladder, so maintenance is easy and there is no hose to become entangled or to get in the way.

I like the concept and hope that it will soon be adopted by other manufacturers. Currently the GSD BC is unavailable in the U.S. Other constant volume valves are available and could be professionally installed in your BC.

Dry Suits

All manufacturers and some training agencies recommend automatic vent valves for dry suits. Simply having one will not do the job, however, unless the operator uses the valve correctly. The valve should be dialed to minimum tension to vent the suit for descent. Air should be added to the suit to maintain neutral buoyancy during descent and on the bottom, and the valve tension should be increased just enough to retain the required amount of air in the suit. Once neutral buoyancy is achieved, the diver should be able to cause the valve to bubble simply by elevating it a couple of inches above the rest of the suit. Naturally there must be air under the valve when this check is made.

With the valve correctly set for neutral buoyancy at depth, any expanding air inside the suit will be automatically vented during ascent, provided the valve is maintained as the highest point in the suit and the diver is positioned so that all expanding air will migrate to the valve. Upon surfacing, dry suit divers should increase the tension on the exhaust valve and add a small amount of air to the suit to establish a small amount of positive buoyancy.

All dry suit manufacturers agree that buoyancy compensators should be worn with dry suits. The BC should only be used for surface or for emergency flotation, however, and should not be used to maintain neutral buoyancy under water. If the BC is used at depth, the diver is forced to control both the BC and the suit during ascent, and the difficulty of a neutrally-buoyant ascent is compounded.

Some types of undergarments restrict the migration of air within a dry suit. If takes a while for the air to make its way through the resistance of the material to the valve, especially if the suit is compressed tightly against the diver. This means there can be excess air in a dry suit during ascent even though the suit has an automatic exhaust valve. The key to maintaining neutral buoyancy in a dry suit during a trip to the surface is to ascend slower than when wearing a wet suit. This allows expanding air to make its way to the exhaust valve.

Divers should remember that breath control can be used to regulate the speed of ascent. Buoyancy can be reduced by six to eight pounds simply by exhaling. Maintaining a low average lung volume can significantly slow an ascent rate.

New techniques, new equipment, and common sense offer complete control of ascent rates to the modern diver. The most important requirement, however, is awareness. Until sensors and controllers are developed that make buoyancy control completely and continuously automatic, we must pay attention to buoyancy and to our rate of ascent.

The author, Dennis Graver, is the Director of Education of NAUI.

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The address of Undercurrent is P.O. Box 1658, Sausalito, California, 94965, U.S.A.

FLYING AFTER DIVING

Last year, several experts in hyperbaric medicine met at the Headquarters of the Undersea and Hyperbaric Medical Society in Bethesda, Maryland. Their task was to develop a new set of recommendations for flying after diving, based on the latest scientific information. These are their recommendations:

Wait 12 hours

If, in the past 48 hours, you have accumulated less than two hours of dive time (surface to surface) on dives requiring no decompression.

Wait 24 hours

If you have been conducting multiday, unlimited diving.

Wait at least 24 and, if possible, 48 hours

If you have been conducting decompression dives.

These recommendations are based on flying at cabin altitudes up to 8,000 feet. Because of the complex nature of decompression sickness and because unverifiable assumptions are involved in decompression schedules, there can never be a flying-following-diving rule that is guaranteed to prevent bends completely.

The guidelines are the "best estimates" based on current scientific information and expert opinion, and are expected to be conservative, safe surface intervals for the vast majority of divers. In a few individuals their physiological makeup or special circumstances of their dives may result in decompression sickness even though the guidelines are followed.

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The address of UNDERCURRENT is P.O. Box 1658, Sausalito, California 94965, USA.

THE CONSENSUS ON ASCENTS

Research diving officers from several universities put their heads together in September at the "Biomechanics of Ascents" workshop sponsored by the American Academy of Underwater Sciences (AAUS) at Cape Cod's Woods Hole Oceanographic Institution.

Bearing in mind the advice of Dr Ed Lanphier, who cautioned the group to "avoid voting to determine truth in the absence of knowledge", the workshop participants did formulate a number of recommendations.

Much of the focus was on the rate of ascent. After many presentations and much discussion, it was agreed, not surprisingly, that the maximum rate of ascent should not exceed 60 feet per minute. However, as far as decompression is concerned, slower rates provide little benefit until in the range of about 2.5 feet per minute. At the same time, slower tissues continue to ingas with slower rates, and this can affect the end-of-dive group assignment.

Participants believe buoyancy compensation is a significant problem in control of ascents. Before certification, a diver should be required to demonstrate proper buoyancy, weighting and a controlled ascent that includes a hovering decompression stop. Certified divers should periodically review proper ascent techniques to maintain proficiency. All buoyancy compensators should have reliable, rapid exhaust valves that can be operated in a horizontal swimming position. Dry suits should be equipped with "hands-free" exhaust valves. Divers using dry suits should be trained in their use, and buoyancy compensators should be worn with dry suits. At the end of every dive, a three- to five-minute stop in the 10- to 30-foot zone is recommended. Stopping causes divers to be in control of the ascent, which many felt was every bit as important as the precaution against decompression sickness.

The participants felt strongly that every diver, even those in training, should have instruments to monitor the rate of ascent. Several speakers indicated the need for an inexpensive ascent "speedometer".

The attendees agreed on revised procedures in the event required decompression is missed. Breathing 100% oxygen above water is preferred to in-water air-breathing procedures for omitted decompression.

Expert speakers included the Rev. Dr Ed Lanphier, Dr David Yount of "tiny bubbles" fame, Dr Andrew Pilmanis, Dr Van Liew, John Lewis, Bill Hamilton of Tarrytown Labs and Dennis Graver from NAUI.

Complete proceedings of the workshop will be published by the AAUS and will be available in January 1990. For information contact the AAUS at 947 Newhall, Costa Mesa, CA 92627.

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THE FIRST DEMAND VALVE?

John Bevan

Recently, while innocently browsing through the fascinating archives of the Patent Office, I stumbled across a truly remarkable discovery. I found that in London, on June 19, 1838, some 30 years before Rouquayrol and Danayrouze patented their demand valve, a Mr William Edward Newton first filed a patent for a diaphragm-actuated, twin-hose demand valve for divers.

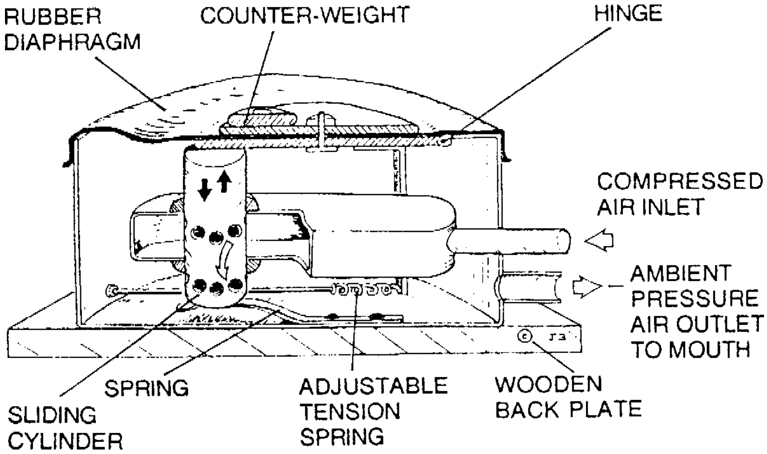
Now it was Rouquayrol and Danayrouze in 1872, and later still, Cousteau and Gagnan, who are popularly credited with inventing the first working demand valves. So is it possible that Newton's demand valve patent of 1838 displaces these august names into second and third places?

To be absolutely fair, it would largely depend on whether or not Newton's precedent was a viable, workable design. Unfortunately, my research to date has failed to turn up any reports of its actual construction or use.

Let us look at the Newton design, the purpose of which was to "supply air to the diver in a regular and uniform manner, and not by puffs, as it would be if conveyed to him directly from a pump".

The valve itself, which Newton dubbed the "manometre" was mounted on a flat piece of wood and strapped to the back of the diver. A circular diaphragm, which was made of india rubber or oiled silk, covered the top of a cylindrical housing or "box". This diaphragm was stiffened by being sandwiched between two thin wooden plates which, in turn, were hinged to the main housing. Newton termed this a "lid" to the "box".

An elegant arrangement consisting of an adjustable spring and counter-weight provided the diver with the facility to "tune" the diaphragm in a similar way that the second stage of some single-hose demand valves are adjusted to this day.



The next component of the demand valve further demonstrates the classical simplicity and brilliance of Victorian engineering. The diaphragm was drawn inwards as the diver began to inhale. This movement caused a cylinder (a "peculiarly formed valve") to slide through a flattened tube which was connected to the source of compressed air to pass from the inside of the flattened tube into the cylinder and out again into the void enclosed behind the diaphragm. From here it was conveyed directly to the mouth of the diver. The air would thus continue to flow until the diver had completed his inhalation. At this point the pressure beneath the diaphragm would rise again the meet the ambient pressure, whereupon a small spring returned the sliding cylinder together with the diaphragm back to the "off" position, shutting off the supply of compressed air.

In this position none of the holes in the sliding cylinder was in communication with either the voids behind the diaphragm or within the compressed air supply hose. The valve thus supplied the diver with air only on demand, in the same way as demand valves work today.

A further beautiful aspect of this particular design is that since there is no change in overall surface area of the moving parts exposed to differential pressure during the sliding movement of the cylinder, the valve is perfectly balanced.

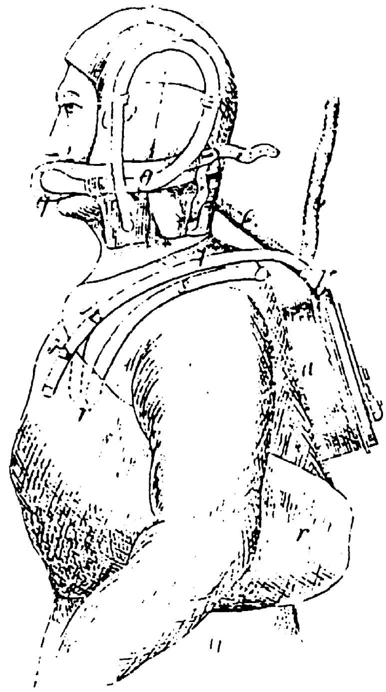
Even more remarkable features were ahead of the much later Cousteau-Gagnan product. The inspired air was conducted to a mouthpiece which also incorporated an exhaust tube. Within this mouthpiece, two spring-loaded non-return valves ensured that water could not be sucked back into the mouth, and equally, any water that may have got in could be vented safely through the exhaust tube.

A further simple but effective feature to avoid the ingress of water was provided by looping the exhaust tube at the side of the diver's head "so that in whatever position the diver may be placed, the end of the tube is never upper most and consequently, there is no danger of being drowned".

This general arrangement incidentally provided a safety mechanism whereby any compressed air that may have leaked through the demand valve could be vented safely through the mouthpiece and exhaust tube into the sea, just as in modern demand valves.

Finally, we discover a direct feed facility into a "stab jacket"*, complete with open/shut valves and left/right equalisation tube. This Newton described as "a waistcoat, at the lower part of which a sort of bag is attached, made of any flexible water-proof material".

The compressed air supply for the direct feed came from a T connection into the main air



This drawing from Newton's patent specification shows the demand valve on the diver's back and the "stab jacket"on his chest and under his arms with the looped exhaust tube by his head.

supply hose, just before its connection with the demand valve. The piping and valving arrangement to the stab jacket was such that air could be vented during ascent, though it clearly lacked the sophistication of the modern safety blow-off valve.

In the early 1800s there was obviously no method of compressing air sufficiently to produce a self contained breathing system, so the compressed air supply for Newton's patent was a low-pressure reservoir maintained by a pump on the surface.

The original Rouquayrol and Danayrouze apparatus was, like the Newton apparatus, a surface-demand breathing apparatus, though it did take the first step towards self-containment.

So there we have it - a truly incredible discovery! Anyone wishing to obtain a full copy of this patent can do so by application to the Patent Office in London. The title is simply, "Diving Apparatus", patent number 7695, dated 19th June 1838, patentee William Edward Newton.

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* "stab jacket" is short for "stabilising jacket" which is the UK term for a jacket-type buoyancy compensator.

MIDDLE EAR BAROTRAUMA IN SCUBA DIVING TRAINEES

H N Staunstrup, L Knudsen B Malling and P Paaske

Abstract

Twenty-one male scuba diver trainees were investigated during their diving course, where they did from 2-7 dives (in all 104 dives). Before and after each dive, they were investigated by a questionnaire (comprising questions of tubal dysfunction and other otological symptoms), by otoscopy and by tympanometry.

Forty-eight per cent of the divers experienced symptoms of tubal dysfunction at some time. Otoscopy mainly revealed minor degrees of barotraumas to the middle ears. In only two cases we saw bleeding in the tympanic membrane. Otoscopic findings correlated to symptoms of tubal dysfunction ($p < 0.05$). Tympanometry revealed no further signs of barotrauma than those seen by otoscopy.

Symptoms and signs of middle ear barotraumas are often seen in scuba divers, but mostly they are of minor degree.

Introduction

Authors describing aural problems in divers have stated that middle ear (ME) barotrauma is the most common malady experienced by divers.[1-5]

The mechanism and pathophysiology of ME barotrauma has been described in detail by several authors.[1-5] The capability of opening the Eustachian tube (ET), which is essential for avoiding ME barotrauma has been described by P.W. Head.[5] ME Barotrauma is seen in the tympanic membrane (TM), but reflects the damage in the ME mucosa. Recreational diving is one of the most expanding sports, and the purpose of our study was to investigate how often ME barotraumas occur in sports divers and how serious the traumas are. We investigated scuba diver trainees by questionnaire, otoscopy and tympanometry.

Subjects and Methods

Twenty-one male scuba diver trainees doing a basic scuba diver course were investigated. Prior to the diving course the students had passed a medical examination by a general practitioner. The examination included a history of actual or previous otological disorders, an otoscopy and a simple test for hearing loss (hearing whispering at a distance of three metres). All students in our study were further examined at the Ear, Nose and Throat Department, University Hospital, Århus. They were otoscopied under a microscope, and their tubal function was investigated with Impedance Audiometer ZO 73 A (Madsen Electronics, DK 2730 Herlev) measuring ME pressure before and after the Valsalva manoeuvre. Before each student was included in the study, he had finished the theory lectures and the pool training, so he was familiar with the technique of equalising the middle ear pressure by swallowing or by a Valsalva manoeuver.

Before the dive

Before each dive the students were asked if they suffered from a cold or from allergic rhinitis. In the presence of these symptoms and if the student was not able to equalize the middle ear pressure by using a mild Vasalva manoeuvre, he was excluded from diving. Each student was otoscopied prior to the dive. The findings were divided into six gradings (Table 1). The gradings were slightly different from those described by Edmonds et al4, but we found our gradings easier to reproduce. Also the ME pressure was measured with an Impedence Tympanoscope ZS 330 (Madsen Electronics, DK 2730 Herlevl), as described by Birch, Elbrønd & Kritiansen.[6] The tympanometric curves were classified according to Jerger[7] and Fiellau-Nicolajsen.[8] Curve A shows ME pressure above -100 mm H_2O. Curve C_1 shows ME pressure between -100 mm H_2O and -200 mm H_2O. Curve C_2 shows ME pressure below -200 mm H_2O and curve B is a flat curve, indicating fluid effusion in the ME.

TABLE 1

OTOSCOPIC GRADINGS IN MIDDLE EAR BAROTRAUMA.

Grade	Otoscopic Finding
0	Normal otoscopy
1	Injection of pars flaccida and manubrium
2	Injection of pars tensa
3	Retraction of the tympanic membrane
4	Bleeding in the tympanic membrane
5	Blood in the middle ear
6	Perforation of the tympanic membrane

After the dive

After the dive, the students were asked about tubal dysfunction expressed by problems in equalising the ME pressure during the dive, pain in the ears during or after the dive, and about sensation of blockage in the ear after the dive. Like the examination before the dive, otoscopy and tympanometry was done after the dive.

To verify possible inner ear damage from the dive, all students were asked about vertigo and tinnitus. They were examined with Bartells binocular for nystagmus, the Rinne and the Weber tests of hearing were made.

Maximum depth and the duration of the dive was recorded for each dive.

Correlation between the different parameters was assessed by the ^{c2}-test. Differences before and after the dives were assessed by the Mann-Whitney test. Results are given as median and ranges. A probability value of 0.05 was considered significant.

Results

Twenty-one students, all males, with a median age of 23 years (range 16-27), did 104 dives, median 5 dives (2-7). The median depth of diving was six metres (2-12). The depth and duration of the dives are shown in Table 2.

TABLE 2

NUMBERS AND DURATION OF DIVES TO THREE DIFFERENT LEVELS OF DEPTH

Depth of Dive (meters)	Number of Dives	Duration of Dive (minutes)
- 5	30	28 (10-50)
5 - 10	60	34 (5 - 54)
10 - 20	14	10 (5 - 18)

Two hundred and eight ears were tested with tympanometry and otoscopy. In 24 cases the divers had symptoms of rhinitis, two allergic, before the dive.

The otoscopic changes before and after the dives are shown in Table 3.

TABLE 3

OTOSCOPIC FINDINGS BEFORE AND AFTER THE DIVES

Grade	0	1	2	3	4	5	6
Before	184	22	2	0	0	0	0
After	131	73	1	1	2	0	0

In eight cases, Grade 1 otoscopic changes, found before the dive, were not seen after the dive. In another case, Grade 2 changed into Grade 4. In the other cases, the findings seen before the dive were reproduced in the same grade or a grade higher after the dive. Grade 1 findings represent 94% of the total number of otoscopic changes.

There was no correlation between otoscopic findings and symptoms of rhinitis, between the otoscopic findings and depth of dive, between tubal dysfunction and rhinitis, and between tubal dysfunction and depth of dive. There was a correlation between otoscopic findings and tubal dysfunction ($p < 0.05$).

Eleven tympanograms were excluded because of improper testing. The tympanometry curves before and after the dives are shown in Table 4.

TABLE 4

TYMPANOMETRY CURVES BEFORE AND AFTER THE DIVES

Curve	A	C1	C2	B
Before	194	0	3	0

In two cases, C_2-curves found before the dive changed into A-curves. In one case, a C_2-curve changed into a C_1-curve. In two cases, A-curves changed into C_1-curves. In one case, an A-curve changed into a flat B-curve. This was the only flat tympanometry curve we found, indicating fluid in the middle ear. This curve corresponded with a Grade 4 otoscopic finding. The middle ear pressure increased in 113 cases during the dive. In 47 cases the ME pressure decreased. In 34 cases the pressure was unchanged. The median pressure before the dives was 0 mm H_2O range (-230 mm H_2O to +80 mm H_2O). The median pressure after the dives was +10 mm H2O (-170 mm H2O to +160 mm H2O). The ME pressure after the dives was significantly higher than before the dive ($p < 0.05$).

Ten divers experienced tubal dysfunction (48%). Dysfunction was registered in twenty-eight ears. In five cases the complaints were of more than one type, giving a total of 33 complaints from the 208 ears.

There were no complaints of tinnitus or vertigo. The Weber and Rinnes tests were normal, and we found no cases of nystagmus. This indicates that there were no cases of inner ear barotrauma in our investigation.

Discussion

According to Edmonds et al.[4], the Eustachian tube opens when the pressure gradient is 25 cm sea water. Other authors[9] have found the passive ME clearing pressure to be between 40 and 50 cm sea water, depending on the subject's position. Pain and discomfort occurs at two metres of sea water or at a 20% volume reduction in the ME area.[4] The depth of our dives (median 6 metres) should therefore be sufficient to observe changes in the middle ear and tympanic membrane as a result of a barotrauma. As expected, we found no correleation between depth and otoscopic changes or depth and tubal dysfunction complaints. This corrresponds to the physics of diving, since the first metres of descent are where the greatest relative pressure changes occur. Our experience is that it is rare that divers complain of ME pressure problems at greater depths.

In this study we wanted to find out if tympanometry could give us a tool to determine the severity of ME barotrauma. When there is fluid effusion in the middle ear, tympanometry becomes pathological, expressed by a flat curve. In this study there were two cases with bleeding in the tympanic membrane. In one of these cases the tympanometry gave a flat curve. For practical reasons, tympanometry did not reveal any cases of bleeding in the tympanic membrane or in the middle ear, that was not seen by otoscopy. We did not make any measurements 24 to 48 hours after diving. If this had been done, we might have found more than two cases of severe barotrauma, since fluid effusion to the ME can be a late finding.[3] Rhinitis predisposes to tubal dysfunction,[10] but if the diver can equalize the ME pressure by a mild Vasalva manoeuvre, we conclude that the risk of ME barotrauma is not increased.

During ascent the expanding air in the ME escapes without any active effort by the diver, but our tympanometry measurements, showing a significantly higher ME pressure after the dive, indicate that the expanding air does not all escape during ascent.

Otoscopic changes were found, after one or more dives, in 18 of the 21 divers. 94% of the changes were Grade 1. It could be a reaction to the tympanic membrane due to immersion, but there was no control group of swimmers to confirm this. If it is so, the correlation between tubal dysfunction and otoscopic changes would be even greater.

We found complaints of tubal dysfunction in thirteen per cent of the 104 dives, 208 ears at risk. We had a low complaint-value, when we look upon the ears numerically. If we count the number of divers who complained, we find that 10 out of 21 divers experienced signs of tubal dysfunction at some time. This number corresponds to 48%. This corresponds with the statement that middle ear barotrauma is the most common problem for divers, and that almost every diver will experience it at some time.

In conclusion, this study showed that middle ear barotrauma is a very common disorder which will be experienced by the majority of divers. Complaints of tubal dysfunction are verified by otoscopy. Severe ME trauma, with fluid effusion in the ME, that could be shown by tympanometry, is rare.

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WHAT ARE WE DOING TO OURSELVES? What goes on with the bends

Dick Clichy

A recent *UNDERCURRENT* article led me to wonder just what the typical diver believes happens to him or her when struck by decompression sickness.

Look at what divers have reported:

> "Twice to the chamber due to bends-like symptoms.... probably wasn't the bends.... although diving may be involved, it's not the bends."
>
> "Wasn't bent badly but did make trip to the chamber..."
>
> After the incident, which was mild to light in nature..."
>
> "....constricted visual field in left eye, confusion.... think I had transient decompression sickness."

Among too many sport divers, there is a frightening casual attitude toward what happens when they have decompression sickness.

Any time inert gas bubbles form in the bloodstream, a diver has decompression *sickness*. Perhaps we should describe a diver with bends *symptoms* as one who is suffering from decompression *syndrome* .... "a group of symptoms that occur together and are typical of a particular disease". Decompression sickness is represented by the presence of inert gas bubbles in body tissues.

We know that nitrogen is villain in decompression sickness, but we must recognise just how much we still *do not know*! A while back, Dr William Schane wrote in his seminal article in *UNDERCURRENT* that "more than 100 of the brightest minds in the field [have reviewed] the assumptions underlying the development of decompression tables.... The consensus was that we still do not have the vaguest notion of how the body handles culprit gases".

How the body reacts

Autopsies performed on divers by a team of British researchers have revealed that the spinal cords have been terribly damaged after a period of years of diving, presumably as a result of either hyperbaric exposure or the presence of inert gas bubbles forming in the tissues of the spinal cord.

Other recent British research has shown that divers, regardless of length of diving history, develop aneurysms (bulging or weakening of the wall) of capillaries in the eye's retina. There is no loss of visual acuity but the implications of such an observable physiological change are certainly curious. Is it possible that such vascular changes may occur elsewhere in the body as well?

Bubbles appear to form at sites throughout the body called "bubble nuclei". Scientists disagree as to whether these bubbles form in the bloodstream or in nearby soft tissues, but there is no disagreement that most of these bubbles ultimately end up in the bloodstream or the lymphatic circulation. Even if no symptoms are present, it is conceivable that these bubbles possess the ability to cause injury.

Some of these bubbles may end up blocking capillaries that surround the alveoli, the small sacs responsible for gas exchange in the lungs. If 10 percent or more of the respiratory capillary bed is blocked by these bubbles, the diver may experience the "chokes", a respiratory problem that results in inadequate respiratory gas exchange due to increased rate of breathing and reduced depth of breaths.

In the spinal cord, bubbles may form in either the white matter of the cord itself or the circulatory system of the spine. Regardless of where the bubbles form, the potential for cord damage is present. The bubbles in the spinal cord tissue may actually destroy nerve cells of the cord, or if bubbles and their by-products are in the spinal circulation, the smaller vessels can be occluded with spinal cord tissue death ultimately occurring where the circulation is stopped. Evidence of such damage might include localised loss of feeling, impotence, loss of bladder or bowel control, and paralysis. Such consequences are not pleasant to contemplate.

The immune system reacts to nitrogen bubbles in the same manner it does to any other foreign material. The body's defense mechanisms attempt to isolate these bubbles by first coating then creating clots around the bubbles. These free-floating clots take on the shape of the bubbles and seem to have an affinity for each other. So, in addition to the other problems, the body has a number of microemboli circulating shortly after the formation of nitrogen bubbles. These microemboli can block the circulation anywhere: the brain; soft tissues; the sensory organs; the lymphatic systems; the circulatory system at the skin surface; or perhaps block more capillaries in the respiratory system. In addition, this process and the changes mentioned below result in the blood becoming "thicker" or "stickier" and thus less efficient.

This process, like a snowball rolling down a hill, can progress to degrees of injury far beyond the scope envisioned simply from the presence of nitrogen bubbles that might have been resolved by early recompression therapy.

With all of the circulatory blockage already mentioned, much of the blood volume normally available to the rest of the body is shunted and unusable. The diver therefore becomes relatively unstable from a blood volume standpoint and such reduction in volume serves to accelerate and exacerbate clotting, thickening processes mentioned above.

Decompression sickness can look or act like anything. If you have been diving and simply don't feel right after a dive (say within 24 hours), it would be prudent to consult with someone knowledgeable in diving medicine. Early intervention with appropriate recompression therapy has been shown to be beneficial in that most studies conclude that the earlier the treatment is initiated, the less severe will be the residual effects.

Decompression sickness/syndrome is an extremely insidious illness and should not be treated lightly. Instead of trying to find out how to dive longer and deeper, responsible divers should make an effort to better understand the environment being penetrated, their own physical limitations and what they should be doing to prevent the formation of bubbles from inert gases. We simply do not know what the long-term implications of diving exposures are physiologically and should do everything we can to protect ourselves.

Author Dick Clinchy is Chief of Emergency Medical Services in Baton Rouge, Louisiana, and the owner of Emergency Medical Resources, a firm that offers scuba instruction and scuba-related continuing medical education programs. He has been diving for 30 years.

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ABSTRACTS FROM THEUNDERSEA AND HYPERBARIC MEDICALSOCIETY ANNUAL SCIENTIFIC MEETING 1989

DECOMPRESSION SICKNESS

Comparison of 14 and 18 metre tables in the resolution rate of decompression sIckness (DCS) in divers.
Wilson M,.Scheinkestel CD and Tuxen DV. *Undersea Biomed Res* 1989; 16 (Supp): 87-88

The Alfred Hospital's multiplace hyperbaric chamber treats divers with DCS as well as patients with conditions accepted by the Committee on Hyperbaric Oxygenation of the Undersea Medical Society. All divers with DCS are initially treated using table RN62, follow-up treatments being with 18 m tables (RN61/modified RN61). In order to overcome attendant staff shortages, a "universal 14 m table" was introduced for the follow-up treatment of divers, so that all patients, regardless of disease state, could be treated in the chamber simultaneously. The 14 m table consists of 100% oxygen at 14 m for three thirty minute periods separated by two five minute air breaks and a one metre/ minute ascent rate to the surface. DCS severity was judged by clinical assessment of standard parameters and was similar in both goups. Relapse was defined as recurrence of symptoms or signs after clinical recovery and cessation of treatment. A retrospective analysis of 65 divers with DCS over 12 months revealed a relapse rate of 22%.

Treatment at	18 m	14 m	p
total number of divers	50	15	
Total inital treatments	2.8+1.4	3.4+1.2	NS
Minutes in chamber	516+192	561+192	NS
Divers relapsing	8 (16%)	6 (40%)	0.032

Z test of proportions revealed p = 0.003 for the relapse rate of divers using a 14 m vs 18 m table, but the numbers are small and need to be confirmed with a larger study. The Alfred Hospital, however, has abandoned the 14 m table for the treatment of DCS.

Hyperbaric Unit, Alfred Hospital, Commercial Road, Prahran, Victoria, Australia.

The treatment of dysbaric disease at the University of Hawaii Hyperbaric Treatment Center since its opening in March 1983.

Arnold A and Overlock R. *Undersea Biomed Res* 1989; 16 (Supp): 29-30

Dysbaric disease continues to be a frequent occurrence in Hawaii, often with severely life-altering residuals, and high costs in terms of medical expense and human suffering. Standard treatment tables have changed little since the publication of the USN oxygen tables 5 and 6. The University of Hawaii hyperbaric treatment Center (HTC) has developed and utilizes treatment tables that are both deeper and longer. HTC treatment involves use of a brief deep spike to a maximum depth of 280 fsw (typically 220 fsw), followed by a bubble-limiting step-out to 60 fsw using 50/50 Nitrox, then oxygen breathing periods similar to table 6, with extensions if necessary. A chart review of all diving accident victims treated at this facility since its opening in 1983 has been completed. Epidemiologic factors, dive profile, time of onset, diagnosis, severity of disease, delay in treatment, treatment routine and residuals were recorded as a database for subsequent review. Analysis indicated that diver profiles tended to be deeper, longer and often repetitive; and that serious dysbaric disease was more likely in this population. Although direct comparison with other treatment facilities is always difficult, our treatment results compare favourably despite this population's use of exceptional exposure dives, and their higher incidence of serious disease.

Hyperbaric Treatment Center, University of Hawaii, School of Medicine, 42 Ahui Street, Honolulu, Hawaii 96813, U.S.A.

Altitude exposure in decompression sickness reported to the Divers Alert Network.

Wachholz CJ, Dovenbarger JA, Bond BG and Bennett PB. *Undersea Biomed Res* 1989; 16 (Supp): 36

Altitude exposure is considered to increase the risk of decompression sickness. Commonly-known guidelines advise a wait of four, 12 or 24 hours following diving prior to flight. Analysis of 27 dive accident reports from 1987 reveal a wide range of onset or worsening of DCS symptoms with altitude, both within and beyond 24 hours post-dive. DCS occurred in altitude exposures ranging from 2 to 110 hours post-dive and elevation increases from 1,000 feet to 7,500 feet in seven altitude cases.

Post dive altitude exposure (in hours)	**Onset of DCS Symptoms**	
	occurred or worsened in flight	occurred with car elevation
0-6	6	4
7-12	2	1
13-24	5	2
24-36	3	-
72	1	-
110+	1	-

Twenty-seven additional cases flew after the onset of DCS symptoms with no change resulting from altitude. While the sample size is not large, 13 (6%) of DAN's 218 DCS cases collected in 1987 were within the commonly discussed flying after diving guidelines of four, 12 or 24 hours. As more data becomes available, altitude after diving guidelines are expected to improve.

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

Saturation treatment for decompression sickness with limited chamber facilities.

Overlock R. *Undersea Biomed Res* 1989; 16 (Supp): 35-36

Saturation treatment of decompression sickness in sports divers has been reported as successful in large and sophisticated facilities. This report describes very favourable results with limited facilities in Hawaii. In four cases a

54 inch double lock chamber was used. An air driven CO_2 scrubber was installed during treatment. Regular venting controlled temperature and humidity. Hygiene and chamber cleaning were accomplished via use of the outer lock as a bathing or holding facility. The author was primary physician and provided inside patient care. The decision to saturate was based upon deteriorating patient condition during ascent from initial treatment. Storage depth was 60 to 50 FSW using compressed air as the breathing gas. Twice daily excursions to 220 or 280 FSW were carried out followed by oxygen breathing periods. Patient progress was carefully evaluated before and after each excursion. When patient progress was no longer evident, decompression was begun. During decompression, oxygen breathing periods were continued on a daily basis until reaching surface depth. Outcome was favorable for four of the five patients; the fifth patient improved, but remains paraplegic.

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Venous gas emboli in humans after prolonged exposure to 1.48 ATA (16 fswg) air.

Eckenhoff RG, Olstad CS and Carrod GE. *Undersea Biomed Res* 1989; 16 (Supp): 67-68

Previous work established that most human subjects generate venous gas emboli (VGE) after direct decompression from prolonged 1.78 and 1.89 ATA air exposures (UBR 13:305). To establish the minimum decompression that results in gas phase formation in humans, we have extended these studies to include 48 hour exposures to 1.48 ATA (16 fswg). Twenty-seven male sport divers, aged 16-63 years, served as subjects. Ten groups of two to three subjects each were exposed to 16 fswg pressure (±0.5 fswg tidal variation) in an underwater habitat in Key Largo, Florida. The subjects were allowed to make excursions within the range of 15-20 fswg in the first 24 hours (average number of excursions = three), but were required to remain in the habitat for the final 24 hours. After surfacing and doffing gear, they were monitored with doppler ultrasound over the precordium at regular intervals. Signals were recorded and scored using the K-M code (UBR 5 [suppl]:28) by two investigators independently. No symptoms consistent with DCS occurred. Sixteen (60%) subjects had VGE detected over the precordium. VGE mean peak-time was 2.8 hours with a mean duration of 5.9 hours. Four (15%) subjects still had detectable VGE 12 hours post-ascent, but none had VGE at 24 hours. The age of Grade 0 subjects was 25.9±10.5 and that for Grade 3 subjects was 44.4±14.1 (years±SD)($P<0.01$). We conclude that the degree of supersaturation for VGE formation in humans is less than previously thought, VGE grades up to Grade 3 can be tolerated without symptoms, and that **aging is associated with a greater incidence of VGE.** *(SPUMS J emphasis)*

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Hyperbaric oxygenation does increase pulmonary excretion of venous air emboli.

Russell GB, Snider MT, Richard RB, Rutherford TM and Loomis J.L. *Undersea Biomed Res* 1989; 16 (Supp): 82

Venous air emboli (VAE) resolve by pulmonary excretion across the alveolar-capillary membrane and dissolution into blood. While using a nonradioactive nitrogen isotope (15N15N) as the N2 component of the VAE and quantitating excretion in exhaled gases, treatment with either 100% O2, compression to 2.8 ATA, or 100% O_2 + 2.8 ATA compression, were compared with a control state in twenty anaesthesized dogs. All VAE were detected by increases in measured $^{15}N^{15}N$ in exhaled gases. Duration of $^{15}N^{15}N$ "washout" was similar to previously documented N_2 washout during O_2 breathing. Pulmonary and systemic BP increases and decreases respectively, were similar in each group. Control group embolus recovery within 20 minutes was 76.1±19.5%. Of the treatment groups only combined therapy (100% O_2 + 2.8 ATA exposure) significantly increased (p=0.5) the amount of air bolus recovered (90.7±13.7%). Dissolved $^{15}N^{15}N$ was not assessed.

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Percent bodyfat and human decompression sickness.

Curley MD, Robin GJ and Thalmann ED. *Undersea Biomed Res* 1989; 16 (Supp): 29

The relationship of percent body fat (%bf) to the presence of human decompression sickness (DCS) was examined in 376 male military divers during three decompression table development dive series. All dives were conducted under controlled conditions in the U.S. Navy's Ocean Simulation Facility. Percent body fat was calculated using skinfold (Series I and II) or circumferential (Series III) methods. Series I involved 135 divers breathing a PO_2 of 0.7 in Helium. Thirty four divers experienced DCS (X %bf = 17.7); 101 were DCS free (X %bf = 17.3). In Series II, 125 divers breathed air or a constant 0.7 ATA PO_2 in N_2 mix. DCS was experienced by 39 divers (X %bf = 14.4); 87 divers were DCS free (X %bf = 13.3). In Series III, 116 divers breathed air or 0.7 PO_2 in a N_2 mix. Forty-one divers who experienced DCS (X %bf = 15.6) were matched with their 75 non-DCS diver partners for that dive (X %bf = 15.4). Point-biserial correlational analyses conducted between DCS and non-DCS divers both within and among the series revealed no statistically significant differences between the groups in %bf. The overall series DCS incidence was 30%. The overall range of %bf was 4 to 31. Results of tests for the significance of differences between proportions of extreme groupings of %bf were non-signficant. In this study of healthy, non-obese divers, %bf was not associated with an increased incidence of DCS.

Navy Experimental Diving Unit, Panama City, FL 32407, U.S.A.

Readjustment of O_2, CO_2, and H_2O in bubbles after a decompression.

Van Liew HD. *Undersea Biomed Res* 1989; 16 (Supp): 32

In a closed system, a 1 ml bubble at 1 ATA becomes 2 ml on going to 1/2 ATA, but pre-existing bubbles in the body undergo a readjustment of o2, co2, and water vapor after a decompression. The readjustment increases volume and decreases N_2 partial pressure (P_{N2}) inside the bubble. The magnitudes of the changes can be estimated by assuming that bubble content of N_2 does not change during the short time required for the other gases to readjust and by choosing reasonable values for tissue partial pressures of the other gases (P_{O2}, P_{CO2}, and P_{H2O}) at various depths and altitudes in an air-breathing person:

$$V_2/V_1 = (P_{A1}-P_{O21}-P_{CO21}-P_{H2O}/(P_{A2}-P_{O22}-P_{CO22}-P_{H2O})$$

where V is bubble volume and P_A is ambient pressure; subscripts 1 and 2 designate before and after the decompression. Calculations show that for tissue gases in a normal range, the changes of volume and P_{N2} are greater on decompression to altitude than from depth, are relatively independent of tissue metabolic rate, and are never more than 25% different from values expected without readjustment. The tendency for equilibration of O_2, CO_2, and H_2O across the bubble wall, which causes these moderate effects, could cause drastic growth in anaerobic tissue: Local acidification of bicarbonate could cause very high P_{CO2} which would lead to entrance of CO_2 into bubbles, and also cause entrance of N_2 as the high P_{CO2} lowers P_{N2} inside.

Department of Physiology, University at Buffalo, SUNY, Buffalo, NY 14214, U.S.A.

High partial pressures of inspired O_2 decrease perfusion and N_2 elimination.

Anderson D, Nagasawa G, Norfleet W, Olszowka A and .Lundgren C. *Undersea Biomed Res* 1989; 16 (Supp): 87

Oxygen breathing is an integral part of decompression tables and preflight protocols as a means of hastening N2 elimination. Hyperoxia may, however, induce cardiovascular changes which interfere with N_2 elimination from some tissues. To study the effects of high PO_2 on N_2 elimination, 36 two hour nitrogen washouts waere performed in six subjects saturated at 2.5 ATA (air equivalent depth 64.8 feet). A closed circuit system supplied the subjects with one of three O_2-Ar mixtures with PO_2 of either 0.2 ATA, 2.0 ATA, or 2.5 ATA. The mean cumulative N_2 yield was consistently greater with normoxic than with either hyperoxic mixture (average difference 16.2%). Additionally, the 2.0 ATA O_2 induced a higher N_2 yield than the 2.5 ATA O_2 gas (average difference 6.1%). Simultaneous measures of blood pressure (sphygmometer), cardiac output (impedance cardiography), heart rate, and skin perfusion (laser doppler) were obtained. Mean arterial pressure increased with higher PO_2 in the face of decreases in cardiac output, heart rate, and skin blood flow. The hyperoxia directly or indirectly induced vasoconstriction and reduced tissue perfusion resulting in a slowed N_2 washout. Theory as well as indirect evidence indicates that this was not an Ar effect. Therefore, the use of O_2 breathing for inert gas elimiation should be scheduled at the lowest ambient pressure compatible with safe decompression.

Center for Research in Special Environments, Department Physiology, School of Medicine, SUNY, Buffalo, NY 14214, U.S.A.

HYPERBARIC MEDICINE DATABASE

Development of an hyperbaric medicine database.

Howe S and Weaver LK. *Undersea Biomed Res* 1989; 16 (Supp): 83-84

The amount of medical data regarding each patient's hyperbaric treatment or procedure can be large. We have developed a database, written in dBASE III+, allowing storage and reporting of hyperbaric patient data in an organized fashion. Eight major categories of accepted indications were provided:

1. Air or gas embolism/decompression sickness;
2. CO/Cyanide poisoning;
3. Crush injury/trauma;
4. Healing enhancement;
5. Exceptional blood loss;
6. Gas gangrene/necrotizing soft tissue infections;
7. Refractory osteomyelitis;
8. Radiation necrosis.

The data regarding any patient or any number of patients with a given treatment is quickly and easily reviewable. Our goal is to develop a standard data structure allowing organized data transferral between hyperbaric centers. This data can then be used for longitudinal studies of hyperbaric treatments and procedures from any number of centers all collecting the same data.

Hyperbaric Medicine, Pulmonary Division, LDS Hospital, Salt Lake City, Utah 8413, U.S.A.

VENTILATORS IN CHAMBERS

Mechanical ventilator function under hyperbaric conditions

Blanch PB, Desautels DA and Gallagher TJ. *Undersea Biomed Res* 1989; 16 (Supp): 17

We studied whether hyperbaric conditions affected the function of 18 different mechanical ventilators. The ventilators studied were: Auto-vent (Life Support Products); Baby bird, IMV bird, Urgency bird, Mark 14 bird, and THE bird (Bird Products Corp.); BioMed IC 2A, BioMed ET-3, BioMed MVP-10, and BioMed P-7 (BioMed Devices); Drager OxyLog (Drager Werk AG); Ohmeda Logic 7 (Ohmeda); PneuPac Model 2, PneuPac PNS 106, and Oxford Penlon (Bear Medical Systems); Hydraulic Emerson (JH Emerson Co.); Monaghan 225 (Monaghan Medical Corp.); and Bennett PR-2 (Puritan-Bennett). The eighteen ventilators were grouped for evaluation into three functional groups - pneumatic time-cycled, pneumatic pressure-cycled, and volume-cycled (piston or bellows) ventilators. Function of these ventilators was consistent within each group with some minor exceptions. However, function varied between groups. The Oxford Penlon was the only commercially available ventilator to maintain rate, tidal volume, and inspiratory time during hyperbaric conditions. Use of other ventilators during hyperbaric oxygen therapy should be carefully considered because of the effects of compression.

Departments of Anesthesiology (Div. of Crit. Care Med.) and Surgery, University of Florida College of Medicine, and Jerome Johns Hyperbaric Facility and Respiratory Care Services, Shands Teaching Hospital at the University of Florida, Gainesville, Florida, 32510-0254, U.S.A.

Effect of varying atmospheric pressure on compressible volume of mechanical ventilators.

Desautels DA and Blanch PB. *Undersea Biomed Res* 1989; 16 (Supp): 17-18

Ventilator circuit compression factors (C_f) and therefore compressional gas losses were directly related to ventilator circuit volume (V_c) and were inversely proportional to atmospheric pressure (Pb). The ideal gas law was used to derive the equation $C_f = V_c/P_b$, which may explain the effect of varying P_b on C_f. Clinicians operating volume-cycled mechanical ventilators in hyperbaric chambers or on aircraft should be aware that V_c should be minimal. We recommend that clinicians measure delivered tidal volume after any significant alternation in P_b. This will prevent the possibility of dangerous increases or decreases in tidal volume as compressional gas increases or decreases.

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DECOMPRESSION COMPUTERS

Comparison of no-decompression limits of dive computers.

McGough EK, Desautels DA, Winston RS, Parker LL and Gallagher TJ. *Undersea Biomed Res* 1989; 16 (Supp): 28

We compared the no-decompression limits for single, square dives between the U.S. Navy Dive Tables (USN) and six commercially available dive computers: Datamaster II and Datamaster-Sport (Oceanic); the Edge and Skinny Dipper (ORCA Industries); Micro Brain (Dacor); and Suunto SME-ML (Seaquest). All computers were submerged together in a 1- to 2-inch bath of water, which was placed in a hyperbaric chamber; 48 hours were allowed between tests. Except for compression at 130 feet of seawater (fsw), all the computers allowed less time than the USN.

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Responses of decompression computers, tables and models to"yo-yo"-diving

Hahn MH. *Undersea Biomed Res* 1989; 16 (Supp): 26

Edmonds drew attention to a habit of multiple repetitive diving, called “yo-yo” diving: emptying a 72 cft tank at about 120 fsw, taking a surface interval of 1-2 hours, going for a similar dive again a.s.o. for a whole day (eg. on Truk Lagoon). Also instrutors busy all day in teaching and taking exams may pile up similar profiles.

Most table reading rules do not forbid this, although repetitive systems were obviously not designed with “yo-yo” profiles in mind, let alone chamber testing of such profiles. Edmonds already lashed the fact, that the “low-pass-filter” properties of monoexponential, parallel compartment models, used in some decompression computers yield no specific “punishment” for this kind of diving.

The responses of various brands of ’89-generation decompression computers as well as table repetitive systems and published decompression models to some idealized "yo-yo" profiles are displayed.

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Diving accidents associated with the use of dive computers.

McGough EK and GallagherTJ. *Undersea Biomed Res* 1989; 16 (Supp): 27-28

In 1987, 557 diving accidents were reported to the Diving Accident Network. In approximately 20% of the accients that could be analyzed, divers were using dive computers. To see whether there might be an association beteween diving computers and diving accidents, we reviewed the teaching hospital because of decompression sickness. From January to October 1988, 34 patients underwent hyperbaric treatment at the study institution. Records of 30 patients were available for review; 9 of these were excluded because of incomplete information (n = 5), use of mixed gas (n = 1), or diagnosis other than DCS (n = 3). Of the 21 patients who had DCS, 11 (52%) had been using a dive computer. Of these, according to dive profiles, 10 (90%) had missed decompression stops as scheduled by U.S. Navy Dive Tables. Of those who were not using dive computers, only 4 of 12 (40%) missed decompression stops, a significant difference from those who did use computers ($P < 0.02$). More patients who used dive computers had dives deeper than 100 ft than patients who did not use computers (82% vs. 33%, $P < 0.04$). Also, more divers who used computers had multiple dives (82% vs. 63%) and surface intervals less than 2 hours (86% vs. 66%) than divers who did not use computers, but these differences were not significant. The use of dive computers by divers who suffer DCS may be increasing; there may be an association with multiple dives, a greater use of dive computers by people at risk of DCS, a lack of agreement between U.S. Navy Tables and dive computer programs, or some other problems with dive computers.

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Conservative aspects of dive computer decompression algorithms.

Heinmiller PA. *Undersea Biomed Res* 1989; 16 (Supp): 27

Recent attention has been given to the fact that most dive computers allow more repetitive diving and longer multi-level dives than the U.S. Navy tables. Little notice has been taken of the conservative simplicications made to existing models when implemented as computer algorithsms,

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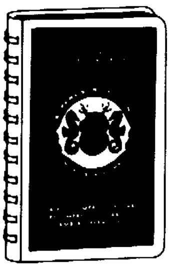

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This Diver's Handbook provides a readily available pocket guide for air decompression procedures, administration of recompression treatment, chamber operations and also emergency first aid procedures. Instruction, examples and tables are included for quick reference.

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and to the effects of these modifications upon dive profiles. The ORCA decompression algorithm utilizes the Workman equations, in the form $M = M_0 + \Delta M * D$, where M_0 is the maximum surfacing compartment pressure and ΔM is the increase in allowed compartment pressure with depth. The conservative aspects come from the selection of constants M_0 and ΔM, and the computer's use of the results of the calculation. First, M_0 values are selected that produce no-decompression limits similar to the doppler no bubble limits, rather than the symptom based limits of the U.S. Navy. Second, the inclusion of slower compartments, in the 120 to 480 minute half-time range, produces less available dive time than tables, beyond the third or fouth day of an intensive schedule. Third, the no-decompression limit is defined as the time to reach the controlling compartment M_0 at depth, not including outgassing during ascent to the surface. Fourth, the use of a ΔM of 1.0 in Workman's equations to simplify computer processing produces decompression ceilings that are 1.5 to 2.2 times deeper than the Navy model for similar compartment pressures. Fifth, ascent rates as slow as 20 feet per minute, enforced by visual feedback, produce more controlled ascents in the field. Finally, in the latest addition to the algorithm, altitude modification of M_0 produces acceptably conservative time limits at altitude without reduction of sea level limits. As a result of these conservative elements, over 1.5 million dives have been made on the ORCA algorithm, with an overall field bends rate less than that of the U.S. Navy tables.

ORCA Industries, Inc., 10 Airport Way, Toughkenamon, Pennsylvania 19374, U.S.A.

ACCIDENT DATA

Comparison of accident data vs survey data of uninjured divers of DAN membership, June 1988.

Wachholz CJ, Dovenbarger JA, Rust JS and Thompson LD. *Undersea Biomed Res* 1989; 16 (Supp): 37

In June 1988, epidemiological data was presented on 270 completed accident cases collected by DAN during 1987. At that time surveys containing identical epidemiological questions to the accident report were mailed to DAN's June 1988 membership of 24,000. 2,633 were returned and compared to the data in the accident report. Below is a sample of data presented in the comparison.

	Survey Population		Accident Population	
Total Responses	**2,633**		**270**	
Mean Age	39	—	33	—
Mean Years Diving	8	—	7	—
Mean Dives Per Year	41	—	47	—

Smoking Currently	243	(9%)	43	(16%)
Male	1987	(75%)	205	(76%)
Female	628	(24%)	65	(24%)
Using Prescription Meds.	670	(25%)	46	(17%)
Using Non-pescription Meds.	624	(24%)	56	(21%)
Diving with Asthma	27	(1%)	11	(4%)
HBO Rx for Dive Accidents	45	(2%)	248	—
Diving with Diabetes	21	(1%)	1	(0.04%)

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

GLEANINGS FROM MEDICAL JOURNALS

Right-to-left shunt and neurological decompression sickness in divers
Cross SJ, Thomson LF, Jennings KP and Shields TG.
Lancet 1990; 336: 568
Letter, stating that their test results do not agree with those of Moon[1] and Wilmshurst[2]. Propose to do large controlled study of the relationship.

Department of Cardiology and the Hyperbaric Medicine Unit, Aberdeen Royal Infirmary, Aberdeen AB9 2ZD, UK..

The use of verapamil to treat box-jellyfish stings.
Burnett, JW. *Med J. Aust* 1990; 153: 363
Letter

Department of Medicine, Division of Dermatology, University of Maryland, 22 South Greene Street, Baltimore, Maryland 21201, USA.

The use of verapamil to treat box-jellyfish stings.
Sutherland SK. *Med J Aust* 1990; 153: 363.
Reply

Commonwealth Serum Laboratories, 45 Poplar Road, Parkville, Victoria 3052, Australia.

Ciguatera and mannitol: a successful treatment
Williamson J. Med J. Aust 1990; 153: 307
Letter

Hyperbaric Medicine Unit, Royal Adelaide Hospital, North Terrace, Adelaide, SA 5000.

Scuba divers at risk of decompression sickness.
Tomlins R. *Med J Aust* 1990; 152: 615
Letter, suggesting single easy to use table be adopted by all diving organisations.

112 Woongarra Street, Bundaberg, QLD, 4670.

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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 ASM convener is Dr Des Gorman, RNZN Hyperbaric Medicine Unit, HMNZS PHILOMEL, Devonport, Auckland, New Zealand, who is interested in hearing from members wishing to present papers.

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, details of which will be sent to members with in the near future, are in the hands of

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Victoria 3147, Australia.

Phone (03) 885 8818
Fax (03) 885 1164 who

SPUMS MEETING MARCH 2nd AND 3rd 1991 COFFS HARBOUR, NEW SOUTH WALES

A weekend meeting will be held at Coffs Harbour, New South Wales, on March 2nd and 3rd 1991. The organiser is Dr Darryl Wallner, 114 Vasey Crescent, Campbell, ACT 2601, phone (06) 248 5950, who would like to hear from those wishing to present a paper.

The lecture programme will be held on Saturday afternoon and will be followed by a dinner, approximate cost including wines, $ 30.00.

The meeting will be held at the Aanuka Resort which has first class facilities, pool, spa, gym, tennis courts and an excellent surf beach. The accommodation is on the basis of twin share in individual units set in beautiful tropical gardens. Early registration will enable numbers to be finalised with the Resort at very favourable room rates, approximately $ 100.00 per person per night, which includes breakfast, lunch, Saturday afternoon tea and the use of all facilities.

Diving is unique at the Solitary Islands as it has a mixture of tropical and temperate zone marine life with true corals, sponges and tropical fish life mixed with colder water species.

There is a registration fee of $ 10.00 which should be sent to Dr Wallner as soon as possible with the following information; name, address and phone number, accommodation required, arrival date, time and length of stay, method of transport and whether diving is required on Saturday or Sunday. A registration form will be found on below.

SPUMS MEETING AT COFFS HARBOUR ON MARCH 2nd AND 3rd 1991

REGISTRATION FORM

Name Phone number ( )

Address

Type of Accommodation Share twin Single (extra charge) Family

Travel Car / Plane Arrival Date Time Departure date

Number diving Saturday morning Sunday morning

Do you wish to present a paper ? Yes / No Topic

Please send, with your cheque for **$ 10.00** made out to **SPUMS Coffs Harbour Meeting**, to

Dr Darryl Wallner, 114 Vasey Crescent, ACT 2601.

Phone (06) 248 5950