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South Pacific Underwater Medicine Society Incorporated

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OBJECTS OF THE SOCIETY

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.

MEMBERSHIP

Membership is open to medical practitioners and those engaged in research in underwater medicine and related subjects. Associate membership is open to all those, who are not medical practitioners, who are interested in the aims of the society.

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All contributions should be typed, double-spaced, using both upper and lower case, on one side of the paper only, on A4 paper with 45 mm left hand margins. Headings should conform in format to those in the Journal. All pages should be numbered. No part of the text should be underlined. These requirements also apply to the abstract, references, and legends to figures. Measurements are to be in SI units (mm Hg are acceptable for blood pressure measurements) and normal ranges should be included. All tables should be typed, double spaced, and on separate sheets of paper. No vertical or horizontal rules are to be used. All figures must be professionally drawn. Freehand lettering is unacceptable. Photographs should be glossy black-and-white or colour slides suitable for converting into black and white illustrations. Colour reproduction is available only when it is essential for clinical purposes and may be at the authors' expense. Legends should be less than 40 words, and indicate magnification. **Two (2) copies of all text, tables and illustrations are required.**

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 illness (DCI) can thereafter be referred to as DCI.

The preferred length for original articles is 2,500 words or less. Inclusion of more than 5 authors requires justification. 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. Accuracy of the references is the responsibility of authors. Acknowledgments should be brief.

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).

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

Computer compatibility

The SPUMS Journal is composed on a Macintosh using Microsoft Word 5.1 and PageMaker 4.2. Contributions on Macintosh discs, preferably in Microsoft Word, or in any program which can be read as "text" by Microsoft Word, save typing time. Microsoft Word 5.1 can read Microsoft Word for DOS, Microsoft Word for Windows, Word Perfect for DOS, Interchange Format (RTF) and some text files provided the disc is a **high density** (not double density) 3.5" IBM compatible disc formatted as 1,400 k. Discs must be accompanied by hard copy set out as in **Minimum Requirements for Manuscripts** above.

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All manuscripts will be subject to peer review, with feedback to the authors. Accepted contributions will be subject to editing.

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Telephone enquiries should be made to Dr John Knight (03) 819 4898, or Dr John Williamson (08) 224 5116.

SPUMS ANNUAL SCIENTIFIC MEETING 1993

ARTICLES OF INTEREST REPRINTED FROM OTHER JOURNALS

GLEANINGS FROM MEDICAL JOURNALS

MEETINGS AND COURSES

DIVER EMERGENCY SERVICE/DAN AUSTRALIA
NEW NUMBER 1-800-088-200

The DES/DAN number 1-800-088-200 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.

The Editor's Offering

When SPUMS was started 23 years ago it was a small society of 12 people, which grew rapidly to over 150 in a year. In those days diving medical expertise resided in the Committee as there were only six doctors in Australia who had ever held a full time diving medicine job. Five of these were in the Royal Australian Navy. That is not to say that all other doctors knew little or nothing of diving medicine. However it was true to say that the majority of doctors who dived in Australia knew no more of diving medicine than their instructors had taught them. This explains the early rapid growth of SPUMS as doctors wanted to improve their knowledge and answer the curly questions put to them by fellow divers who had not understood what the instructor had told them.

At the first SPUMS AGM held at Heron Island it became clear before and during the first dive that many of the members did not dive safely. Some put themselves at risk by dropping over the side before the boat had stopped, risking propeller bite, and others set off down current and could not swim back against it. Naturally enough the naval contingent, Carl Edmonds (President) and Bob Thomas, recast the scientific program to focus on diving safety. They started running courses in basic diving medicine in various warm water venues which were well attended, but education was not spread widely as almost the same people came to every course!

Even in 1976 it was possible to photograph a SPUMS member sitting on the gunnel of a boat, with his bottom well over the side, wearing his weight belt and buoyancy vest, but no fins or mask or air cylinder. And he was not the only one.

Given the members lack of safe diving habits, or was it ignorance, the 1977 ASM took the form of a mini-course in diving medicine using the Royal Navy and US Navy films made to instruct their divers. That was the first year that people had to use buoyancy vests when diving with SPUMS. This was because divers getting into trouble underwater die if they do not reach the surface. Five people ran out of air underwater that year, but none came to harm because the convener had arranged for safety divers with octopuses to watch over the members.

Those who served on the Committee in those far off days had it regularly confirmed that they knew more about diving medicine than the vast majority of members. So it is not surprising that policy was made “from above”. A further reason was the lack of change in the membership of the Executive Committee. The Editor has been on the Committee since 1975 and can only remember about 5 elections where a vote has been required in that time. It is flattering that the membership thinks that the current Committee cannot be improved on, but it is almost certainly untrue. All committees can be improved by new ideas, which usually come in new bodies.

Since 1986, when the Royal Adelaide Hospital Hyperbaric Medicine Unit took its modern shape under Des Gorman, it has become much easier to obtain an adequate training in diving medicine. Over 100 doctors have done the two week course at Adelaide. There are many more jobs where doctors are exposed to diving and hyperbaric medicine. There are many doctors who know more than basic diving medicine (defined as enough to diving medicals properly) in Australasia. SPUMS needs their input to continue to advance.

The Society made a step towards a consensus type policy in 1990 when there a sub-committee was formed to work with the SPUMS representative, on the Standards Australia Committee preparing the Recreational Diver Training Standard, on the requirements for the diving medical. Their work resulted in the SPUMS Diving Medical published in 1992. This meeting was not controversial as all held similar views, but it did result in some improvements to the representative’s original draft.

Last year SPUMS, with a much better informed membership than in the past, went part of the way with participatory democracy as a method of arriving at a policy with the workshop on emergency ascent training. It was unfortunate that some members, who find it difficult to believe that the sketchy training given to divers is worth the risk, even if it is only 2 deaths in 1.25 million trainees, were not able to attend and put their views. The views in the letters to the Editor and Dr Walker’s paper *The no-air problem in scuba diving* should have been presented before the workshop. Certainly many more divers die from running out of air than from practising emergency ascents, but what is missing from the equation is how many divers are actually saved by the training given on their open water course.

This year’s workshop on dive computers will attract similar criticism if all the thinking and speaking is left to a few. SPUMS needs all its members to participate in policy decisions. It is obvious that not everyone can attend the ASM, some are kept away by work and some by the cost. But they can put pen to paper, or more usefully finger to keyboard (so that it can be read easily), and send in their views and the reasons for them. It is only if those who cannot attend the ASM participate from a distance that the workshop can come up with a consensus decision which represents the Society correctly. All members are affected by Society decisions and all should play their part in the decision process. So send in your DIMS and Project Stickybeak reports, your letters to the Editor and your nomination for a position on the Committee.

ORIGINAL PAPERS

FITNESS FOR DIVING
A review of the critical issues

Des Gorman

The nature of the problem

Despite romantic illusions that humans may have significant dormant "reflexes" that remain from their evolutionary past and that adapt them to underwater activities, in reality, humans are poorly equipped to dive or swim underwater. This is not to say that they are not attracted to diving. New Zealand, and then Australia, has relatively the greatest number of active divers (Table 1). The Australasian diving exposure is even greater still, in relative terms, because of the local mild winters and the coastal predominance of communities. Many other Australasians dive for employment or science.

TABLE 1

THE NUMBER OF ACTIVE RECREATIONAL DIVERS IN DIFFERENT COUNTRIES

Country	Number	% of population
Australia	450,000	2.8
Great Britain	60,000	0.1
New Zealand	150,000	5.0
USA	2,500,000	1.0

The role of a diving fitness assessment is as either a pre-diving screen or as an ongoing health-surveillance. These exercises will vary according to the nature of the diver, that is, whether the diver is or intends to use diving as an occupation. In most western countries, the assessment of occupational divers is prescribed, the medical practitioners are designated according to relevant post-graduate training, the minimum fitness standards are defined and the frequency of the assessments is set. There is a major program underway to produce an uniform international standard because of the "migratory" nature of the working diver. It follows that this is an actuarial exercise.

In contrast, in most countries, the assessment of the fitness of a candidate for recreational diving is essentially discretionary and either does not involve, or can be performed by, any medical practitioner.

This distinction is nonsensical. The ultimate need for training of a medical practitioner is in the conduct of a discretionary assessment. Here there is no prescription of fitness and the role of the medical practitioner is to determine and explain the risk to the risk acceptors (the diving candidate and the intending instructor). In comparison to determining the compliance of a candidate with a prescriptive standard, an assessment of individual risk requires that the medical practitioner be able to use an understanding of the special physical environment of diving and the consequent effects on the diver's physiology in an estimation of absolute (if possible) or relative (more common) risk.

The ability of an Australasian medical graduate to perform such a risk assessment, without special training, is controversial. Some branches of the Australian Medical Association (AMA) have argued that this could be done adequately by any medical practitioner and that no extra training is needed. This is contrary to the experience of physicians with a special interest in diving medicine, the New Zealand and Australian Divers Emergency Services and the South Pacific Underwater Medicine Society (SPUMS). Published surveys of local medical practitioners who have had no training in diving medicine have shown that they have little intrinsic knowledge in the area and that their assessments of diving fitness are neither prescriptive nor discretionary.[1]

The need for post-graduate training courses in diving medicine in Australasia has been established by the large number of aspiring and existing divers requesting an assessment of fitness for diving and by the (essential) absence of diving medicine in undergraduate medical courses. Given the extraordinary competition for teaching time in medical student programs, it is naive to believe that this situation will change soon.

A risk related approach to the determination of fitness

In any assessment of risk, the first step must be to identify the risk acceptors. In the context of occupational diving, this is the employer and the diver and is variously defined in Health and Safety legislation as a "duty of care". In some Australian States, self-employed divers are exempt. This is at best a curious anomaly given that relevant medical and rehabilitation services are available at no cost to the diver. Because of the artificial description of candidates as either "fit" or "unfit" that arises from the use of a prescriptive occupational standard, a review or arbitration system is required. In New Zealand, for example, this arbitration is performed by the Medical Directorate of the Department of Labour. A change from a prescriptive occupational diving fitness standard to a discretionary "standard" in Australasia is not possible given the need for international reciprocity.

No such independent arbitration exists for recreational diving candidates, nor is any probably needed. It is essential then that recreational candidates and their medical examiners understand the determination of their fitness. A didactic and dogmatic pronouncement by a medical practitioner does not impress most candidates. Indeed, it is well established that the usual response to such treatment is for the candidate to present to another medical practitioner and not report the "problem" that generated the negative response from the first practitioner. It follows that the candidate must be included in the risk determination and fully understand the prevalent rationale. Not only will this reassure them that the risks presented to them are real, but it will also help them to explain their consequent decision to their peer group. This is a major consideration and it is recommended that all candidates be asked about their motivation to learn to dive.

Given the nature of the process outlined above it can be seen that the extent of the assessment will either be prescribed or discretionary. There is a need here to discuss only the logic of the latter. Any part of the assessment must be a cost-effective use of both the medical practitioners' and the candidates' time. In general, the criteria for any effective health surveillance activity can be used. For an activity (eg. chest X-ray) to be useful as a diving health screen it must be able to sensitively and selectively identify conditions that are both relevant to diving fitness and are prevalent in the subject community being screened. In this context, in many parts of Australasia, a chest X-ray would not be cost-effective as a screen unless the candidate had a personal or family history of respiratory disease or the medical practitioner found some relevant abnormality on examination of the candidate.

It is not possible to "rule out" all potential problems that may interfere with diving fitness, a stance which would limit diving fitness to individuals with gills. This approach would also have all diving candidates being subjected to a glucose tolerance test, haemoglobin analyses, repeat provocative EEGs and MRI bone surveys. It is important to retain the perspective of the exercise, which is an informed assessment of risk. The concept of "safe to dive" for a human is a nonsense.

Critical questions in determining fitness

In part, those AMA Branches that argue that any medical practitioner can determine diving fitness, mistakenly see diving fitness as an absolute phenomenon. If so, then a list of contraindications (e.g. Dilantin controlled epilepsy) would be all that was required. However, the "real" world is populated by people with conditions such as hypertension and within the hypertensive population are subjects at every conceivable level of fitness. It is not possible to be didactic about such a heterogeneous group and an individual risk assessment is needed. In addition to a knowledge of the underwater environment, the medical practitioner must also have a systematic approach to any condition (disease, disability, level of fitness, morphology) that the candidate may possess and that may be relevant to diving. The following questions provide a suitable framework (asthma is used as an example here):

a Will diving make the condition worse (or interact with any medication to worsen side-effects)?
- i Aspiration of salt-water, breathing a dry cold gas and exercise may all precipitate asthma.

b Will the condition (or its treatment) compromise the diver's or their companion's safety in the water?
- i It is essential that the hostile non-respirable nature of the environment be the basis of this consideration.
- ii The concept of mutually dependent diving pairs intrinsic to modern diving training is also relevant.
- iii The work-load in even recreational diving is often unpredictable and extreme. Asthmatics are over-represented in diving fatalities. They die on the surface trying to swim to safety in adverse conditions.

c Will the condition (or its treatment) predispose the diver to a diving-related illness or injury?
- i If there is any air-trapping in an asthmatic's lungs, then this could precipitate barotraumatic lung damage.
- ii Most bronchodilators are also vasodilators and hence limit the ability of the lungs to filter bubbles from the blood.

These questions also provide a suitable template to explain the risks of diving to an individual candidate.

The role of the diving school

Much of the assessment of a candidate's fitness for diving cannot be performed in a medical practitioner's rooms.

For example, water fitness can only be determined by the diving instructor. Claustrophobia and aquaphobia, both common and incompatible with successful diving, will become apparent, usually during the first pool training session, and previously undeclared problems such as asthma may become apparent. Diving-related phenomena (eg. middle-ear barotrauma) may require referral of the candidate back to the medical practitioner. The diving instructor must also be sensitive to the motivation of the candidate to become a diver.

It follows that there is a pivotal role for the diving instructor in the overall determination of a candidate's fitness for diving and that the medical practitioner and the diving instructor should have an established liaison. This will require the consent of the candidate, but such consent is usually forthcoming when it is requested.

The emphasis on needing to determine water-fitness in this discussion is deliberate and appropriate because of the changing demography of recreational diving candidates. Twenty years ago, the diving candidate was usually young, male and an already established snorkel/breath-hold diver. This, fortunately, is no longer true and all ages, both sexes and candidates of varying water-skills are requesting training as divers.

Summary

The assessment of a candidate's fitness for diving is either an actuarial exercise (occupational divers) or a determination and discussion of risk (recreational divers). The former is based on a prescriptive standard and the latter on an understanding of the underwater environment and the consequent effects on human physiology. Training for the latter is essential and available at different centres in Australasia (Table 2).

References

1 Edmonds C. MMM, the Mickey Mouse medical. SPUMS J 1986; 16 (1): 3-4

Suggested reading

Edmonds C, Lowry C and Pennefather J. *Diving and Subaquatic Medicine*. London: Butterworth Heinemann, 1992.

Postscript

Since this paper was submitted for publication the Australian Medical Association has acknowledged the need for training in underwater medicine for those who do diving medicals. See the letter on page 24.

Surgeon Commander D.F.Gorman, BSc, MB ChB, FAFOM, DipDHM, PhD, is Director of Medical Services, Royal New Zealand Navy. His address is RNZN Hospital, Naval Base, Auckland 9, New Zealand.

TABLE 2

COURSES IN UNDERWATER MEDICINE IN AUSTRALASIA

Australia	
Adelaide	Royal Adelaide Hospital (twice a year) (61)-(0)-224 5116
Sydney	RAN School of Underwater Medicine (annually) (61)-(0)8-960 0333
New Zealand	
Auckland	RNZN Hospital (annually) (64)-(0)9-445 5972

COURSES TO PREPARE DOCTORS TO DO DIVING MEDICALS FOR RECREATIONAL DIVERS

Australia	
Eastern Australia	Diving Medical Centre (as required) For details contact Dr Bob Thomas Diving Medical Centre 132 Yallambee Road, Jindalee, Queensland 4047.
Phone	(07) 376 1056 / 1414
Western Australia	Hyperbaric Medicine Unit Fremantle Hospital (annually) For information contact Hyperbaric Medicine Unit Fremantle Hospital Fremantle, Western Australia 6160
Phone	(09) 431 2233
Fax	(09) 431 2819

THE NO-AIR PROBLEM IN SCUBA DIVING

An alternative approach to prevention

Douglas Walker

The recent SPUMS Workshop on Emergency Ascent Training[1] appears to have been based on the assumption that making a few "emergency ascents" during the basic scuba training course produces a diver who will be safer when he or she encounters an "inevitable" low/no air situation.

The same inappropriate assumption was made during the Workshop run by the Undersea Medical Society (UMS) in 1977.[2] There is no report that anyone seriously questioned this assumption at either the SPUMS or UMS Workshop. Indeed, no diving experts who held other views were represented. Discussion was limited to a comparison of the various ascent options. At least there was one dissenter in the printed report of the UMS Workshop, Dr Eric Kindwall,[3] though he was neither present at the meeting nor was his paper presented there. Although McAniff[4] gave a highly negative opinion of the proposal to include such practice as an essential part of basic training, he failed to follow the logic of his own data and apparently accepted statements of opinion that the practice was essential. A cautious legal opinion[5] was ignored, if the printed report accurately conveys what was discussed.

A more appropriate subject for a Workshop would have been an examination of the factors which favour the development of a low/no air situation, and whether the inclusion of a few practice "emergency ascents" during a training course can be shown to influence the course and outcome of such a situation.

There is a chronic dichotomy of approach to the subject of safety and this can be illustrated by considering the example of how to make a cliff edge path safe for users. One can either construct a fence at or near the cliff edge to stop people from falling over the edge or one can accept that such accidents are inevitable and provide an ambulance service at the foot of the cliff plus a short course in cliff climbing. Although this rather over simplifies the options in the scuba diving situation it identifies the basic differences in how one can approach the management of any safety related problem.

It has been well said that for every complex problem there is a solution which is simple, appealing, and wrong. The essence of criticism directed at the design of the SPUMS Workshop was distilled by G K Chesterton through the words of his creation Father Brown, who said "It isn't that they can't see the solution. It is that they can't see the problem". So what is the problem which requires attention ?

The purpose of all basic scuba training courses is to produce a diver who is aware of the problems he or she is likely to meet, is able to recognise them at an early stage in their development and respond correctly and calmly to them and is aware of the limitations of his or her knowledge and ability. The time available for training is necessarily limited by financial considerations, so it is mandatory for courses to concentrate attention on developing those skills which are demonstrably essential, and the primary one is to avoid allowing a low-air situation to develop. The Provisional Reports[6] on diving-related fatalities show that nearly half (64/153) of the diving deaths in Australia occurred in grossly inexperienced divers (Table 1). This a very clear indication that the above level of training is not achieved by a proportion of those certified. Eleven others had not dived for a long time

The case for regarding practice in out-of-air ascents as essential has three main elements :-

1 That it is inevitable that however well trained the diver is, he or she will, at some time, unexpectedly run out of air.

2 That practice under controlled conditions on a few occasions of some form of "no personal air supply" ascent procedures will produce a skill which will persist, and work faultlessly, in some for-real situation at some time in the future.

3 That absence of such an item in the training will decrease the safety of the diver after certification.

This paper was written to refute these propositions, in the hope that it will stimulate a long overdue investigation of the low-air problem in scuba diving. I have made several unsuccessful attempts to persuade two major diving organisations to take part in such an investigation. It is unlikely that this paper will alter the training philosophy of any of the main American based instructor organisations, as this subject has become one of faith and dogma and as such is beyond being influenced by argument. This may be the reason why no investigations have ever been made into whether the emergency ascent training produces any practical benefit, and the lack of requests for input into the discussion from the Royal Australian Navy (RAN), the Royal Navy (RN) or the British Sub-Aqua Club (BS-AC).

Is running out of air inevitable ?

There are only two basic reasons for a scuba diver to run out of air during a dive, either there has been some equipment malfunction, or the diver is responsible for the situation. The "acceptable" example of the former occurs in cold water diving where a freeze-up of the regulator can result in a free flow of air. However training can prepare divers to meet such situations.[7]

TABLE 1

LOW EXPERIENCE LEVELS (78 OF 153) SCUBA DEATHS 1955-91

DIVERS UNDER INSTRUCTION OR WITH MINIMAL EXPERIENCE (64)

Case	Experience	Comment	Equipment	Remaining Air
SC 72/6	Just trained		Hired	None
SC 72/10	Very inexperienced		Hired	Low
SC 72/11	During training	Panic ascent	Own	Low
SC 72/12	During training	Surface change to snorkel on 1st OW dive	Diveshop	Yes
SC 73/1	2nd OW dive	1st OW was on just-completed course	Own	Yes
SC 73/6	2nd use of scuba		Own	Not stated
SC 73/7	Newly trained		Own	None
SC 73/8	Part trained, inexperienced		Own	Yes
SC 73/9	1st dive after course	Cardiac death	Own	Yes
SC 73/10	Very inexperienced	Alcohol involved	Borrowed	Not stated
SC 74/1	1st use of scuba	In a muddy dam	Borrowed	None
SC 75/1	1st use of scuba		Hired	Yes
SC 75/4	1st use scuba lesson	Not wearing fins	Not stated	Yes
SC 76/1	2nd use of scuba		Not stated	Yes
SC 76/2	Not trained, inexperienced	9th dive	Own	Yes
SC 76/8	Probably 1st use of scuba	Cardiac death	Not stated	Not stated
SC 77/1	2nd use of scuba	1st time was in a rock pool	Borrowed	Yes
SC 77/3	1st sea dive		Hired	Low
SC 78/1	2nd use of scuba	Entangled in weeds	Own	Not stated
SC 78/2	2nd use of scuba		Own	None
SC 78/3	Just trained		Own	Low
SC 78/4	Probably very inexperienced		Hired	Yes
SC 78/5	Part trained	Dangerous dive location	Borrowed	Yes
SC 78/7	During training	Deep dive in dam	Own	Yes
SC 78/8	Untrained	9th use of scuba	Hired	None
SC 79/1	1st dive after course 14 months before		Own	Not stated
SC 79/3	4th dive after course		Own	Low
SC 79/5	During training, OW course		Diveshop	Yes
SC 79/6	3rd use of scuba		Hired	Yes
SC 80/1	3rd or 4th use of scuba		Borrowed	Yes
SC 80/2	3rd dive after course		Own	Low
SC 80/3	2nd use of scuba		Hired	Not stated
SC 80/4	3rd OW dive		Own	Low
SC 80/5	During training, 3rd OW dive, end of course	Current	Diveshop	Not stated
SC 80/6	3rd use of scuba	Buddy similarly inexperienced	Buddy hired	Yes
SC 81/2	2nd use of scuba		Hired	Yes
SC 81/4	1st use of scuba		Hired	Yes
SC 81/5	1st use of scuba		Buddy hired	Yes
SC 82/1	Probably 3rd use of scuba		Buddy hired	Yes
SC 82/5	1st use of scuba	1 buddy also 1st scuba dive	Buddy hired	None
SC 83/3	Untrained, a few dives some years age,		Hired	Low
SC 83/6	No training, inexperienced,		Buddy hired	None
SC 84/10	Just trained, 3rd OW scuba		Hired	None
SC 85/1	Just trained		Hired	Low
SC 85/3	1st drift dive		Own	None
SC 85/4	Just trained		Borrowed	Low
SC 85/6	1st dive after course		Hired	None
SC 85/8	1st dive after course		Own	None
SC 85/9	9th dive	No dives in the previous 12 months	Own	None
SC 86/2	2nd dive after course		Hired	Yes

SC 86/3	2nd dive after course	1st night dive, tight wet suit	Club	Yes
SC 86/4	Taken on class dive	Cardiac death	Diveshop	Yes
SC 87/1	6th or 7th dive	4th or 5th dive after course	Own	Low
SC 87/2	1st dive after course		Own	None
SC 88/1	10th dive	1st dive after "Advanced Diver" course	Hired	Low
SC 88/3	Just trained	1st dive after course, epilepsy	Club	Yes
SC 88/4	1st dive after course		Hired	Low
SC 89/4	1st use of scuba		Borrowed	None
SC 90/4	7th after dive course	1st cold water dive	Own	Yes
SC 90/6	6th use of scuba	No dives in the previous 12 months	Own	Not available
SC 91/3	During training	Cardiac death	Diveshop	Low
SC 91/6	1st use of scuba, resort dive,	Cardiac death	Diveshop	Yes
SC 91/7	1st use of scuba, resort dive	Surface drowning	Diveshop	Yes
SC 91/12	1st dive after course	1st night dive	Diveshop	Yes
ON DEEP DIVE COURSE (2)				
SC 89/8	Deep Dive Course	Practice buddy ascent	Own	Yes
SC 89/9	Deep Dive Course	Inadequate air supply from regulator	Own	Yes
FIRST NIGHT DIVE (1)				
SC 75/2	Experienced	Solo in harbour	Own	Not stated
NO RECENT DIVING EXPERIENCE (11)				
SC 72/11	Not dived for a year or two		Own	Low
SC 76/5	Few dives since course 12 months before		Own	Yes
SC 78/6	Not dived for 4 years		Own	Low
SC 79/1	Not dived since course 12 months before		Own	Not stated
SC 83/3	Not dived for 12 years		Hired	Low
SC 85/9	Not dived for 12 months		Own	None
SC 89/1	Not dived for 12 months	Buddy 1st dive after course	Borrowed	Low
SC 89/2	Not dived for 12 months		Hired	Yes
SC 89/5	Not dived for 12 months		Hired	Low
SC 89/6	Not dived for 12 months		Own	Low
SC 91/13	Not dived for 12 months		Own	Yes

SPECIAL NOTE

SC 84/7-8 Newly trained divers saved an unconscious diver

Over half of all fatalities occur in divers low on air or out-of-air (Table 2). The majority of those who run low on air are both trained and have some, though sometimes slight, diving experience (Table 3). This is a serious indictment of the training they have received.

TABLE 2

REMAINING AIR IN 153 AUSTRALIAN SCUBA DEATHS 1972-1991

None	47
Low	37
Adequate	49
Not available	3
Not stated	17
Total	**153**

TABLE 3

TRAINING AND EXPERIENCE IN 84 AUSTRALIAN SCUBA DEATHS WITH NO AND LOW AIR

	No air	Low air
Training		
None	9	5
Some	4	4
Trained	28	26
Not stated	6	2
Experience		
None	10	10
Some experience	19	15
Experienced	17	12
Not stated	1	-

TABLE 4

CRITICAL EQUIPMENT DEFECTS AND FAILURES IN 153 AUSTRALIAN SCUBA DEATHS

Case number	Critical defect or failure	Other factors
82/5	Tank "blew off"	Vest had no CO_2 cylinder. Inflator hose was not connected. Untrained. First ever use of scuba.
84/9	Verdigris and slime in first stage Rust in (small) tank	
85/6	Vest failure Weights jammed belt release	Spray of water from regulator when used. Novice.

In only three of 153 Australian scuba diving fatalities was equipment failure the basic critical factor (Table 4). Police investigation of such deaths routinely includes examination of all the equipment. Although a significant error in the contents gauge was found in four cases (Table 5), in none of these was it a factor which affected the course of events. The report by Dr Chris Acott on the analysis of the DIMS reports[8] notes a higher incidence of contents gauge errors than was found among the diving deaths. This implies such gauge problems infrequently have fatal consequences. From his report it is not possible to determine whether the contents gauge errors were significant factors in the incidents or whether they were admitted rather as a stand-in for the diver's own carelessness.

Other faults in equipment, such as a hard-to-breath regulator, should become apparent and ascent started long before any significant lack of air problem developed.

Running out of air in the absence of any equipment failure can be regarded as an avoidable error which good training and a correct dive procedure would obviate. To offer a simile, one would look with suspicion at the teaching standards of a driving instructor who was so certain that his pupils would be likely to run out of petrol after they obtained their licence, that he had them practice siphoning up petrol from another car on a public highway to prepare them for such an eventuality. Air is the diver's essential fuel. In the UMS report the late Dr Charles Brown gave as an example of the need for emergency ascent skill the case of four divers who managed to make an out-of-air ascent from 30 m sharing a single regulator, this being the first open water dive performed by three of them. While accepting that they had been well trained in buddy breathing, it was almost criminal to take three novices to such a depth and a sign of incompetence that three ran out of air. An alternative view of this incident is that fools can survive, rather than ascent training was a vital part of their scuba training. These divers were unfit to be allowed to dive, even though they survived, because they were so ignorant and should never have received certification.

Do a few in-course "emergency ascents" create a skill ?

There is general agreement that it requires the practice of a new and complex skill possibly 15 times under varying conditions before it can be regarded as "overlearned" so that it will be performed both correctly and without need for conscious thought in an emergency.[9] None of the recreational diver training organisations offer this intensity of training in their courses (it would make courses too costly), although this intensity of training was provided, and perhaps still is, by the University of California at Los Angeles (UCLA) and the National Oceanic and Atmospheric Administration (NOAA) in 1977 for the divers they employed. As these divers were more thoroughly trained and regulated than most recreational divers, they should be the ones who are at least risk of making the mistake of running out of air. NOAA required a diver to make 15 open water dives to attain the category of limited diver, and 100 before being granted unlimited diver status.[10]

That actual training practice may not be an essential factor in order to perform a successful out-of-air ascent is illustrated by both positive and negative examples. On the positive side, evidence given at Inquests on fatalities among abalone and pearl (hookah) divers shows that their usually untrained colleagues have frequently made emergency out-of-air ascents after some failure of their air supply. These are all solo true "free ascents" and are regarded as a normal event by these divers, whose tolerance of poor equipment is not to be commended. On the negative side, the DIMS study shows that problems are still arising despite the inclusion of some emergency ascent practice in courses run according to the protocols of the three main instructor groups in Australia.

The first ever successful escape from a sunken submarine was made in 1851 by Corporal Bauer and his two companions from the *Brandtaucher* (*Sea Devil*) at Kiel, from 60 fsw depth. They had neither training nor breathing apparatus.[11] A more recent case which illustrates the

TABLE 5

CONTENTS GAUGE INACCURACY IN 153 AUSTRALIAN SCUBA DEATHS

Case number	Comments
81/2	Resort dive. Over-reading gauge was not responsible for fatality
88/2	One of the group required a decompression stop at 3 m in open water. The victim was deputed as companion. Separation occurred just before they were due to surface together. The victim was found floating at surface, with an empty tank. The gauge read 50 bar but had a loose indicator needle. The cause of death was Acute Myocarditis
88/4	Experienced as a hookah diver but was making first scuba dive. Diving alone. Was seen at the surface calling for help. The backpack was ditched. The tank was empty when found and the gauge read 200 psi.
89/6	Trained 6 years before, then made 2 dives before having a serious road traffic accident. Had only done 3 more dives and none in the last year. Separation occurred during the return to boat on the surface. Died from the effects of inhaled vomit. The gauge over-read by 200 psi

benefit of knowledge even in the absence of any actual practical experience of performing an ascent occurred in 1992. A novice diver was making his first ever hookah dive, at the invitation of a friend who had given him a short trial dive in a garden pool. He had made one scuba dive 9 years before and was totally untrained. Fortunately for him he had at some time heard that one should breath out while making an ascent and this he did when his weight belt came loose, taking the attached hose and regulator with it. He reached the surface successfully and it was his friend who died on a dive later that day. This incident will be more fully described in a later Provisional Report (case H 92/2).

Dr Kindwall[3] has described how he and Dr Glen Egstrom in the early days of diving, before commercial scuba equipment was readily available, frequently experienced equipment failures and had to perform free or swimming ascents. He admitted to being unaware of air embolism at that time and was relaxed about the procedure, but he became uneasy after working at the submarine escape training tower (SETT). He stated his belief that being sufficiently relaxed in the water is the secret of making a successful out-of-air ascent. He told this tale. In the 1940's, while Dr Charles Shilling was supervisor of training at the New London SETT, he took a mongrel dog down to 100 ft in the roving bell and there threw the dog into the water. The dog swam towards the surface exhaling all the way and suffered no ill effects. The dog had received no previous escape training, though as it had been provided by Harvard University it may have been smarter than some. In the current climate of respect for animals it is unlikely permission would be granted to repeat this experiment.

It is noteworthy that while several of the experts offering their opinions at the UMS Workshop stated that numerous practices were an essential prerequisite if the desired skill level was to be achieved, and they were discussing the simpler skills of scuba diving, none drew the logical conclusion that the actual training given to novices was critically inadequate by their standards.

Although McAniff[4] stated that it was unacceptable to have any fatalities during training unless it could be clearly shown that such training saved a greater number of lives, he offered no analysis of the matter and his statement did not seem to lead to a discussion of this important point. When Wenzil[5] spoke to present the legal aspect of this problem he gave a carefully cautious assessment. He believed that there was uncertainty as to the outcome should a diver, or the heirs, bring a case for damages against the instructor and organisation involved if morbidity resulted from performing any form of practice emergency ascent. He suggested that it would be best to re-examine the fundamental need for the skill in the first place. Sixteen years later this has still not been done.

It should be noted that the Royal Australian Navy (RAN) decrees[12] that basic training in emergency ascents is to be performed as close to a recompression chamber as is possible, "after a few accidents".[13] Proponents of the proposition that it is safe to practice emergency ascents can rightly state that there have been no reports of morbidity in divers under instruction in Australia, but neither has there been any attempt to seek out this type of information. One should remember that sub-clinical lung and brain damage has been shown in those performing SETT ascents[14,15] and it is likely that such pathology sometimes occurs in association with civilian training.

Proponents of the inclusion of this element in training usually ignores three factors.

1 That its inclusion takes up time possibly far better spent on other items in the training program,
2 that it may not provide any actual benefit, and
3 that indeed it may lead divers to undervalue the necessity of avoiding becoming low on air.

These are significant considerations. It is not sufficient to declare that the skill could be useful, it has to be shown that it is imparted and cannot otherwise be achieved.

Is omission of such training deleterious to safety ?

This is unsustainable as it has been the policy of the British Sub-Aqua Club (BS-AC) for more than 30 years that no such practice be performed in its training programs. This has been on the advice they have received from the RN on numerous occasions. Possibly the secret of their excellent safety record has been the absence of hurry in their diver training programs, much criticised by many as being too careful. That BS-AC divers make stupid mistakes and sometimes die is due to the tendency of divers to fail to behave responsibly rather than to any omission of free ascent in their training. Knowing the psychology of divers, the RN allows a few BS-AC divers to make supervised ascents in the SETT each year. The BS-AC is the only training organisation which not only actively attempts to collect Incident Reports, but which publishes its findings annually and discusses their import ![16] It is from these reports that one learns that BS-AC divers suffer low-air and out-of-air situations and have to perform shared or solo emergency ascents. The records show these are successfully performed. It is a great pity that none of the main Instructor organisations in Australia show such a dedication to obtaining information.

At the present time the majority of divers are likely to have received training which includes an "emergency ascent" module of some type.[17] But being out-of-air still appears to be a significant item in the analysis of adverse factors in diving fatalities. There is an obvious need to review training programs in order to produce more careful divers. While the "octopus" system is the most logical and potentially fool proof response to an out-of-air situation it has the limitation that the donor is likely to be almost as low on air as is the recipient. The suggested solution of carrying a supplementary air cylinder ignores the probability that only responsible divers (such as cave divers) would resist the temptation to use its contents to prolong their dives. After all, the divers who run out of air have almost always already ignored the reading of the contents gauge on their main air cylinder.

The reprinted papers by Dr Harpur contain two statements of very special relevance to this discussion.[7,18] The first is that "teaching a technique does not necessarily involve practicing it". The second is that "we have not been able to document a single case in which equipment malfunction directly caused a diver's death or injury. It has always been the diver's response to the problem which results in the pathology. Recognition of the malfunction and effective management of it are part of good diver training."

Conclusion

There is an old adage, dating back long before the days of AIDS, that if you can't be good, be careful. This could well apply to air management. When the instruction of divers includes a greatly increased number of practice "emergency ascents" (preferably near a manned recompression chamber) there will be less need for discussions such as this. But surely avoidance of predictable dangers has precedence over accepting them as inevitable ? Nature is not malevolent, and if it seems so, you are doing something wrong. As air is essential to a diver's survival underwater, surely every effort should be bent to ensuring this is always available. Anything less is inferior.

The recent SPUMS Workshop was "designed to develop a policy on EAT and to illustrate that a Workshop is an appropriate method of deciding on a SPUMS policy".[19] I contended that this objective has not been achieved. This is in part because the terms of reference were seriously defective. It was concerned solely with which of several emergency ascent options should be practised and not with the wider, and more important, question of ascertaining whether the out-of-air status is inseparable from scuba diving rather than being an unusual and avoidable event. There should have been questioning of the value of such training based on facts rather than unsubstantiated opinions. It was defective in that there was no input from those who were known to oppose the proposal or had reservations concerning the benefits of the training provided. One should remember the countryman's reply when a traveller asked him the way to a distant city, "If I were you I wouldn't start from here". Hopefully a serious attempt will now be started to investigate the low-air and out-of-air problems which occur far too frequently during scuba diving.

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THE CASE FOR DIVING DIABETICS

Phil Bryson, Chris Edge , David Lindsay and Peter Wilmshurst

Up until the mid 1970s, the British Sub-Aqua Club (BS-AC) allowed diabetic divers to dive provided they were well-controlled and had not had an attack of hypoglycaemia within the past year. However, in 1975 a diabetic diver was diving on a wreck off the south-west coast of England called the *Persier.* This cold water wreck is at a depth of about 28 m. The diver had ascended normally, well within the no-stop time according to the BS-AC/RNPL 1972 tables, and had signalled "OK" to his buddy on the surface. On swimming back to the boat, he was noted to be having some difficulties and had to be dragged on board the boat, where he collapsed. His problems were ascribed initially to diabetes and not to decompression illness. He was therefore not recompressed for some hours. Unfortunately, even after the symptoms of decompression illness were recognised and treated, he was left with permanent paraplegia from a level of approximately T10 down. He later committed suicide as a result of his confinement to a wheelchair. The ban on diving by diabetics was introduced by the BS-AC as a direct result of this accident.

This diabetic diver suffered from sudden onset decompression illness. There was no evidence that his diabetic condition had caused this. A post-mortem showed the presence of a patent foramen ovale (PFO)[1] which may or may not have contributed to this particular incident. Further, it was known from an unpublished survey carried out by Eno that several diabetic divers had continued to dive despite the ban on diabetics and that none of these divers had suffered from an increased incidence of decompression illness or, more importantly, suffered from hypoglycaemic attacks whilst diving.

Given this data, three of us (Edge, Lindsay and Wilmshurst) came to the conclusion that there was no reason, given the current state of knowledge and medical technology, for prohibiting diabetics from diving with the BS-AC, *provided certain strict medical criteria were met by the potential diving diabetic*.[2] Independently, Bryson had come to the same conclusions on behalf of the Sub-Aqua Association (SAA).

To be allowed to dive, the diabetic must not only satisfy medical criteria, but he or she must take additional precautions when diving, both to ensure the well-being of him/herself and also the well-being of the diving buddy and the rest of the party of divers. These conditions are set out below:

Medical conditions

Stated briefly, the diver should not have any of the long-term complications of diabetes. The medical conditions apply to both insulin dependent and non-insulin dependent diabetics. Although hypoglycaemia is a relatively uncommon in non-insulin dependent diabetics the risks are not negligible and any potential diver should be using a short-acting anti-diabetic drug, if such medication is necessary.

However it does appear that non-insulin dependent diabetics can generally exercise without fear of a deleterious metabolic response.[3] The BS-AC issues forms for the diabetic and his/her diabetologist to complete which ask if any of the following statements are true:

1. Has the diabetic's medication regime altered within the last year?
2. Have any episodes of hypoglycaemia occurred within the last year and if so, under what circumstances did these occur?
3. Has the diabetic been hospitalised within the last year for any condition related to diabetes?
4. Has the diabetic's level of control been in any way unsatisfactory throughout the last year?
5. Is microalbuminuria present?
6. Is there any degree of retinopathy present?
7. Is there any degree of neuropathy (sensory, motor or autonomic) present?
8. Is there any evidence of vascular or micro-vascular disease present and, if so, where?

In addition, the form asks the diabetologist to say whether in his/her opinion, the diabetic is in any way mentally or physically unfit to undertake scuba diving, a recreation that involves a degree of stress and exertion. If the answer to any of these questions is "yes", then the diabetic would not normally be allowed to dive. An exception is usually made if the diabetic has only a mild background retinopathy. The diabetic must undergo a complete physical examination annually and be passed as fit to dive by a physician with a special interest in scuba diving after reviewing the answers to the questions posed above. Finally, a copy of the forms is sent to one of the authors (Edge) in order that a database can be built up on the diabetic divers for future use.

Diabetic diving standards

In general, we advise the diabetic to dive only once or twice per day and not to dive more than three days consecutively. This prevents the build-up of an excessive tissue nitrogen load. It is helpful to both the diabetic diver and to the other members of the diving club if the diabetic gives an annual lecture to the club on the problems of diabetes and diving, if necessary with practical illustrations of the administration of glucose and the measurement of blood glucose.

The dive itself can be divided into three stages, namely pre-dive, dive and post-dive. Each diabetic diver and their branch diving officer is given a sheet with the following guidelines for each of the three stages of the dive:

Pre-dive

The diving diabetic should be as fit and mentally prepared to dive as his or her non-diabetic buddy. They should preferably be wearing at all times an SOS (Medic Alert) bracelet stating that the bearer is a diabetic and also a diver and that therefore the possibility of decompression illness must be considered should the diver be taken ill. The diabetic partner should be especially careful with regard to being adequately hydrated as there is some evidence that the level of hydration affects the chances of experiencing decompression sickness. The dive marshal should be aware that the subject is a diabetic and should also be informed of the profile of the dive (plan the dive and dive the plan). The diabetic diver's buddy should be a person who is either i) a regular diving partner and who is familiar with the diabetic and the problems he or she is likely to experience or ii) a trained medic or paramedic who is familiar with the problems of diabetics. Clearly, the buddy should *not* also be diabetic. The diabetic should carry with them on a dive a kit consisting of:

1. Oral glucose tablets.
2. Emergency intramuscular injection of glucagon.
3. Glucose oxidase sticks together with the necessary kit and instructions for the use of such kit.
4. Normal diver safety equipment with one or more of the following items: surface marker buoy, flag, personal flares, emergency beacon.

Diabetics should plan to carry glucose tablets or a tube of glucose paste with them in a small waterproof casing or bag *during the dive*. The diving buddy must know the whereabouts of these tablets or paste and be able to gain access to it in the event of an emergency. It is essential that there is at least one person in the dive party of the diabetic who is able to use and administer the glucose tablets and intramuscular injection of glucagon. Just prior to diving, it would seem sensible for the diabetic diver to ensure that he or she has a *slightly* higher than normal blood sugar level by consuming glucose in whatever form takes their preference (glucose tablets, barley sugar sweets etc.). Blood glucose should be measured using a glucometer at this time.

Dive

A diabetic diver should not dive deeper than 30 metres until a considerable experience of diving and its associated problems has been gathered by the BS-AC/SAA medical committee. He or she should remain well within the tables or have more than 2 minutes no-stop time left on a dive computer.

Post-dive

On arrival back at the boat (or on shore if a shore-dive) the diabetic must check his glucose level and, if necessary, correct it in the appropriate manner. Any adverse symptoms or signs should be reported immediately either to the diving buddy or to the dive marshal and should not be passed off as merely "part of diving''.

The instructions to the diabetic diver and the diving officer are at pains to emphasise that the symptoms of low blood sugar may mimic those of neurological decompression sickness or a gas embolism and vice-versa, e.g. confusion, unconsciousness, fits. In this situation, first aid therapy must be given to the diabetic casualty as though both conditions were present i.e. 100% oxygen and treatment for low blood sugar. In the event of there being an incident in the water or on the boat, the diabetic diver should be brought to the boat or shore as soon as possible. The blood glucose should be measured using the equipment in the diabetic emergency kit if this can be swiftly performed. Oral glucose should be administered to the subject with low blood sugar if conscious; otherwise, an intramuscular injection of glucagon (1 mg) should be given. Medical attention and recompression facilities should be sought as soon as possible.

Experience to date

The BS-AC and SAA have admitted diabetics who fulfil the medical criteria set out above to dive since November 1991. During this time, more than fifty diabetics have registered with the BS-AC. Their ages range from 17 to 46 and are of both sexes in roughly equal numbers. Both insulin-dependent and non-insulin dependent diabetics are registered. Some of the diabetics who contact us wishing to dive state that they will be diving to a depth of no more than 15 metres and will be diving in warm tropical waters but the majority are diving in British waters. Currently, there are three National Instructors (the highest teaching grade) within the BS-AC who are registered diabetic. Thus far (October 1993) there have been no reported incidents involving diabetics or their diving buddies. We hope that the standards set out above are such that this will remain the situation, but the situation is kept under constant review.

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SINUS BAROTRAUMA

A BIGGER PICTURE

Carl Edmonds

Abstract

The major English language publications on sinus barotrauma are reviewed, and a new clinical series of 50 cases is compared with a previous survey. The various symptomatologies, complications, investigations and treatments are discussed in relation to these series.

Background

Fifty years ago sinus barotrauma from aviation exposure was well described by Campbell [1,2]. The injury was due to the changes in volume of the gas within the paranasal sinuses during ascent or descent, when those changes could not be compensated by the passage of air between the sinus and the nasopharynx. It was the clinical manifestation of Boyle's Law, as it affected the sinuses.

The pathological changes found within the sinuses due to these aviation exposures included: Mucosal detachment; submucosal haematoma; blood clots in membranous sacs; small haemorrhages within the mucosa; and swelling of the mucous membrane (especially in the absence of previous sinusitis).

Weissman et al.[3] described a series of 15 cases of frontal sinus barotraumain aviators. Mostwere Grade III. They used a grading systems as follows:-

Grade I A transient discomfort which cleared promptly and had only a slight oedema but no X-ray changes.

Grade II Characterised by pain over the affected sinus for up to 24 hours. There was thickening of the mucosa seen on X-ray. If such a sinus was opened, small amounts of blood-tinged fluid were found. Serosanguinous fluid sometimes drained from the sinus, with or without the use of decongestants.

Grade III A severe pain or a "bee sting" or "being shot" sensation. If the pain was not quickly relieved by the Valsalva manoeuvre, the pilot had to ascent rapidly to relieve symptoms.

Usually Grades I and II did not seek medical aid, and were usually treated simply. Grade III cases resulted in oedema and congestion of the sinus mucosa with submucosal haemorrhages. As the sinus mucous membrane was pulled away from the periosteum by the negative intrasinus pressure, a haematoma formed. Sinus X-rays showed an air fluid level or a polypoidal mass. Incising this mass brought forth a spurt of old blood, with clots.

Reviews of the diving related sinus barotraumas were not easy to find. Flottes[4] in 1965 described sinus barotrauma in divers. Other authors, whom I can not translate, included Ameli and Caligaris,[5] Sliskovic,[6] Conde,[7] Czech and Chojnacki.[8]

Sinus barotrauma has been previously described in various texts on diving medicine[9] and aviation medicine,[10] but initially without any specific clinical series being documented. A reasonably large clinical series of divers with sinus barotrauma was first described in Australia by Fagan, McKenzie and Edmonds in 1976[11] and quoted widely thereafter.

The initial Australian series

The Australian series included 50 consecutive cases of sinus barotrauma as they were observed in a Navy setting, where all such cases were referred for medical opinion, irrespective of severity. In the majority of these cases the divers were inexperienced, undergoing their first open water diver training course. This series was valuable in that it quantified the imputed symptomatology and the extent of specific provocation factors. Unfortunately it did have the disadvantage of including many cases that might otherwise have not attended for treatment.

In that series 68 % of the presenting symptoms developed during or immediately upon descent, and in 32% during or immediately upon ascent. Pain was the predominant symptom present, in all the cases on descent, and in 75% of the cases on ascent. It was referred to the frontal area in 68%, the ethmoid in 16% and the maxillary in 6%. In one case it was referred to the upper dental area.

Epistaxis was the second most common symptom, occurring in 58% of cases. It was rarely more than an incidental observation, perhaps of concern to the diver but not usually of great severity. It was the sole symptom in 25% of the cases of ascent barotrauma.

Even though these were inexperienced divers, in 32 % there was a history of previous sinus barotrauma, and this had been produced by scuba diving, aviation exposure or free diving. Half had a history of recent upper respiratory tract inflammation and others gave a history of intermittent or long-term symptoms referable to the upper respiratory tract e.g. nasal and sinus disorders, recurrent infections, hay fever, etc.

In 48% of cases, otoscopy showed evidence of middle ear barotrauma on the tympanic membrane.

Radiologically the affected sinuses did not replicate the frequency of the clinical manifestations. The maxillary sinus had either mucosal thickening or fluid level in 74% of the cases, the frontal in 24% and the ethmoid in 15%. This is in reverse order to the clinical manifestations. A fluid level was present in 12% of the maxillary sinuses.

Most of these divers required no treatment, or responded to short term use of nasal decongestants. Antibiotics were prescribed if there was a pre-existing or subsequent sinusitis. Neither sinus exploration nor surgery was required in any case. This series has unfortunately, and inappropriately, been used to imply that such intervention is never applicable in the treatment of sinus barotrauma. The fact that it was a series covering the range of cases diagnosed as sinus barotrauma, meant that most were of minor severity.

Despite the fact that this survey was done almost two decades ago, and before computer imaging techniques became commonplace, there has been little in the way of clinical series documented since.

This is unexpected, because sinus barotrauma and its complications remain a common medical hazard of diving. The importance has been stressed by many workers.[12-15]

There have been many single case reports in the literature, mostly reiterating the observations of previous authors or those of the diving and aviation medical medical text books.

The second Australian series

The initial Australian series, by design, comprised relatively minor cases of sinus barotrauma, not necessarily typical of those that present for medical consultation on their own volition. The diagnosis was made on the symptomatology alone, based on symptoms produced with pressure changes, but verified by radiology. The Australian group has, by default, been used as being typical of all sinus barotrauma cases, even those that present with recurrent or delayed symptoms, or complications, in emergency wards or ENT consulting rooms. That extrapolation is not necessarily valid.

To offset that presentation, a new series of 50 cases of sinus barotrauma, more accurately represents the type of case that is likely to confront the ENT or Diving Medical consultant, has been collected by the Diving Medical Centre. It consists of the last 50 cases that have presented with the following criteria:-

1 They were seen within 1 month of the most recent incident.
2 Incontrovertible or overwhelming evidence was present to verify the diagnosis of sinus barotrauma or disease. This usually included a CT scan of the sinuses, but with sinus endoscopy and/or surgery in some cases.
3 The divers were referred by primary care physicians and came specifically for treatment at their own instigation.

This second series, because the symptomatology was far more dramatic and often repetitive, dealt with more serious cases. The cases were self-selecting because the divers with repetitive or more significant problems were more likely to present for medical treatment. The investigations frequently involved CT scans of the sinuses, sinus endoscopy and occasionally MRI.

Despite the difference in selection procedures, the two series were very similar in their major symptomatology and provoking aetiologies. The pain, provoked by descent and/or ascent, and the extrusion of fluid on ascent was similar to the first series. This fluid takes the form of a thick mucus secretion (especially if there had been chronic sinusitis in the past) or blood, from the nose into the face mask or down the back of the nasopharynx. This is due to the expansion of gas with ascent, producing a "washout" of the damaged sinus.

The main differences from the first series

Diving Experience

Unlike the initial series, 88% of the divers in the second series were experienced (over 50 dives). The distribution was strongly skewed to the extremely experienced, with 70% of the divers having over 5 years diving, and many being dive masters, dive instructors or professional divers.

Because of the extreme amount of diving exposure in this group, it is presumed that the sinus ostia or ducts become scarred and narrowed from the repeated insults they sustain.

Symptoms

In some cases the diagnosis was not evident when the client was initially seen by the primary care physician. This was especially so in 12% of the cases, where the presenting headache developed and progressed whilst at depth. With questioning it could usually be elicited that the headache would be made worse with subsequent ascents or descents, but the initial development of the headache during a time when there was no substantial change in depth, did apparently cause some confusion in the emergency physician's assessment.

A small degree of negative pressure[16] is sustainable within the sinuses, without symptoms. Exceeding this may be sufficient to cause a gradual effusion to develop, and the full or heavy sensation within the sinus may take some time to develop. Extrapolation from aviation physiology would suggest that diving related barotrauma could occur with a reduction in sinus air volume of 5-10%, i.e. at a depth of 0.5 to 1 m below the surface.

We now must accept that headache developing during the dive, with the diver neither ascending nor descending, should not exclude the diagnosis of sinus barotrauma. When this develops at considerable depth, the sedative effects of narcosis may distort the clinical features. Diagnostic complications may arise. Also, small changes of depth are not particularly noticeable when swimming in mid-water, so producing a misleading history.

Because of the method of selection of the initial 50 cases, such symptomatology was not considered. On the contrary, patients were selected who developed their symptoms only during ascent or descent. In retrospect, this was clearly a design fault in the survey.

"Pop"

In 8% of the cases there was a very clear-cut and dramatic sensation of a bursting or popping, during depth changes. Half were on descent and half on ascent.

It has been described in aviation medicine as; the "popping of a champagne cork", a "gun shot", "like a bee sting over the eye", "like being struck on the head with a club or bat". It is presumed, both from the observations of Campbell[1,2] and Mann and Beck[16], and from this series, that the sensation is due to a haemorrhage stripping up the mucosa of the sinus, produced by the negative intra-sinus pressure with descent encouraging hyperaemia and stretching of the mucosa.

A similar sudden sensation can also occur from the rupture of an air sac or release of pressure from a distended sinus during ascent. This may be followed by a "hissing" sensation of air movement, which may then relieve discomfort and pain. One of the cases involved the ethmoidal area, and there was a subsequent small oval shaped haematoma noted over the ethmoid region, within hours (Figure 1).

Figure 1. Oval haematoma at root of nose

Maxillary Nerve Involvement

In 4% of the cases the pain was referred to the upper teeth, on the same side as the maxillary sinus affected. This is presumably an involvement of the posterior superior alveolar nerve. In another 4% there was involvement of the infra-orbital nerve, with numbness over the skin of cheek on the same side.

Two separate branches of the maxillary division of trigeminal nerve can be affected[17,18] as they traverse the maxillary sinus. The infra orbital as it runs along the wall of the maxillary sinus and the posterior superior alveolar nerve as it runs along the lateral or inferior wall of the maxillary sinus. The former produces a numbness or paraesthesia over the cheek. The latter a numbness over the upper teeth, gums and mucosa on the same side. In some cases pain and hypersensitivity are noted. Problems with neurapraxes are more common with ascent than descent, suggesting that the pathology is pressure induced impaired circulation is more frequently than congestion or haemorrhage of the nerve.

There is a possibility of involvement of any division of the trigeminal nerve, including its maxillary division, with involvement of the sphenoidal sinus.[19]

Atypical Symptoms

In a small number of the cases (8%) some additional symptoms did not appear to be easily explicable on the basis of local sinus pathology. These included; nausea or vomiting, a sensation of impending syncope, and disorientation at the time of injury. These all occurred in the more dramatic cases of the sinus barotrauma.

Differential Diagnosis

In 6% of the cases an initial diagnosis of decompression sickness was made, with the case subsequently demonstrated to be sinus barotrauma, often with complicating sinus infection. At the time of presentation, which could be some hours after the dive, the clinical pattern was confused with cerebral decompression sickness, and treated as such. These were understandable mistakes and there should be no hesitation in repeating them, if there is any doubt regarding the diagnosis.

It would be preferable to miss and mistreat a case of sinus barotrauma than miss and mistreat a case of cerebral decompression sickness.

The only other case of incorrect diagnosis was one subsequently attributed to a dental aetiology (barotrauma associated with pneumatisation around a carious tooth) and this case was therefore not included in the series.

Inappropriate Diving Techniques

This was not fully appreciated in the initial series, and so not documented. In 10% of the second series, repetitive incidents of sinus barotrauma appeared to be provoked by inappropriate diving and equalisation techniques. Often there was a head first descent, and/or swallowing as a method of middle ear equalisation. The substitution of a feet first descent (preferably down a shot line), together with frequent positive-pressure middle ear equalisation manoeuvres, appeared to rectify the situation. These are fully described in medical texts[20] used by divers.

A similar problem developed if descents were slow, due to the discomfort noted in the sinus. The blood or effusion gradually accumulating in the sinus equalises the pressure and reduces the degree of pain and discomfort. This might be appropriate for an emergency dive, but is not reasonable if damage is to be avoided. On the contrary, divers inappropriately used the development of the pathology (blood or effusion, mucosal congestion, etc.) as a "treatment" to replace a contracting air space in the sinus during descent, and allow the dive to continue.

Divers were advised of the correct methods of descent and to use positive pressure middle ear equalisation (e.g. a Valsalva manoeuvre). This can aerate the sinuses before major pathology and haemorrhaging develops.

Sphenoidal Sinus

Lew and his colleagues[19] not only referred to the symptomatology of sphenoidal sinusitis, but also referred to its association with "deep sea diving".

Sphenoidal sinus involvement occurred in 6% of the current series. It is important because of the tendency of clinicians to not recognise it and to not appreciate its potentially serious complications.

Another case, which is well known to the author but was not part of this series, sustained sphenoidal sinus barotrauma and caused considerable concern because of the proximity of the space occupying lesion to other important structures near sinus, and the possibility of the lesion being more ominous than a mucosal cyst or haematoma. Although operative intervention was contemplated in that case, the lesion cleared up within a few weeks, following abstinence from diving.

Spenoidal sinusitis is not easy to demonstrate radiologically, but is often obvious with tomography or CT scans.

Complications

Acute Sinusitis

Acute sinusitis developed some hours after the dive, and extending into subsequent days, in 28% of the cases, usually with an exacerbation of pain over the affected area,

The cases of sinus barotrauma that subsequently developed a sinus infection, possibly did so because of the haemorrhage and effusion in the sinus. This becomes a culture media for organisms introduced by the flow of air into the sinus during descent.

For this reason we now vigorously treat with antibiotics any symptoms following sinus barotrauma, which commence hours after the dive or continuing into the following day.

Chronic Sinusitis

The criteria for this diagnosis included a continuation of sinus symptomatology longer than one month. In 18% of the cases the initial barotrauma episode and acute sinusitis continued into chronic sinusitis.

In another 14% the chronic sinusitis was initially present, with recurrent barotraumas developing.

Complications not evident in the second series

Pneumocephalus

None of the cases in this series sustained a pneumocephalus, either radiologically or by CT scan. The presence of pneumocephalus, in association with sinus injury in general medicine, has been well recorded by Markham[21] and it is one of the dangers associated with sinus barotrauma.[9] It has been well demonstrated by Goldmann.[22]

Surgical Emphysema

This did not occur in any of the cases in this series. Nevertheless, it has been demonstrated elsewhere.[9] The tracking of air into the tissues can present as orbital surgical emphysema (usually from the ethmoidal sinus though a fracture of the eggshell-thin lamina papyracea). In other instances the air has passed from other sinuses, such as the mastoid.

Treatments given

These can be divided into groups:-

1 The first group were those that cleared up spontaneously, and were advised to not dive until this had happened.

2 Those that were using inappropriate diving techniques. They usually responded to appropriate regimes of:
   - feet first descent
   - positive pressure manoeuvres to autoinflate both middle ears and sinuses, on the surface, immediately before descent, and then at regular intervals of 0.5-1 m during descent
   - avoiding diving with respiratory tract inflammation.

3 Those who responded to medical treatment of the nasal pathologies. This included the topical use of steroid nasal sprays, cromoglycate, topical or generalised decongestants, avoidance of nasal irritants and allergens, and cessation of smoking.

4 Infective sinusitis cases required treatment of the infections, usually by decongestants and antibiotics.

5 The intractable group required sinus exploration, usually with endoscopy and reconstruction, or nasal surgery. In some cases surgery was required to produce patency of the ostia and to remove polyps or redundant mucosa that caused obstruction to the ostia. Othertimes it was needed to improve nasal air flow.

6 The sixth group continued to have difficulties and usually gave up diving.

All were strongly advised to not dive during times of upper respiratory tract inflammation (infections, allergic or vasomotor rhinitis, etc.). As in the original series, over 50% of the divers had a history of diving with such conditions at the time of the barotrauma.

Some patients moved between treatments, as various measures failed to completely resolve or prevent problems.

It was difficult (and would be misleading) to allocate percentage incidence of success to each of these treatments. Many were involved in more than one type. Also, many of the patients could not be traced 1 - 2 years later. Divers are an itinerant group.

Also, other environments, countries and consultant practices would result in different clientele and treatment indications. Our general impression is that approximately equal numbers fell into each "treatment" group.

Investigations and pathology

The appearances were often described by radiologists as suggestive of haematomas, mucous cysts, mucocoels, polyps or polypoid masses, opacification and, most commonly, a thickening of the mucosa. Our series was no different in the various radiological descriptions. However, the CT scans showed more identifiable and definitive pathology. Magnetic resonance[23] using T1 and T2 weighted imaging would be expected to be more useful in differentiating blood from mucosal thickening.

Most of the effects of sinus barotrauma rapidly regress if diving is suspended and the underlying or consequential inflammatory pathology of the sinus treated.

Campbell [1] stated that infection occurs only rarely, and his series may be comparable, in terms of selection, with our initial survey.[11] If, however, one considers our second survey, with its more serious cases, then infective complications are more frequent.

The use of CT scans of the sinuses made diagnosis and treatment more definitive in most of these cases. Sinus endoscopy, sinus surgery and/or nasal surgery was needed in 12% of the cases, often with excellent results. Bolger, Parsons and Matson[24] in 1990, have questioned the value of surgery in aviators with sinus barotrauma. Their guarded enthusiasm for functional endoscopic sinus surgery is tempered by the possible complications of this procedure.

Nevertheless, endoscopic sinus surgery is advancing rapidly, and may offer value to the more serious and chronic cases. With current endoscopic surgical procedures, the maxillary, ethmoid and sphenoid sinuses can be treated so as to widen the sinus ostia, preventing sinus barotrauma. The frontal sinus is less amenable, but may be assisted in some cases

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Acknowledgment

I wish to thank Dr Martin Forer, ENT consultant, for his help with information about endoscopic sinus surgery.

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FACIAL PARALYSIS AFTER SCUBA DIVING
A CASE HISTORY

Noel Roydhouse

Introduction.

The occurrence of facial paralysis after scuba diving has been reported by Molvær[1] and Becker.[2] Their cases suffered transient ipsilateral facial paralysis associated with middle ear overpressure during ascent. When it occurs it produces a marked and unmistakable deformity which prompts the seeking of medical advice even if it is transient. Bell's palsy is the commonest clinical variety to be seen. Other causes are acute otitis media, chronic otitis media with or without cholesteatoma or mastoiditis, skull fracture, tumours, and iatrogenic. Viral peripheral neuritis and vascular spasm of perineural vessels are also rare possibilities. In the course of all middle ear and mastoid operations the facial nerve is at risk from trauma. It emerges from the lower border of the pons passing laterally down the internal auditory meatus, then between the cochlea and the vestibule until it reaches the medial wall of the middle ear. It bends sharply backwards to travel in the horizontal part of the facial canal which is a rounded eminence above the fossa ovalis. At the posterior margin of the fossa ovalis the nerve arches downward behind the middle ear between it and the mastoid region.

In about 40% of cases the bony facial canal during passage through the middle ear has dehiscences. This lack of bone covering the facial nerve varies from complete to small 2-3 mm gaps. At the time of operations such as total stapedectomy, a procedure rarely carried out now, an instrument may press against such an exposed nerve. However rarely is there any problem but facial paralysis for up to 6 months has been known to occur. It takes 6 months for re-growth of the fibrils from the middle ear to the muscle motor end plates. However without a break in the neural tubes the paralysis may last 5 minutes to a day or two.

Case History.

This 16 year old male patient was doing his first diving session in a PADI scuba diving course. He was diving in a swimming pool with a depth of 3 m and had carried out about 6 descents and ascents over a period of 45 minutes. After descent he would swim around the bottom of the pool before ascending. He stated that he was able to equalise his middle ear pressure with the ambient pressure without difficulty. His method was to hold his nose and blow hard through his nose and his ears would pop. On descent he inflated his ears in response to the feeling of pressure in his ears. There was some soreness on descent but he developed more soreness in his ears on ascent. Both ears were affected equally.

He first noticed his facial symptoms when he had finished underwater and had come out of the water. His left lower lip felt numb and 5 minutes after this he noticed the numbness had spread to the side of his face and that his left lower lip was hanging down and he could not whistle. By this time he had removed his scuba gear and was surface swimming. He found that he could not close his left eye fully and that water was getting into it and it was sore. This failure to close the eye was noticed by other people. This was about five minutes after the initial numbness that he felt in his left lower lip. This condition lasted for 15 minutes when there was a fairly sudden return to normality of his face.

About one and a half hours after getting out of the water he noticed some deafness in his left ear as he used the telephone. This ear felt as though there was water in it and felt blocked. The deafness was definite. The morning after the incident of the facial asymmetry he reported to his General Practitioner who syringed out a lump of wax from the left ear with the relief of the left deafness.

In the past he had had ventilating tubes inserted into his eardrums along with the removal of his tonsils and adenoids at the age of five years. His mother never saw the ventilating tubes come out. This is not unusual. He stated that his ears as a rule did not get itchy nor did they block but he did rub them at times. He did not use cotton buds in his ears. He denied grinding his teeth but admitted that he did clench his teeth at times and used to get headaches at the back of his head about twice a year. Two days before his diving incident he developed a minor sniffle in his nose and the day after his incident he had as bad a cold as he had ever had. He had no dizziness nor loss of balance nor complained of a deafness in his right ear.

He was seen by a second doctor two days after his facial paralysis who stated that he had "grade two barotrauma of both eardrums". Audiometry was performed. There is no indication as to whether this was clinical or screening audiometry but it showed a hearing loss in both ears slightly worse on the left. The loss was mostly in the low tones and presumed typical of screening audiometry under non-sound proofing circumstances. Tympanometry at that stage showed a low A curve on the right and a normal A curve on the left with a negative pressure of 50 mm of water.

Examination.

Both eardrums were thin and the incus was visible through the eardrum. The region of the facial nerve could be seen on both sides. In the sitting position he could hold his nose and blow and the eardrum was seen to move. The nose was congested still and the patient stated that it had been like this ever since two days before the incident. He had a slight deviation of his nasal septum to the right. His throat appeared normal. He has not erupted his molar teeth and there was no wear on his front teeth. An audiogram showed the hearing in the left ear to be normal apart from a minor low tone loss and that the hearing in the right ear was abnormal. Bone conduction testing on the right side showed a minor high-tone loss but the air conduction showed a lowtone loss indicating a minor conductive hearing loss in the right ear.

Diagnosis.

The diagnosis was a left facial paralysis, grade two barotrauma from scuba diving and minor conductive deafness in the right ear due to permanent damage as a result of otitis media with effusion prior to and around the age of five years.

Discussion.

The cause of the facial paralysis is obscure but it could have been due to a virus infection co-incidental with his diving as he had a bit of a sniffle 2 days before the incident.

Another possible cause might have been a vascular spasm of the blood vessels along the perineurium but this has never been described.

It might be very remotely due to barotrauma with positive or negative pressure in the middle ear. It is hypothesised that there is direct pressure on a facial nerve which has not got its bony canal intact as it passes across the medial wall of the middle ear. He was only in 3 m of water. This causation has no evidence to support it as he went back to finish his diving course six months later when he suffered marked middle ear barotrauma. Towards the end of this course after a dive in 4 m he surfaced and felt slightly deaf and this began to clear so he dived again. He was having difficulty in clearing his ears, feeling pressure in his ears and having a minor pain on descent. His technique was to hold his nose and blow but not as hard as he could. The Toynbee test of Eustachian tube function was positive. He admitted to biting his mouthpiece very hard. He was seen two days after his last dive complaining of minor deafness and blocked ears. Examination showed that the eardrums were mobile but dark in colour due to middle ear fluid. This was confirmed with tympanometry and audiometry. His hearing loss was from 50 to 35 db, a moderately severe loss.

He was given Otrivine and Rhinocort nasal sprays to reduce the amount of nasal congestion which was present and he was able to inflate his ears easily so he was told to do this ten times a day. Despite this third degree of barotrauma there was no sign of any facial palsy. He returned in two weeks stating that his problem had fully resolved in three days and this was confirmed by audiometry although he still had a minor low tone deafness probably due to the scarring as a result of childhood ear infections.

In conclusion, in view of the few reports of facial palsy due to barotrauma, it could be that the actual cause is due to co-incident happenings. If the lack of the bony covering over the facial nerve is a factor then the problem would be more common as alternobaric vertigo is common. Considering the millions of aural barotrauma cases and the lack of facial palsies, some other theory of causation, apart from pressure, is required.

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SPUMS NOTICES

MINUTES OF THE EXECUTIVE COMMITTEE MEETING (TELECONFERENCE)

held on 28.11.93 at 0900 Eastern Standard Time

Present

Drs D Gorman (President), C Meehan, S Paton (Treasurer), J Knight (Editor), D Davies (Education Officer), A Slark (Past President), C Acott, G Williamson and J Williamson.

Apologies

Nil.

1 Minutes of the previous meeting

These were accepted as a true record.

2 Business arising from the minutes

2.1 1995 ASM

It was decided that the 1995 Scientific Conference would be in the format of, Theme, Fitness to dive and Workshop, Asthma with possibly a smaller workshop on ENT problems.

To decide on the convener at the next meeting. Possibles are Drs Davies, Paton and Williams.

2.2 Rabaul ASM

Comment from Dr Slark that the manner in which the depth limit of 39 m was presented was unnecessarily "police-like".

There will be a mixture of topics at the ASM including information on PNG, the history of Rabaul, tropical medicine and perhaps a day off for tours etc.

2.2.1 Peter Bennett's letter of inability to attend the Rabaul ASM was discussed and it was decided to supply speakers from within the SPUMS membership.

2.2.2 Allways to be congratulated for their increased accountability. Letter to be written to Allways to hold the money set aside for the guest speaker on behalf of SPUMS until it is decided how best to deal with it. Include in the letter a request to reimburse the Treasurer for the cost of printing the conference booklet by SPUMS and notification of how much of $2,000 budgeted for printing had been set aside for printing the booklet. Also clarification of how the figure of $3,000 for Telecom was arrived at and the allocation of the FOCs to be requested. Dr Acott to organise the purchase of safety sausages and DCIEM tables for distribution to delegates.

3 Treasurer's report

There is approximately $43,500 in the account. Acknowledgment and appreciation of the hard work of Dr Paton in helping to turn the finances of the society around was expressed. Dr Knight requested that a quarterly income and expenditure report be made available when the finances are computerised.

4 Correspondence

4.1 Expansion of the hyperbaric section of SPUMS was considered a good idea.

4.2 The committee ratified the accreditation of the course run by Dr Geoff Gordon in Townsville.

4.3 Correspondence with the AMA about training for doctors performing diving medicals. Dr Slark considered the tone in general was rather aggressive and that a more diplomatic approach may have achieved better results.

4.4 Queensland Workplace Health and Safety

The committee decided that SPUMS would fully support the International Diving Health and Safety Symposium to be held in Cairns in October 1994. Dr Knight to send address labels of the membership to the organisers for mailing out information. The letter from the Council to be printed in the next Journal.

5 Other business

5.1 After a discussion about providing committee members with telecards to charge calls made on SPUMS business to a central number it was decided that committee members could obtain telecards so that they could charge SPUMS business calls to their home number. The relevant calls can be highlighted on a photocopy of their telephone bills and sent to the Treasurer for reimbursement.

5.2 The emergency ascent training papers will appear in the December Journal.

5.3 DES will become DAN Australia. The number is now 1 800 088 200.

5.4 Summary of questionnaires about conferences. Some of the suggestion have already been adopted by Dr Acott for the Rabaul ASM. The questionnaire is to be an annual item at each conference. Any suggestions to go to Dr Paton.

6 Future meetings

6.1 Venues and speakers for future ASMs.

6.2 Two committee meetings will be required before the ASM to discuss and analyse the tenders for the 1995 ASM in the Solomons.

6.3 Next committee meeting will be on 13/2/94.

S0UTH PACIFIC UNDERWATER MEDICINE SOCIETY DIPLOMA OF DIVING AND HYPERBARIC MEDICINE.

Requirements for candidates

In order for the Diploma of Diving and Hyperbaric Medicine to be awarded by the Society, the candidate must comply with the following conditions:

1 The candidate must be a financial member of the Society.

2 The candidate must supply documentary evidence of satisfactory completion of examined courses in both Basic and Advanced Hyperbaric and Diving Medicine at an institution approved by the Board of Censors of the Society.

3 The candidate must have completed at least six months full time, or equivalent part time, training in an approved Hyperbaric Medicine Unit.

4 All candidates will be required to advise the Board of Censors of their intended candidacy and to discuss the proposed subject matter of their thesis.

5 Having received prior approval of the subject matter by the Board of Censors, the candidate must submit a thesis, treatise or paper, in a form suitable for publication, for consideration by the Board of Censors.

Candidates are advised that preference will be given to papers reporting original basic or clinical research work. All clinical research material must be accompanied by documentary evidence of approval by an appropriate Ethics Committee.

Case reports may be acceptable provided they are thoroughly documented, the subject is extensively researched and is then discussed in depth. Reports of a single case will be deemed insufficient.

Review articles may be acceptable only if the review is of the world literature, it is thoroughly analysed and discussed and the subject matter has not received a similar review in recent times.

6 All successful thesis material becomes the property of the Society to be published as it deems fit.

7 The Board of Censors reserves the right to modify any of these requirements from time to time.

CHANGE OF ADDRESS

The Australian and New Zealand College of Anaesthetists (ANZCA) has moved into new premises. As a result all correspondence, **addressed to the office holder concerned**, should now be sent to

SPUMS, C/o
Australian and New Zealand College of Anaesthetists,
630 ST KILDA ROAD, MELBOURNE
VICTORIA 3004, AUSTRALIA.

SPUMS SCIENTIFIC MEETING AND DIVE COMPUTER WORKSHOP MAY 14th to 22nd at Rabaul

If anybody who wishes to contribute to this workshop is unable to attend please send their views, in writing before April 21st to me at **1 Landscape Crescent, Highbury, South Australia 5089 Fax (61) 08 232 3283.**

If anyone wishes to present a paper please notify me immediately and send me a copy of the paper as soon as possible. The deadline is April 21st. This workshop is open to everyone. You do not have to be medically qualified to present a paper but have to be willing to argue your point of view. The workshop will be used to formulate SPUMS policy on the use of computers by recreational divers. This policy will be published along with the content of the workshop.

If anyone wants their views published or aired please either send me a paper on the topic or, if you are attending the SPUMS Scientific Meeting, agree to present a paper.

If you do not contribute then it is pointless complaining about the policy after it has been published, particularly if the consensus differs from your views, as has happened with the policy statement on Emergency Ascent Training. If you do not contribute, then do not complain.

For those attending the conference

Remember that Papua New Guinea is a malarial area so anti-malarials need to be taken. Appropriate dress for protection at night i.e. long sleeves and long trousers with mosquito repellent on exposed areas. Full details of protection measures will be sent by Allways Travel to those attending the conference. Tetanus immunisation is important, so please check this before going. Hepatitis A and B immunisation is also recommended

Chris Acott
Convener

SPUMS ANNUAL SCIENTIFIC CONFERENCE 1994

Hamamas Hotel, Rabaul, Papua New Guinea
Saturday May 14th to Sunday May 22nd 1994

CONFERENCE THEME

THE CAUSES AND MANAGEMENT OF DIVING ACCIDENTS

PROVISIONAL PROGRAM

Saturday 14 May Day 1

Registration

Official opening and welcome

Conference arrangements

Introduction to dive guides C Acott and Allways
Demonstration of oxygen equipment C Acott

Welcome cocktail party

Sunday 13 May Day 2

Hazards of wreck diving

Introduction: DIMS data C Acott
The hazards of wreck diving T Cummins
Wreck diving: another perspective P Lunn

Open papers

Diving retinopathy M Cross
Medical hazards of the tropics C Acott
A personal view. The history of SPUMS G Leslie and G Thomson

Monday 16 May Day 3

Diving Accidents Part I

Overview of decompression illness D Gorman
Discovery Bay Lab. Some interesting cases of decompression illness M Cross

Diving Accidents Part 2

Reflections of diving safety in the USA. D Richardson
Factors in diving accidents. Failure to check C Acott

Tuesday 17 May Day 4

Diving Accidents Part 3

Overview of diving accident management D Gorman
Diver retrieval and medical outcome in NSW M Bennett

Management of diving accidents Part 1

Teaching of rescue and retrieval T Brown
The unconscious diver in the water. Can CPR/EAR be effectively performed? C Pask and C Acott

Wednesday 18 May Day 5

Management of diving accidents Part 2

Heliox trial: an update from RNZN D Gorman
Management of diving accidents in the UK M Cross
Diving fatality causes: post mortem considerations in diving accidents P Lewis
Some interesting case histories C Acott

Workshop. Dive computers, friend or foe ? Part 1

Introduction to the 1994 SPUMS Workshop C Acott
Why I use a computer G Williams
What I like (and don't) about computers J Knight

Thursday 19 May Day 6

Workshop. Dive computers, friend or foe ? Part 2

Summary of part 1
Computer assisted diving D Richardson
Diving behaviour. A DIMS update C Acott
Inert gas kinetics D Gorman

Friday 20 May Day 7

Workshop. Dive computers, friend or foe ? Part 3

Formulation of SPUMS policy on Dive Computers

South Pacific Underwater Medicine Society Annual General Meeting

Saturday 21 May Day 8

Tropical Medicine.
Visit to the local hospital

Gala Dinner

LETTERS TO THE EDITOR

TRAINING OF DOCTORS DOING DIVING MEDICALS

Australian Medical Association
A.C.N. 008 426 793
PO Box E 115, Queen Victoria Terrace
Parkes, ACT 2600
Tel: (06) 270 5400 Fax (06) 270 5499

10 February 1994

Editor, SPUMS Journal.

Dear Dr Knight,

I refer to the long-running exchange of correspondence between the South Pacific Underwater Medicine Society and this Association concerning suitable or necessary qualifications of medical practitioners who undertake examination and certification of would-be scuba divers.

AMA Executive Council considered this matter during the course of a meeting on 4 February and resolved:

"That Executive Council considers that, in the interests of patients' safety, medical practitioners who intend to examine and certify the fitness of candidates for recreational scuba training should ensure that they possess the appropriate expertise and carry out such examinations in accordance with recommendations concerning these medical examinations, as published by the Standards Association of Australia from time to time."

Additionally, the President agreed that details of dates, venues and costs for SPUMSapproved instructional courses should be publicised in *Australian Medicine* for members' information.

I trust that these actions will mean the end of our disagreement over this important issue. I shall leave it for you to contact Ms Penny Cummins to arrange for appropriate publicity for forthcoming courses.

P S Wilkins
Assistant Secretary General

The above letter, adopting the SPUMS position that only doctors with traing in underwater medicine should do diving medicals, brings to an end our disagreement with the AMA. The latest issue of Australian Medicine carries the above information and the courses that are available for doctors wishing to have training in underwater medicine.

INTERNATIONAL DIVING HEALTH AND SAFETY SYMPOSIUM

Workplace Health and Safety Industry Committee
GPO Box 69, Brisbane
Queensland 4001

Dear Editor

I am writing to inform you of an important three day function, *Diving, an International Health and Safety Symposium* and to seek your assistance in making it a success. The Symposium, a joint initiative of the Division of Workplace Health and Safety and the Diving Industry Workplace Health and Safety Committee, is to be held at the Radisson Cairns from Friday 21 October 1994 to Sunday 23 October 1994. The main aims of the symposium are to establish the:

risks associated with the conduct of multiple dives during multiple days of diving;

risks associated with the conduct of multiple ascents by recreational diving instructors and students during training and by occupational divers during normal working conditions;

risks associated with post diving altitude exposure and to explore the potential risks associated with post treatment altitude exposure.

The symposium has already attracted world wide interest. International experts from the USA and UK as well as Australia and New Zealand will be presenting papers at the symposium. A report of proceedings will be published.

Surgeon Commander, Dr D F (Des) Gorman, BSc, MB ChB, FACOM, Dip DHM, PhD, Director of Medical Services, Royal New Zealand Naval Hospital, Naval Base, Auckland, New Zealand has agreed to Chair the symposium.

Our intent in writing to you is threefold:

to advise your members of the existence of the event and to invite them to attend;

to ascertain if any of your members have an interest in presenting an abstract for consideration and presentation at the seminar; and

to seek your assistance in publicising the event through your journal.

Should your members be interested in attending or being kept up-to-date with details of the symposium or be able to assist in identifying people interested in attending and/or presenting a paper could they please contact:

Mr Peter Harmond
Conference Administration Co-ordinator,
Council Secretariat and Intergovernmental Services
Branch, Division of Workplace Health and Safety,
PO Box 69, Brisbane, Queensland 4001
Telephone: 07 227 4647
Facsimile: 07 239 6956

Your co-operation in this very important workplace health and safety initiative is greatly appreciated.

David Windsor
Chairman
Diving Industry Workplace Health and Safety Committee

The Commitee at its last meeting decided that SPUMS would stronly support this symposium. SPUMS has already supplied labels for a mailing by the Conference Co-ordinator to all those who were on the SPUMS Journal mailing list in December 1993.

PERILS OF PELILEU

Alexandra, 201 Wickham Terrace
Brisbane,
Queensland 4000

Dear Editor

Diving on the edge of a drop off in a current that is likely to carry you away into deep water, away from the ledge, is generally associated with hazardous diving. Such a place is the Pelileu Wall and Pelileu Corner south of Palau.

To my knowledge a number of unpleasant incidents have occurred at this dive site and I believe that there are other incidents in the past that have not been reported. It is therefore appropriate to record the very real hazards of this dive site for future visitors to the wonderful diving of Palau.

Dr Chris Lourey and I were told of this near disaster, only a few hours after the divers were rescued, by Debbie Tabb, who had been diving at the Pelileu corner on the 20th March 1993 at about 1600. when she and her six companions, including the dive guide, were swept away.

The man in charge of the dive boat was unable to see them due to the sun in the west and, not having a radio and being nearly out of fuel, he returned to Pelileu for assistance.

Boats and a sea plane searched the area. The pilot flew up and down to Angur on several occasions without sighting the seven in the water, who had tied themselves together with their weight belts, blew their whistles, held up their coloured fins and put up a safety sausage which fell to pieces after half an hour. By an absolute fluke, the pilot was returning to Pelileu from Angur after giving up the search when, tilting the aircraft towards the west, he spotted a strobe from the camera of one of the seven divers who were being swept south-west towards the Philippines. They were picked at 1930 that evening.

The Filipino pilot later told me that he had no idea which way the currents were taking the divers but that he had found five other divers some months previously who had been swept as far south as the reefs immediately north of Angur Island in an area where the currents are so bad that the fisherman can fish there only two weeks each year.

He also told me that five American divers had been swept away from Pelileu and by chance the current had brought them ashore unaided near Blue Corner. There is no doubt that many other similar incidents have occurred at this dive site and perhaps other readers can add to this litany of near disasters.

The main lesson to be learnt from this story is that when diving in a third world country, boats are sometimes not equipped with radio or appropriate search procedures and that divers should be forewarned before entering such potentially dangerous dive sites.

William (Bill) Douglas

IS SCUBA DIVING SAFER THAN SWIMMING AND LAWN BOWLS?

Diving Medical Centre
66 Pacific Highway
St Leonards
New South Wales 2065

Dear Editor,

In the SPUMS Journal,[1,2] we are told that "recreational scuba diving has a lower injury rate..... relative to swimming and bowling". I do not believe this any more than I believed "driving was more dangerous than diving" which had a run a few years ago.

In the 1980's, the diving industry claimed that the deaths in scuba diving were minimal in number. Unfortunately they assumed that there were far more divers than there really were. The myth was exploded by Monaghan and others[3-7] in the late 1980's, when the denominator had to be almost halved, increasing the fatality rate proportionately.

The authors of these papers[1,2] should be aware that the injury rate as stated in the original report[8] was, in fact, figures from emergency room statistics, and these do not usually include such occurrences as:

1 the death of a diver, who did not detour through the emergency room en route to the morgue;
2 recompression treatment for decompression illness;
3 divers injured on live-aboards, remote areas, or tropical islands
4 divers who, very sensibly, elected to be treated by diving physicians.

These should be included if one is documenting recreational scuba diver injuries (being somewhat old fashioned, I still consider death to be an injury).

Also, most swimmers and bowlers would probably spend more time participating their sport than the average scuba diver. No allowance was made for this factor.

Carl Edmonds

References

1 Richardson D. Current philosophy and practice of emergency ascents training for recreational divers. *SPUMS J* 1993; 23 (4): 214-221
2 Richardson D and Cummins T. A training agency perspective of emergency ascent training *SPUMS J* 1993; 23 (4): 225-230
3 Monaghan R. Australian diving death rates comparison with USA and Japan. *SPUMS J* 1989; 19 (1): 24-25
4 Monaghan R. The risks of sport diving. *SPUMS J* 1988; 18(2): 53-60
5 Mano Y, Shibayama T, MinzunoT and Ohkubo J. Safety of sports diving: Comparison of novice and expert divers. Chapter 5 in *Man In The Sea, Vol 2,* edited by Yu-Chong Lin and K.K. Shida. San Pedro, California: Best Publishing Company, 1990
6 Edmonds C and Walker D. Scuba Diving Fatalities in Australia and New Zealand. *SPUMS J* 1989; 19 (3): 94-104.
7 Edmonds C, Lowry C and Pennefather J. *Diving and Subaquatic Medicine. 3rd Ed.* Oxford: Heinermann/ Butterworth, 1992
8 *Accident facts 1991*. National Safety Council (U.S.A.)

SPUMS POLICY ON EMERGENCY ASCENT TRAINING

Diving Medical Centre
132 Yallambee Road, Jindalee
Brisbane, Queensland 4074

Dear Editor,

I have just read with some considerable trepidation the SPUMS policy on EAT in the Journal.[1] There are several legal implications of this policy which I feel require urgent clarification. In view of increasing medical litigation I feel that SPUMS members must be protected from class actions etc. which could arise from publications (especially concerning contentious issues) of this sort.

My concern in this matter is based on my belief that at some stage in the not too distant future, SPUMS could be held legally responsible for recommending EAT (along with any consenting individual diving doctors and instructors) in some class action or similar, when litigation follows an injury or death which is attributable to EAT.

I personally, do not wish to be associated in any way (which may affect me legally) in such actions with any such policy statement, especially one that I totally reject as being inherently unsafe, and which shows considerable inconsistencies. It is even quite possible that I, or other doctors who disagree strongly with this policy, could be acting on behalf of the injured party against SPUMS.

With this in mind, and on behalf of many other members (often unsuspecting members who do not even know of the dangers of EAT) of SPUMS, I request that SPUMS urgently obtain expert legal opinion (in writing and published in the Journal) concerning the legal ramifications on individual members of this policy statement which has been made by the Society of which they are a member (and which policy may well be totally contrary to their own beliefs), but which could well result in SPUMS being required to defend this policy in a Court of Law.

Does membership of SPUMS confer legal obligations even despite public denouncement of this policy by certain members, or is resignation from the Society the only safe alternative? If there is a legal commitment, then ALL SPUMS MEMBERS MUST BE NOTIFIED ASAP OF THESE LEGAL OBLIGATIONS and be given the opportunity to either resign or accept these dangerous (in my opinion) responsibilities.

The inconsistencies within this Policy Statement appear quite incongruous. This is especially so regards "buddy breathing" (paras 3b and 7). It would also appear that the instructor has been allowed "carte blanche" regards minimising the number of ascents that instructors/ assistants have to perform (para 6). Does this mean that one instructor can supervise EAT with several (?how many) students whilst performing "buddy breathing"? It is obvious that more students per instructor will reduce the number of ascents that particular instructor will be required to perform, and I am sure this interpretation will apply in practice. The costs of employing more instructors will obviously be too onerous for most dive shops!

Even if all diving students were to have a thorough medical examination before undertaking EAT, I do not feel this would eliminate all pulmonary and other risks. The fact that many students (especially in States other than Queensland) do not have a full and thorough examination by a diving medical practitioner renders this policy even more hazardous in my opinion.

Richardson and Cummins state[2] (on page 229) that "the RSTC has put into place an improved medical screening process". No detailed medical examination by a trained medical practitioner is even required by this document, hence it would be foolish indeed to rely on the RSTC to prevent injury from EAT.

I feel it is extremely foolhardy for SPUMS to ever publish a Policy Statement that is quite pointedly in favour of a certain action, when numerous members of SPUMS (not necessarily at the meeting in Palau) obviously disagree, and the subject is so contentious. Indeed, any statement should have been far more generalised, have been formulated by an expert SPUMS committee, as was the SPUMS Medical examination, rather than by a limited group as in Palau, and certainly expert legal advice should have been obtained about members' obligations before publication.

Bob Thomas

References

1 The SPUMS policy on emergency ascent training. *SPUMS J* 1993; 23 (4): 239

2 Richardson D and Cummins T. A training agency perspective of emergency ascent training. *SPUMS J* 1993; 23 (4): 224-230

Diving Medical Centre
66 Pacific Highway, St Leonards
New South Wales 2065

Dear Editor,

I am appalled to find that the SPUMS official policy from a workshop[1] now supports emergency ascent training involving buddy breathing (sharing a second stage regulator) during ascent (Item 3B). SPUMS policy now appears to be that this **should** be **taught to** and **practised by** entry level scuba trainees. This is despite:

1 The excellent articles in the same Journal from Harpur, showing the dangers of swimming ascent and likelihood of hypoxia being produced. Any long-practising diving physician will have recognised many such cases of unconsciousness during ascent from depth of this effect.

2 The paper of Dr Chris Acott who calls attention to the danger of buddy breathing ascents, especially when they are rapid.

3 The excellent work of Glen Egstrom (quoted, but not reprinted, in the same journal) showing the repeated training that is necessary for buddy breathing to be carried out safely. The implication in the SPUMS policy is that safe emergency ascents can be taught adequately with one experience of each of three different forms of EAT.

4 The previous work from the University of Rhode Island death statistics showing the dangers of buddy breathing, especially during ascent - in which the cases of failed buddy breathing were studied and the recommendation was made that "there appears to be a good case for abandoning buddy breathing in favour of free ascents, with the buddy guiding the victim to the surface or using on alternative air source".

5 The Australian death statistics, showing that such incidents of buddy breathing continue to contribute to death, despite the recommendations from the past (see Walker's doctoral thesis on the Investigation of Critical Factors in Scuba Diving Fatalities, Australia 1955-91).

6 SPUMS own policy statement in Item 7, that the safety and efficacy of buddy breathing is suspect and is under active review.

With all this contrary opinion, the SPUMS policy statement on EAT, that this buddy breathing ascent **should** be taught and **practised** (unless very specific and restrictive conditions are applied) is illogical.

There is no evidence that this technique is of benefit (compared with its risk) in the field.

When one considers that the buddy breathing EAT is:

1 only performed from a maximum of 9 m,

2 is carried out with a fully qualified instructor controlling the trainee, and

3 is carried out in a relatively panic free situation, it must be differentiated from the genuine out-of-air situation in the field.

Under those conditions:

1 there is often a significant element of anxiety or panic;

2 the companion "buddy breather" is often inexperienced;

3 there has not been the repeated training as described by Egstrom; and

4 the out-of-air situation may occur at much greater depth.

Confusion, distress and panic is likely to develop, causing abandonment of the technique and an emergency dash to the surface, the very situation warned about by Dr Chris Acott and others.

The experiences of the controlled conditions during training may not in any way be applicable to the "in field" experience, and may well mislead the diver into opting for such a choice.

Some of the participants at the meeting were prepared to extrapolate from the minimal open water diving certificate training in this procedure, to its advisability under much less controlled circumstances. I personally wish to distance myself from such a position, as I think most experienced diving physicians would.

A "maturing relationship between SPUMS and the recreational diving industry" (Gorman and Richardson) should not be achieved at the expense of diver safety.

The most tragic implication of this policy statement is that the more reputable diving instructor organisations could be intimidated into making the practice of buddy breathing with EAT obligatory. And we would be responsible for this happening!

The policy is claimed to be under active review. OK, review it. As a Society, we should have the courage to correct a mistake, without qualification, so we do not have to live with the shadows and the ghosts of our decisions. If this means we offend powerful commercial groups, then so be it.

Carl Edmonds

References

1 The SPUMS policy on emergency ascent training. *SPUMS J* 1993; 23 (4): 239
2 Gorman D and Richardson D. The SPUMS workshop on emergency ascent training. *SPUMS J* 1993; 23 (4): 236-239

Diving Medical Centre, 66 Pacific Highway,
St Leonards, New South Wales 2065

Dear Editor,

The SPUMS policy on emergency ascent training (EAT)[1] in Item 6 is as follows; "the number of students per instructor.... should be organised to minimise the number of ascents the instructors..... have to perform".

There are three ways of achieving this reduction of instructor ascents during EAT.

1 Increase the ratio of instructors to trainees;

2 Permit others (assistant instructors, dive masters, divers or trainees) to control the trainee;

3 Have one instructor control more than one trainee at the time.

I have no problem with solution 1.

Solutions 2 or 3 cannot be as safe as the current methods.

If any organisation wishes to drop their standards by applying solutions 2 or 3, and I fear that this is possible, as the new policy statement can be interpreted in this way, then SPUMS should certainly not support it.

I would also hope that all instructor organisations would be ethical enough to explain what the hazards of emergency ascent (training or otherwise) are, as regards both death and injury to divers. In the case of buddy breathing ascent, not only should the diver trainee be warned against using it under conditions different from those employed in training, but he should also be allowed to opt out of such a procedure during training, without harassment, and without discrimination (loss of diving certification).

Carl Edmonds

References

1 The SPUMS policy on emergency ascent training. *SPUMS J* 1993; 23 (4): 239

P.O. Box 120, Narrabeen
N.S.W. 2101

Dear Editor,

I wish to register my disquiet at the action of the Committee of SPUMS promulgating a statement approving the inclusion of emergency ascent practice as a mandatory element in the training programs of all scuba divers. Furthermore they have made this into the official SPUMS policy without consulting the general membership. This highly contentious decision could possibly have grave legal implications for all SPUMS members.

The Policy text as printed in the Journal is a document which begins with a statement which implies that the unnecessary inflation of buoyancy vests is a major reason why scuba divers are so frequently running out of air. No mention is made of divers' failure to monitor their contents gauges. The suggested remedy is to carry "an appropriate alternative air supply" and to be given a limited practice of more than one type of emergency ascent. The total number of such ascents is not stated. The instructors, it is implied, can ascend with several pupils at the same time in order to lessen their personal risk of developing DCI. This increases the risk potential, particularly as all ascents are required to be performed close to the surface, the zone where the most rapid lung volume changes occur from air expansion.

There is no warning note that this type of ascent (ETA) carries with it any additional risk to the participants. As all doctors should be aware, all significant possible unsatisfactory results of treatment should be discussed with a patient before the treatment or investigation is commenced. The Medical Defence societies frequently remind members of this necessity. It is not mentioned in the Policy Statement.

This Workshop's decision was apparently based on what could best be described as a highly partial examination of the problem. The Workshop was poorly conceived as it was developed from two unproven assumptions, that the majority of scuba divers will at some time unavoidably run out of air, and that performing a few practice ascents is the only safe way to prevent such situations from becoming fatal.

It is hoped that the Committee will support an approach to the Instructor organisations for a joint investigation of the reasons why divers run out of air, and whether there is any evidence concerning the value of a few basic training course ETA practices.

I believe this Policy Statement should be withdrawn immediately and clear thinking replace uncritical acceptance of an historic American dogma.

Douglas Walker

Alexandra, 201 Wickham Terrace
Brisbane, Queensland 4000

Dear Editor,

I found the various papers, and the opinions expressed as to the best actions for divers who have the misfortune to suddenly find themselves out of air whilst underwater, in this workshop of considerable interest.[1]

The papers indicate that there is only a marginally better chance of survival for those divers who ascend while keeping the regulators in their mouths than for those who attempt to ascend while buddy breathing.

In practice it has been my experience (thirty years of diving) that when a diver runs out of air it generally occurs unexpectedly, when there is a sudden increase in current, loss of direction or equipment failure. Generally when this situation arises the buddy may be out of reach and thus unable to offer his or her immediate air supply. I agree with Larry Williamson[2] and with the SPUMS recommendation No. 2,[3] that an alternative air source, independent of one's own regulator and first stage, should be available, particularly for deep diving beyond thirty metres, cave diving and penetrating wreck diving, also staged decompression diving.

An independent air supply in the form of a pony bottle with regulator with a volume of 20 cu/ft achieves this independence at little cost, makes the octopus regulator redundant and means that the diver always has enough air to get safely to the surface and to decompress on the way without having to chase around after a buddy or perform a risky out-of-air ascent.

It is all very well for Mr Gerry Stokes of the Irish Underwater Council to state that "a diver should not run out of air" but the fact is that this sometimes occurs and a pony bottle allows the diver to be independent and not dependent on his or her buddy.

One often sees a pair of divers swimming around studying each other's gauges and not enjoying the underwater scenery.

I congratulate SPUMS on their policy on emergency ascent and believe that the spare air cylinder with an independent regulator should be encouraged, which would allow the diver to dispense with his redundant octopus regulator.

William (Bill) Douglas

References

1 SPUMS Workshop on Emergency Ascent Training. *SPUMS J* 1993; 23 (4): 195-239
2 Williamson L. A letter from the U.S.A. *SPUMS J* 1993; 23 (4): 212-214
3 SPUMS Policy on Emergency Ascent Training. *SPUMS J* 1993; 23 (4): 239

Dear Editor,

Any combination of letters on a single subject from eminent members of the Society such as Drs Edmonds, Thomas and Walker requires publication and thoughtful reply.

All three disapprove of the Society's published Policy on Emergency Ascent Training. This is not surprising as this issue has been, and is, capable of generating very strong opinions. Nevertheless, the Society's workshop on emergency ascent training came to a very similar position to that adopted by the Undersea and Hyperbaric Medical Society's workshop on the same subject in 1977 and it would appear, at least in part, that these correspondents have misinterpreted the Policy. For example, the Society is concerned about buddy breathing and this is reflected in the Policy both by a direct statement to this effect and by the recommended limitation of buddy breathing practice to a pool session (confined water) that does not involve an ascent.

Indeed, buddy breathing was the only issue on which the workshop could not reach a consensus. While most in attendance believed that the practice should be abandoned, others argued forcefully that in situations such as entrapment it could be life-saving in the absence of any other air supply, hence the nature of the Policy. This decision is under review (as is stated in the Policy), but this is true for all policies of a Society such as ours if we are to avoid a translation of policy into dogma.

Some of the written and verbal criticism of the Policy suggests that there is an intrinsic distrust of the data presented to the 1993 workshop. This is not particularly complementary to the participants who presented these data or to the members of the Society who were in attendance. Data can never be "true" or "false" and are always subject to criticism and analysis. Ultimately though, data such as presented to the workshop can only be properly refuted objectively (by data) and not subjectively. Distrust of diving-risk data may be well-founded historically, but is not conducive to current or future effective Society management. If data do exist to refute those presented to the Workshop, "please present them", or if there are overt flaws in the current data, "please point them out".

Antipathy (of any origin but especially historical) is destructive. This is not to say that the relationship between the Society and the recreational instructor agencies should one of "blind" acquiescence. For the benefit of both parties an energetic debate is essential. Those members of the Society who attended the 1993 workshop saw that such a relationship either now exists or is developing.

Another very respected member of the Society, Dr Tony Slark, questioned whether the Society should ever make policy statements. However, one of the objects of the Society is to "provide information on underwater and hyperbaric medicine". In the context of other societies, agencies, companies and government bodies, this requires a policy (whatever name it is given to it such as recommendations, consensus statements etc.). The need for such policy to be dynamic is mentioned above and is self evident. The incorporation of the Society was essentially to limit the liability of the members with respect to the Society's role in public debate (policy statements). Defensive (litigation-driven) medicine is an abhorrence and in general, an abrogation of responsibility.

During the Executive Committee's discussion of these issues, it was argued that the workshop in its current format is not a democratic way of developing Society policy and that the opinions of the entire membership should be canvassed on a draft policy. This practice (much liked by politicians) will destroy the essential nature of the workshop process. A postworkshop vote of this nature would also not favourably weight informed opinion and be subject to the bias of the writers of the draft, the reviewers of the literature (for the benefit of those who are not well informed about the subject matter) and the analysers of the consequent correspondence. It must also be noted that while the current workshop format is under trial, it is already a clear improvement on the Society's previous practice of "doling" out responsibility for policy writing to some member of the Executive Committee.

Hopefully, this year's workshop on diving computers will be even more successful now that the Society's members are aware that the workshop is a meaningful activity and not an interlude between dives. Clearly, not everyone can afford to attend the Annual Scientific Meeting (ASM), but, as was made clear before last year's ASM, written submissions are encouraged (and will be published, after editing). Indeed, submissions before the workshop have the important advantage that the writer's viewpoints can be represented during the formulation of the policy and so influence the outcome more productively.

Any member or associate interested in this year's workshop should contact the convener,

Dr Chris Acott at
The Department of Anaesthesia and Intensive Care,
Royal Adelaide Hospital, North Terrace,
Adelaide, South Australia 5000.
Telephone: (08) 224 5116;
Fax: (08) 223 4761;

Des Gorman
President SPUMS

BOOK REVIEWS

MIXED GAS DIVING
Tom Mount and Bret Gilliam

Watersport Publishing Inc., San Diego, California, U.S.A.
Available from;
Mountain Ocean and Travel Publications
P.O. Box 167 Narre Warren, Victoria 3805.

Price $Aust 35.00 plus $Aust 4.00 packing and postage.

Mixed Gas Diving is a publication which is aimed at the emerging Technical Diving population. There has been debate in recent times on whether technical diving techniques are suitable for use by recreational divers. The debate appears to be polarised into the for's and against's. Mixed Gas Diving takes what would be considered in Australia as the middle ground in the "great debate".

Technical diving is seen by the authors as a way to have access to the places inaccessible to air divers. They do not advocate these practices for all divers; they recognise these practices require specialist training and they stress that technical diving is a high risk form of recreation. These points I agree with, but question what constitutes specialist training.

The first person accounts of the extreme diving carried out by the authors is fascinating reading. Chapters on the early history of mixed gas diving and the politics of gaining acceptance by the diving community, are interesting as they give the pro-technical diver perspective.

Multiple authors in a publication can work well, the two main authors along with five others have created some good chapters. Unfortunately some have strayed from the main theme and do not belong. The text is unnecessarily long due to the inclusion of such chapters including basic diving physics, physiology and psychology of diving, which have been better addressed in many other publications. The book seems to have an identity problem between being a textbook, a definitive diving manual and a history of technical diving. If the intended readership is experienced divers it has no need for many of these chapters.

Unfortunately there are errors in tables, text and at least one formula. This poor editing means that it cannot be used as a reference text. It is not a definitive technical diving manual, however it does give an informed insight to the direction that technical diving may take. Even with the errors and redundant information there is still a great deal worth reading, if one is interested in Technical Diving.

Bob Ramsay
Senior Hyperbaric Technician
Royal Adelaide Hospital

STRESS AND PERFORMANCE IN DIVING
Arthur J Bachrach and Glen H Egstrom

Best Publishing Company
P.O.Box 30100, Flagstaff, Arizona 86003-0100, U.S.A.

Price from the publishers $US 42.00. Surface mail to Australia $US 6.50.

The two authors of this book have an international reputation for their work on diving-related problems. They here present a summary of observations and research on the aspect of diving which is possibly most critical in determining the outcome when the diver encounters some problem which causes him (or her) anxiety or worse. For in the last resort it is the person involved whose decisions and actions set the agenda for subsequent events, unless there is someone nearby who has the knowledge and experience to recognise what is occurring and is able to intervene effectively to interrupt the progression from anxiety to panic. This responsibility is shouldered by the Instructor in the class situation and the buddy in any dive and is a heavy one indeed.

Even the most minor of initial problems may trigger an inappropriate and potentially disastrous response, and, as avoidance of trouble is both easier and more likely to produce a successful outcome than the most spectacular emergency rescue response, recognition of the early signs of stress in the pupil (or buddy) is obviously invaluable.

Although the intended readership for this book is probably any diver interested in learning more about the workings of his or her body in response to problems of survival in the diving situation, it is diving instructors who are likely to be the primary beneficiaries.

It will no doubt seem to state the obvious to those who have acquired knowledge of the ways of novice divers through years of experience, but even the obvious needs stating sometimes. To those instructors newly exposed to the apparently inexplicable actions of their pupils the book may reduce their learning curve by alerting them to the early warning signs of trouble.

Stress is defined as the perception of events by the person involved and it is wise to remember this and not to assume that some situation, which causes you no concern, is experienced in similar manner by your buddy (or pupils). There are many clues, and some of these you may be aware of showing in your personal behaviour, breathing patterns, over frequent checking of air status, perceptual narrowing (concentrating totally on your diving technique and having no time to notice your surroundings), or bravado behaviour. They are listed and described in these pages.

The references to the necessity for repetition and "overlearning" in the teaching situation are generally accepted principles which tend to lose out in the design of courses designed to meet strict financial constraints. Possibly there is need to define the essential skills necessary for survival and to concentrate on these in training, with a recognition that experience in situation management can never be delivered in a few dives using scuba equipment in a class. The training of Rodent E Lee has lessons for all who seek to train others in any complex task, diving included.

This book should prove a valuable resource to diving instructors who wish to improve their understanding of the sometimes unexpected and curious behaviour they will certainly encounter among their pupils. It should make them more alert to those requiring their special care in a dive group whose members have unknown personalities and whose relevant experience is unknown, or possibly thought to be suspect. The book should improve diver safety.

Douglas Walker

SPUMS ANNUAL SCIENTIFIC MEETING 1993

DYSBARIC OSTEONECROSIS

David Elliott

Abstract

Sudden pain in a joint, unrelated to decompression, was the presenting manifestation of many of the first cases of bone necrosis to be reported. Collapse of dead sub-chondral bone led to surgical treatment which was less than satisfactory and many became crippled. Subsequent surveys of populations of divers revealed the presence of many lesions in the shafts of long bones as well as close to the weight-bearing surfaces.

A precise radiological procedure and agreed diagnostic criteria have led to valid comparisons of divers from different locations with different styles of diving. For once in occupational medicine, the boundary appears to have been clearly defined between the extreme of normality and the beginning of pathology. In spite of this, many individuals were medically disqualified from further diving for shaft lesions that had no potential for collapse.

Technetium MDP scanning has been introduced, but false positives are too common for reliable prognosis. Magnetic resonance imaging (MRI) shows some very early changes but it is expensive and, for prognosis, still lacks long-term follow up. A risk of neoplastic change exists, yet the providers of research funds favour other priorities for their resources.

Introduction

Bone necrosis is a relatively neglected hazard of diving. There was a time when dysbaric osteonecrosis was in the spotlight of media attention and was known as "bone rot disease of divers". Numerous cases have been published in the literature about sub-chondral collapse and its surgical treatment. Such cases in professional divers may not be uncommon in some parts of the world, but have become almost unknown in the North Sea. So the media spotlight has moved on. However, the condition has not gone away. Though not a problem for recreational divers who follow the decompression procedures of the world-wide sports diving agencies, I have been consulted in the past 12 months by two sports divers, one an instructor, with disabling osteonecrosis as a result of diving.

Not only is bone necrosis important as an occupational hazard of diving, it is also important because it is an example of how such occupational hazards should be investigated. The first cases of bone necrosis to be reported were those which had presented clinically due to pain in a collapsed joint. Some time later, surveys of populations at risk revealed asymptomatic lesions and, by the use of internationally agreed procedures, it was possible to acquire a reasonable understanding of the condition and its possible causes.

This story is in marked contrast to that of other possible long-term effects of diving in which no specific clinical condition has been described but which are now in the media spotlight. It is the purpose of this introductory paper on dysbaric osteonecrosis not merely to review an uncommon but troublesome diving disease but also, by tracing the history of its recognition and subsequent assessment, set an example against which the more recent "high-tech" conditions may be judged.

The early cases

At the turn of the century thousands of men were employed in the building of tunnels and bridges using compressed air to keep the workplace dry. It is from this population that Bassoe[1] in the United States and Bornstein and Plate[2] in Germany were the first to report disabling hip and shoulder conditions which were associated with radiological evidence of joint degeneration. Perhaps because there are fewer divers and they work in smaller groups than compressed-air workers, the first case in a diver was not reported for another thirty years in 1941. This, too, presented as pain in a joint.[3] Around ten or more cases were reported in the literature during the next ten years and all were in divers who had sought treatment for persistent joint pain.

It is not possible to draw any valid conclusions from these cases because the X-rays are not always published and there was no agreed standard for radiological diagnosis. One can assume that of the 90 divers examined radiologically by Herget[4] possibly more had aseptic bone necrosis than the 29 which he reported. From the same location Alnor[5] found 72 cases of necrosis in 131 divers and of the 65 who had been kept under observation for more than 10 years, only 22 of them remained free from radiological lesions. Of the 43 with lesions 17 had symptoms and 7 were "totally unable to work". Bone necrosis was thus established as a significant occupational illness in divers at a time when the British Medical Research Council was already investigating this condition in great detail among the workers building the Clyde Tunnel.

Pathology

Osteonecrosis in divers is of two basic types: juxta-articular (i.e. sub-chondral) and shaft, a description which includes the neck and a portion of the head of a long bone. The shaft lesions are predominantly saponified fat. It is the juxta-articular lesions that have greater clinical significance. These lesions show areas of dead bone surrounded by a layer of collagen which forms a fibrous band and the formation of new bone. Beyond the area which can be detected radiologically is seen an area of creeping substitution and healing trabeculae.[6] The detailed pathology has been reviewed by McCallum and Harrison.[7]

Pathogenesis

The mechanism causing bone necrosis is not understood. There are many hypotheses.[7] These include lipid emboli, a condition which exists in many other illnesses which are also associated with aseptic bone necrosis; autochthonous bubbles, possibly arising from the disintegration of natural Uranium^{238} and enlarged by decompression; an oxygen effect which leads to the swelling of fat and the possible compression of osteocytes; surface-activity effects possibly due to embolic bubbles; gas-induced osmosis; "stiff" red cells and raised intramedullary pressure. From these and other theories it can be concluded that only uncertainty prevails.

Prevalence

Perhaps the most important step towards the proper assessment of the significance of bone necrosis to the diving population was the standardisation of diagnostic techniques. With agreement on diagnosis it was possible to move away from purely clinical descriptions of the illness to surveys of the prevalence of pre-symptomatic lesions in the apparently healthy population. The credit for this must go to the members of the Medical Research Council's Decompression Sickness Panel in the late 1950s and early 1960s.

X-ray technique

The radiological diagnosis of bone necrosis depends upon the quality of the X-rays that are taken and the experience of those who read them. The X-ray remains the gold standard of diagnosis and although the disabling complications affect only the shoulders and the hips, extensive views of the lower femur and upper tibia are included in knee X-rays in order to find as many shaft lesions as possible. These are of value in confirming the diagnosis of a lesion seen in another view but, because the shaft lesions are relatively benign, can provide an alarming number of positives in a population who may otherwise seem to be perfectly healthy. The radiological technique to be used with each specific view has been described recently.[7] The X-rays should then be read by a radiologist who is experienced in reviewing the X-rays of tunnel workers or divers. In a survey, the X-rays are read independently by two radiologists who then meet to review any films about which there may be disagreement. From such consultations each individual can be described as having lesions according to the classification published by the MRC Decompression Sickness Panel and for each lesion whether that diagnosis is certain or doubtful. Gonad shielding must be used. The measured dose using dosimeters on a phantom was 1.6 rads which is less than half the maximum pubic dose.

A major fault is under-penetration of the radiographs and, because of this, trabecular detail is not always clear and small dense areas close to the joint surface may not be identified. This may be because during the process of bone repair, new bone is laid down on the trabeculae causing an increase in bone bulk. Therefore, unless the voltage is increased possibly by as much as 10 kv, a pale under-penetrated radiograph will result. This may be the commonest cause for misinterpretation and failure to identify osteonecrosis.

Tomography may be required to improve definition particularly in the femoral head, where detail is obscured by the overlying bone. In general however, good quality radiographs preclude the need for frequent use of tomography.

It was not easy to convince hospital radiologists who were unfamiliar with dysbaric osteonecrosis of the importance of such a meticulous approach to radiography and to diagnosis. Indeed, in the 1960s a number said that they "see those kinds of changes all the time". Such perceptions are of course based upon clinical judgement and not upon a scientific approach.

Differential diagnosis

As part of a survey of 383 naval divers[8] a comparable sample based on age and rank was selected from non-diving naval personnel (taking care to exclude those with high altitude flying experience). No lesions were detected in these 88 persons.

The majority of alternative causes of bone necrosis should be readily excluded in divers. They include chronic alcoholism, long-term steroid therapy and other conditions most of which are incompatible with fitness for diving.

Surveys

At the time of the Royal Navy's survey of 383 clearance divers, begun in 1966, in whom 19 were found to have positive evidence of bone necrosis[8] a similar survey was being conducted by Ohta[9] in Japan. He examined 301 diver fishermen and found 152 with lesions, a significantly greater incidence. The Japanese divers also had a greater proportion of juxta-articular lesions.

Some 15 years after the clearance divers had been X-rayed the MRC[10] published the results of their extensive review of commercial divers. They found that of 6,691 divers 4.2% had definite bone necrosis, a figure very similar to that found in the Royal Navy. This included 77 divers with juxta-articular lesions (1.1% of the total number of divers and 26% of those with osteonecrosis) of whom 12 (0.17% and 4%) had a pathological fracture.

Possible pathogenesis

The remarkable difference between the Japanese and UK results appears to have a relatively simple explanation. Whereas the European divers were diving in accordance with agreed decompression procedures, the Japanese had none. A typical diving day would be several hours at around 30 m to collect shellfish in the morning and then after lunch on deck, a similar dive in the afternoon. This technique may account for the diminishing number of divers found in each successive age group reported. Indeed, as one doctor said about the way in which the Japanese dived "this is why the flag of the factory ship is always at half mast". In the naval survey not only was there an association with age which is, of course not easily separated from diving experience but there was also a significant association with those who had undertaken deep dives which in those days were of a pioneering nature. A more analytical study by the MRC[10] found that bone necrosis is related to the type of diving exposure. There were no lesions in divers who never dived deeper than 30 m on air whereas at depths deeper than 50 m the proportion of men with positive lesions progressively increased with greater depth, rising to 15% for those with experience greater than 200 m. As with compressed air workers there is not a one-to-one relationship between acute decompression sickness and bone necrosis. Of those who said that they had never had acute decompression sickness, 1.7% had definite lesions. In contrast 40% of the population had had decompression sickness and in them the proportion was 10.7%. Of all but one of 9 men with a damaged joint reported that they had had decompression sickness. Men who had more than one episode of decompression sickness appeared to be at a greater risk than those who had had only one incident. It is important to remember that bone necrosis occurs in divers who have adhered to recognised decompression procedures.

Another important feature is that it only requires one decompression to cause necrosis. Six men survived for some hours, after the sinking of HM Submarine Poseidon in 1931, at depths between 24 and 36 m (80 and 120 ft) and then made emergency ascents. Twelve years later 3 were X-rayed and all had severe juxta-articular lesions.[11]

Other diagnostic techniques

Radiology is very slow to demonstrate the changes of osteonecrosis and although it is used as the diagnostic standard, other techniques are available and have some value in screening. MDP (^{99m} Technetium Methyl-di-polyphosphate) scans are very sensitive to local bone pathology. A "hot spot" indicates increased perfusion and metabolism and may be seen only hours after a dive. However in a Royal Navy survey[12] only 4 divers became radiologically positive some 2 to 3 years after 22 had demonstrated positive scans. Eleven still had abnormal scans and 7 had reverted to normality. Thus a positive scan is of little diagnostic significance, but may indicate a need for radiological follow-up.

Magnetic resonance imaging (MRI) has a remarkable power to detect early lesions but it is not generally available for routine screening of large populations.

Prognosis

The progression or possible regression of necrotic lesions is unpredictable. Any relationship between the lesion and the continuation of diving has yet to be studied.

The prognosis for an individual with a juxta-articular lesion has been studied in relation to the optimum time for surgery.[13]

However once a diver has got this far it is obvious that preventive occupational health has failed.

The management of shaft lesions is much easier. Since they do not cause joint collapse there seems to be no immediate indication for cessation of diving. However, the divers must be told of their lesion. Very rarely it may become malignant. The risk is considered by **** **** **** **** (AFIP) to be less than one in ten thousand and while a few such cases have occurred in compressed air workers, fibrous histiocytoma has been described in only one diver.[14]

Prevention

Although it seems that bone necrosis is in some way decompression related, and some improvements to compressed air workers decompression tables have resulted in a smaller incidence of this condition, not sufficient is known about the nature of the decompression insult to enable one to come to any conclusion, other than that a certain number of cases of bone necrosis in a diving population seems to be inevitable.

Routine Screening

After an initial base-line X-ray for trainee commercial divers, no X-rays are required subsequently provided that all diving is at less than 30 m and for durations less than 4 hours. Three yearly X-rays are recommended by the MRC for all commercial air divers diving deeper or longer than this. All other divers such as mixed-gas divers require annual X-rays. A recommendation has also been made that all divers should be X-rayed 3 years after an episode of decompression illness. At these follow-up examinations X-rays of only the shoulders and hips are required, a modification which halves the radiation dosage. If radiography is not judged necessary for other reasons, the Health & Safety Executive consider that it should be repeated at intervals of 5 years during the diver's career.

Treatment

Any person who has a suspected juxta-articular lesion must avoid weight-bearing until his condition has been assessed by an orthopaedic surgeon. The further surgical management of such cases is beyond the scope of this review. The report of one case of aseptic bone necrosis in which hyperbaric oxygen therapy was associated with improvement is promising,[15] but a proper case control study is still required.

Conclusion

Bone necrosis thus illustrates the proper progression from isolated case reports to surveillance of asymptomatic individuals by the use of internationally accepted diagnostic criteria.

One consequence of this approach was to show that the potentially crippling lesions were present in only about 1% of the total diver population. This appears to have convinced the authorities responsible for funding research that bone necrosis is not a problem. Certainly, the MRC Registry had its funding stopped by the Health & Safety Executive some 10 years ago. As a result we still know nothing about the possible changing patterns of bone necrosis which may be consequent upon the changing patterns of diving techniques being used in the North Sea. In spite of this, the example of bone necrosis provides a practical model for the study of any diving-related medical condition.

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ROYAL ADELAIDE HOSPITAL HYPERBARIC MEDICINE UNIT

1/5/1992 - 30/4/1993

A Progress Report

John Williamson

Introduction

The Hyperbaric Medicine Unit (HMU), within the Department of Anaesthesia and Intensive Care at the Royal Adelaide Hospital (RAH) is now 9 years old. It was founded by Dr J (Fred) Gilligan, currently Director of Retrievals and Resuscitation at the RAH, and Dr Des Gorman, the inaugural Director (until 1990), currently Director of Medical Services, Royal New Zealand Navy. They were ably supported by the longstanding efforts of Dr Tony Swain, and Dr Robert Ritson, Member of the Legislative Council.

The medical staff consists of a full time Medical Director, a visiting diving medical senior consultant, and 4 part-time medical consultants with senior anaesthesia, resuscitation, and diving and hyperbaric medical qualifications and experience. Two have recreational diving instructor qualifications. Another two senior anaesthesia and intensive care consultants contribute upon request and an honorary senior visiting sports physician with hyperbaric expertise visits and contributes weekly. The Unit has a 6 months training appointment for a provisional year Fellow of the Australian and New Zealand College of Anaesthetists.

The nursing staff comprises a full time clinical nurse consultant with hyperbaric nursing qualifications and experience, a full time clinical nurse and one part time registered nurse with hyperbaric nursing training and experience. These three have intensive care (IC) training and qualifications; supplementing them is a pool of in-house-trained hyperbaric nurses (including some with IC qualifications).

There are two senior hyperbaric technical officers full time, and 1 casual on-call technician. They have extensive international off-shore and in-shore commercial diving, recompression chamber (RCC) operation, and diving supervision experience and qualifications. One is a former Royal Naval clearance diver and diving supervisor, and two are qualified open water diving instructors with commercial experience in recreational diving. A technical research officer participates part time in research trials.

A full time, highly skilled secretary handles correspondence, phone calls, manuscripts, visitors to the Unit, and coordinates advertising, applications and finances for the 3 diver medical technician (DMT) and 2 diving medical officer courses conducted each year. Assisted by one of the hyperbaric technicians she also co-ordinates the other diving and oxygen courses regularly conducted by the Unit.

The Unit fulfils the following general functions nationally and internationally in collaboration with other Australian and New Zealand HMUs; clinical patient care, 24 hour manning of DES/DAN (Divers Alert Network) Australia, research, teaching (including the 5 annual national courses), public education and voluntary work.

Clinical patient care

Ninety-six patients were treated in the recompression chamber (RCC) during the 12 month period from May 1st 1992 to April 30th 1993. The respective diagnoses affecting these patients are shown in Table 1.

Results

There were 2 deaths in the series (post-cardiopulmonary bypass in whom cerebral arterial gas embolism probably occurred during surgery, and post-traumatic cerebral oedema).

At least one of the carbon monoxide (CO) poisoned patients (who had a cardiac arrest at the CO exposure site) was left with severe neurological problems. Only 20 of the 34 CO poisoned patients presented for follow up at 6 to 12 weeks post-treatment. Of these 15 were classed as normal

Figure 1. Some members of the Royal Adelaide Hospital Hyperbaric Medicine Unit at the control panel of the Unit's Multi-place Chamber. Fom left, Bob Ramsay (Senior Technician), Dr Lindsay Barker (Senior Registrar), Andrea Jones (Unit Acting Clinical Nurse Consultant) and Debbie Lombardi (Unit Secretary).

on neuropsychological assessment. Two of the remaining five sought further medical consultation for continuing subjective symptoms but investigations proved normal. A third severely poisoned patient, who presented moribund, is back at University studies, but has undergone a personality change. A fourth, who received cardiopulmonary resuscitation at the CO exposure site, has permanent memory impairment and has lost his job. The fifth patient had a significant pre-existing neurological deficit from a childhood head injury, but now has significant further neuropsychological decrement following her CO poisoning. The other 14 CO poisoned patients were lost to follow up.

Of the 23 decompression illness (DCI) patients, at least 5 were lost to follow up. The remainder made neurological recovery, as nearly as could be determined (including neuropsychological screening at 6 weeks after treatment in 8 cases), back to their pre-illness state. This recovery sometimes took up to 12 months.

All osteradionecrosis patients responded well to therapy. All the patients treated prophylactically before dental and/or maxillofacial surgery healed following surgery.

The single case of unilateral sudden deafness in a healthy young adult recovered completely during HBO. No results are yet available (May 1993) for the burns research patients.

Since 1990 the Unit has had success with both gas gangrene and necrotising fasciomyositis patients, working in close collaboration with other specialist colleagues. Of the 4 cases which occurred during the 12 month period covered by this report there were no deaths. However one patient reuired amputation of the leg.

The treatment failures were 2 of the 3 chronic osteomyelitis cases and the patients with global cerebral hypoperfusion and with spinal cord vascular paraparesis. The patient with a non-healing leg ulcer had her first HBO treatment on the last day of the 12 month period covered by this report and the outcome of the patient with advanced orbital mucormycosis is unknown.

Hyperbaric exposures

These 96 patients involved 796 patient treatments in the RCC, using 552 chamber runs. Total RCC treatment time was 1100.6 hours. The number of RCC treatments for the different diagnoses is shown in Table 2.

TABLE 1

PRINCIPAL DIAGNOSES OF PATIENTS TREATED WITH HYPERBARIC OXYGEN MAY 1992 TO APRIL 1993

Diagnosis	Number
Carbon monoxide poisoning	34
Decompression illness	23
Osteoradionecrosis of mandible	11
Thermal burns	5
Gas gangrene	3
Chronic osteomyelitis	3
Cerebral. arterial gas embolism	3
Post operative cerebral vasospasm	2
Compromised graft or flap	2
Non-healing ulcer	1
Global cerebral hypoperfusion	1
Post-traumatic cerebral oedema	1
Compartment syndrome	1
Necrotising soft tissue infection	1
Idiopathic hearing loss	1
Paraparesis (spinal vascular malformation?)	1
Orbital mucormycosis	1
Mixed anaerobic infection	1
Prophylaxis for Clostridial wound contamination	1
Total	**96**

TABLE 2

THE NUMBER OF RECOMPRESSIONS FOR EACH CONDITION TREATED MAY 1992 TO APRIL 1993

Diagnosis	Treatments	Patients
Osteoradionecrosis of mandible	275	11
CO Poisoning and smoke inhalation	178	34
Decompression illness	104	23
Chronic osteomyelitis	103	3
Burns	28	5
Idiopathic hearing loss	17	1
Cerebral arterial gas embolism	14	3
Gas gangrene	14	3
Postoperative cerebral vasospasm	13	2
Compromised graft or flap	10	2
Mixed anaerobic infection	10	1
Necrotizing soft tissue infection	8	1
Compartment syndrome	7	1
Global cerebral hypoperfusion	5	1
Prophylaxis for clostridial contamination	5	1
Post traumatic erebral oedema	2	1
Non-healing ulcers	1	1
Paraparesis, from vascular malformation ?	1	1
Mucomycosis	1	1
Total	**796**	**96**

Complications

The most common complication in this series was middle ear barotrauma. Among the 796 compressions during the 12 month period there were 49 occasions when ear pain (all during descent) occurred in patients, an incidence of 6%. A minority involved the same patient on separate recompressions, and all responded to pre- and intra-chamber instruction, combined where necessary with standard medications. Seventeen of the 96 patients had barotrauma more severe than Grade 2 on otoscopy. Seven of these (7%) required the insertion of ear grommets. Among the attendants there were 5 occasions when ear pain occurred and 2 of these sustained Grade 3 barotrauma.

There were no cases of oxygen convulsions during the 12 month period. However in 3 patients preventative in-chamber action was taken due to possible warning symptoms and signs. The incidence of convulsions from acute central nervous oxygen toxicity in the RAH HMU during the period 1990-1993 inclusive is 0.4% of patient hyperbaric exposures, and will be the subject of a future publication.

Hyperbaric outpatient attendances

The Unit conducts a half-day Hyperbaric Outpatient session twice a week. Attendance is by appointment. The work involves follow-up reviews of hyperbaric patients, diving medical examinations, and referrals from medical colleagues for diving or hyperbaric assessment or opinion. During the 12 months 389 outpatients (210 diving medical examinations and 179 hyperbaric reviews) attended. Two of these involved serious pathology from marine envenomations (1 stonefish, 1 coral cut).

Postal and telephone consultations (excluding DES/DAN Australia) are numerous and are increasing in number and scope. Advice and consultation from the Unit's clerical, medical, nursing and technical staff is sought nationwide, with some international calls. There is an increasing medico-legal component of this work with plaintiffs or defendants seeking expert opinion related to diving and hyperbaric medical matters.

24 hour a day manning of DES/DAN Australia

DES/DAN (Divers Alert Network) Australia is the name for the former DES (Diver Emergency Service), which is operated by the RAH HMU. This name change is part of a coordinated international move to standardise diving emergency telephone facilities around the world with "International Divers Alert Network", or IDAN. Countries participating at present include Australia, Germany, Israel, Italy, Japan, New Zealand, Russia, Spain, Switzerland and the U.S.A. Apart from a Telecom change of 008 to 1-800 there is no change in the telephone numbers for DES/DAN Australia, which are

Within Australia 1-800-088 200 (user free)
Outside Australia 61-8-223 2855 (user pays)

This service is also increasing in activity and scope and is now an integral part of diving safety in Australia and its immediate environs. During the period of this report 415 calls were received. The busiest month (January 1993) recorded 52 calls. Just under half of all calls involved diving problems in the field, including emergencies, and the remainder were calls from doctors concerning diving medical examinations. There is a small but increasing number of calls related to marine envenomations involving snorkellers and divers. For the first time since the inception of this emergency telephone service in 1986, there was recently a spate of hoax and obscene phone calls. Diving training affiliations and the police were notified and tracing by Telecom Australia located the offenders.

Divers are invited to use DES/DAN Australia for marine envenomation matters as well, as two of the RAH Hyperbaric Medicine Unit's medical consultants are actively involved in marine envenomation studies.

DES/DAN Australia usage provides regular clinical and some logistic interface with Australia's other HMUs. The communications system for DES/DAN Australia involves the round-the-clock first response by the Communications Room of St John Ambulance in Adelaide and is very successful. Tribute must be paid to the officers of this service by all the divers and diving doctors of Australia. The system guarantees connection with an experienced diving medical physician within minutes, 24 hours a day, 7 days a week.

A report of the usage of the Diver Emergency Service (DES) to December 1990 has already been published.[1] A data base of the usage of DES/DAN Australia since that time is being compiled for future submission to the SPUMS Journal.

Clinical research activities

Hyperbaric Oxygen Therapy (HBO) and burns

This is a randomised, controlled study of the treatment of adult burns with HBO.[2] In May 1993 there were 21 patients in this trial, 10 controls and 11 treatment patients. There has been no mortality. No clear trends are yet apparent. Evaluation is by mortality, and morbidity which includes duration of hospital stay, incidence of infection and antibiotic usage, area of grafting, total intravenous fluids, analgesic requirements, theatre visits and long-term cosmesis where possible. This is a potentially important study which will take a further 4-5 years to accrue sufficient numbers. It is hoped that other centres may join this trial, and perhaps extend the investigation to include a treatment group at 1 ATA O_2. Control of the possible influence of CO poisoning upon burns has presented a major protocol design challenge. Based upon current understanding the RAH HMU and Human Ethics Committee no longer regard the withholding of HBO from CO poisoned patients as ethically acceptable.

HBO and xerostomia

The preliminary results from our pilot study[3] support uncontrolled observations[4] that HBO can ameliorate post-irradiation xerostomia. A controlled, randomised, international multi-centre study involving European, American and Australian units is in the planning stages.

Dysbaric exposure and Doppler studies

Ultrasonic Doppler studies of hyperbaric RCC attendants, hypobaric-exposed healthy personnel, and recreational divers in the field are in progress, but it is too early for meaningful results. A review of the subject formed a thesis of the inaugural Fellow appointed to the Unit in 1992, and is being prepared for submission. A pleasing aspect of these studies is the collaboration of civilian hyperbaric and Royal Australian Air Force hypobaric teams. The results of this work should enable a more objective choice of the safe frequency of dysbaric exposure of RCC attendants in therapeutic Units. These studies have the approval of the Australian Defence Forces Human Ethics Committee.

Carbon monoxide (CO) poisoning

Carbon monoxide (CO) off-gassing measurements on CO-poisoned patients[5] and on controls, both at atmospheric and hyperbaric ambient pressures of 100% oxygen have been carried out and analysis of the data is proceeding. The prominence of CO poisoned patients (Table 1) and of research into CO poisoning in the RAH Department of Anaesthesia reflects both the frequency, and the current international uncertainty concerning the optimal management, of this important poisoning.[6-10] Most of the patients presenting to the Unit are attempted suicides. Present indications are that the extent of CO tissue deposition (as opposed to tissue toxicity) is not reflected necessarily by either the presenting clinical state[5] or the carboxyhaemoglobin levels.[6] The correlation of the level of tissue deposits of CO with delayed neurological sequelae also remains unclear. Data from the Unit and elsewhere suggests that the best current treatment for CO poisoning, in addition to normal supportive management, is early and repeated HBO.[6-8,10] Much more work is needed.

Osteoradionecrosis

A retrospective analysis of the long-term outcome of patients treated by the Unit for osteoradionecrosis of the mandible is nearing completion and a prospective study has begun with the Department of Maxillofacial and Oral

Surgery in the University of Adelaide.

Neuropsychological screening

A major collaborative research program with the Adelaide University Department of Psychology (Professor Douglas Vickers) has just begun to develop and evaluate neuropsychological screening tests for CO poisoned and for DCI patients.

The Diving Incident Monitoring Study (DIMS)

The increasingly significant national Diving Incident Monitoring Study (DIMS)[11-14] data is accumulating within the Unit. Plans to centralise diving incidents, morbidity and mortality data at the RAH Hyperbaric Unit are commencing, with the co-operation of Dr Douglas Walker of Project Stickybeak. A progress report of DIMS has been presented.[15]

In-flight resuscitation

A study of in-flight resuscitation capability in the Black Hawk helicopter has been completed.[16]

Ethics Committee approval for all these studies has been obtained. Approval has been obtained for a conjoint, randomised, controlled study of the treatment of unresponsive decompression illness with the Royal New Zealand Navy where the study was initiated.[17]

Other research activities

A pilot study of endogenous catecholamine response during hyperbaric oxygen therapy has recently been completed.[18] This study did not confirm the Russian finding that HBO could suppress endogenous catecholamine production, offering possible anti-arrhythmic advantages to cardiac patients.[19] Further studies are justified.

In keeping with the major incident reporting work current in the RAH Department of Anaesthesia and Intensive Care[20] and the existing interests in the Unit,[21] a newly developed national Hyperbaric Incident Reporting Study (HIMS) is gathering strength. International epidemiology of jellyfish, and other marine envenomations is being published.[22-29]

Studies and development of demand-flow 100% oxygen equipment for first aid use are in progress,[30] and a project studying cardiac arrhythmias during recreational diving has commenced. Performance specifications of oxygen apparatus are also being conducted in the Unit's oxygen apparatus testing laboratory.

Co-ordinating with clinical activities,[31] laboratory animal research relating to cerebral arterial gas embolism (CAGE)[32] occurs.

Other clinical studies

Necrotising soft tissue infections

The 12 months period covered by this report does not reflect the true incidence of life threatening soft tissue infections treated by the Unit over the past 3 years. In the 10 cases of necrotising fascio-myositis and 8 cases of Clostridial gas gangrene treated during the 3 years, in which limbs were at risk in all and lives in some, there was zero mortality. These cases included 2 cases of Clostridial gas gangrene complicated by renal failure. The relentless application of surgical debridement, close microbiological supervision, high quality intensive care and hyperbaric oxygen therapy appears to be one recipe for success.

Co-ordinating role of the HMU within the RAH

It is apparent that the Unit, as do most HMUs, fills a valuable role in bringing together, at appropriate times, the different clinical disciplines. For example when treating chronic non-responding osteomyelitis, orthopaedic surgery, microbiology, radiology, pain clinic, district nursing, drug dependency specialists, psychiatry, rehabilitation medicine and hyperbaric medicine are all involved. Often the specialties have never met about the patient previously, even after years of treatment, and solutions to long-standing problems can become quickly apparent. This experience parallels the earlier evolution of pain clinics.

The future

The RAH HMU has operated to date in cramped and relatively remote quarters within the Hospital, with its clinical care and administrative areas widely separated. It is hoped that the Unit will soon be relocated to larger facilities which will include a second larger RCC, closer to the critical care patient areas within the hospital. This would enable, not only less hazardous transport of patients on life support to and from the RCC, but also greater therapeutic attention to, and studies of, conditions such as chronic, non-healing ulcers. An increase in the number of randomised controlled clinical studies in HBO would also be possible and this is urgently required.

It seems possible to predict that hyperbaric and diving medicine may be forced to re-evaluate, albeit in a calm and scientifically objective manner, its traditional "no-diving stance" with respect to some diseases. Advances in the understanding and management of reactive small airways disease, diabetes mellitus, haemophilia, and intra-thoracic surgery and clean trauma, for example, may cause interesting debates in the future.[33-35] The RAH HMU looks forward to participating in these challenges, for as Xavier Herbert has remarked, "There is only one thing I enjoy more than a good laugh and that's the truth!"

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DIVING INCIDENT MONITORING STUDY UPDATE 1993

Chris Acott

Introduction

The Diving Incident Monitoring Study (DIMS) has been an ongoing project since 1989. Completed forms were initially received on a sporadic basis, but slowly the study has gathered momentum.

Up to the end of 1992, 553 reports had been received. Twenty reports have been rejected for analysis because they contained inadequate information or failed to describe an actual incident. None of the information in these reports has been used. Analysis of the 533 useable reports is presented here.

So far there has been no duplication of incident reports. 57% of those received have been divers reporting their own incidents, 13% reporting their buddy's, while 30% were reports of somebody else's. As more reports are received and more information gathered previous reports have to be reviewed and constantly upgraded. In this way similar incidents can be identified and re-checked.

TABLE 1

INCIDENTS ANALYSED

Year	Number
1989	48
1990	79
1991	162
1992	244
Total	**533**

These 533 incident reports: gather details of incidents; identify common errors made; give insight into current diving practice and behaviour; identify "equipment faults" either due to design or problems associated with diver usage of his or her equipment, or "pure" equipment malfunction.

Why use incident monitoring and not analysis of diving fatalities and accidents?

Firstly, counting the dead is a poor measure of how well "things are going".

Secondly, when a coroner or other official body is involved, the reports of the event tend to be what should have happened rather than what did happen. Unfortunately, the "blame-model" still operates in recreational diving.

Thirdly, most accidents have multiple components and it is difficult to identify and apportion responsibility to these various components.

Fourthly and most importantly, there are not enough accidents and deaths to make statistical "sense" of the data. For each accident there are at least 1,000 incidents. Incident monitoring is a powerful mechanism and gives considerable insight into the "COCK - UP CASCADE" (Table 2).

The ratio of male to female of 3:1 was constant throughout the reports received. This may well reflect the general ratio of male to female divers. The ratio of male to female divers presenting for treatment of diving related disorders at the Royal Adelaide Hospital (RAH) Hyperbaric Chamber is, on average, 3:1 (one abnormal year of 17:1 has been disregarded!)

Morbidity

Table 3 displays the 233 cases of morbidity (44%) reported in the 533 incidents under review.

TABLE 2

THE COCK-UP CASCADE

Incident reporting looks at all stages

Associated patterns of behaviour
|
Contributing factors
|
Errors and or negative incidents
|
*****Accident or major incident*****
|
*****Injury*****

*** Mortality and morbidity studies only look here**

TABLE 3

233 INCIDENTS ASSOCIATED WITH MORBIDITY

Diagnosis	**Number**	**%**
Decompression Sickness	126	54
Ear Barotrauma	29	12
Cerebral arterial gas embolism	21	9
Pulmonary barotrauma	17	7.3
Salt water aspiration	17	7.3
Sinus barotrauma	5	2
Coral sting	4	2
Hearing loss	1	0.4
Other	13	6
Total	**233**	**100.0**

The factors associated with the incidence of decompression illness were rapid ascents, omission of decompression stops, misreading decompression tables, computer error, multiple ascents (yo-yo diving), flying or going to altitude soon after diving, lack of any decompression algorithm (tables or computer), deep diving and a deep dive being the last dive of the day.

The so-called "safety stop" failed to prevent decompression illness in 18 incidents. Fourteen incidents occurred at the safety stop, 11 resulted in morbidity. In some of the incidents, the dive profiles recorded were well within any tables, but a safety stop was used inappropriately; e.g. if a novice is having trouble with his or her regulator then a direct ascent to the surface without a safety stop is prudent management. Poor buoyancy control, free flowing regulators, salt water aspiration and weight belt problems all occurred while at a safety stop and all contributed to panic and the subsequent breath hold ascent, leading to the unfortunate consequences of pulmonary barotrauma and cerebral gas embolism. The safety stop serves to slow down the diver's ascent. Strictly speaking, it is not a required decompression stop, but it is reported as being so. Extended dive profiles are "made safe" by the addition of this stop, however, the data presented clearly indicates that it is not the panacea divers are looking for. Divers should make sure the safety stop does not become an "unsafe stop".

Incidents during training

There were 70 incidents (13% of the total) reported which occurred during training (Table 4). Forty nine (70%) of the these 70 incidents during training caused harm to the diver. The non-harmful incidents recorded reflect good management by those involved with the training of the divers. However, some disturbing trends were noted:

TABLE 4

70 INCIDENTS DURING TRAINING

	Number	**%**
Incidents without sequelae	21	30
Harmful incidents	49	70

Harmful incidents	**Number**	**%**
Decompression illness	17	35
Ear barotrauma	15	31
Salt water aspiration	5	10
Cerebral arterial gas embolism	3	6
Miscellaneous damage	9	18

Novices are not being instructed on the correct use of buoyancy vests. Some incidents demonstrated that novices neither knew how to inflate nor deflate their vests (particularly when a vest spontaneously inflated).

Medically unsuitable candidates are still being allowed to dive. An asthmatic lied, while 3 candidates were psychologically unfit.

The high incidence of decompression illness among diving students is a surprising statistic. This may reflect multiple ascents during training exercises, lack of medical/ physical fitness to dive or just bad luck. However, these data refute the saying "Decompression sickness is a disease of old divers and gas embolism of novices."

Not surprisingly poor ear clearance techniques are reflected. One student commented, "They don't tell you how hard to do it, or when to do it, or when to stop."

Overall these data shows training can be associated with major morbidity as 21% of all harmful incidents occurred during training.

Experience and training

Not suprisingly six out of the 7 untrained divers, 3 on introductory dives, were involved in harmful incidents. These were three cases of pulmonary barotrauma (2 on introductory dives),1 CAGE, 1 C.V.A.(an introductory dive) and 1 ear barotrauma. Table 5 lists fewer than the total of incidents and of harmful incidents because not all reports included the diver's certification status.

The diver who suffered a C.V.A. (stroke) underwater had lied on his medical questionnaire.

TABLE 5

CERTIFICATION STATUS

Qualification	Incidents	Harmful incidents
Not known	26	
Untrained	7	6
Basic	81	31
Open water	171	84
Advanced	102	38
Divemaster	29	11
Diving Instructor	52	16
Commercial	23	14

Dive tables

In 123 reports the dive tables or computer section were not filled in. 410 reports had this section completed. A total of 120 divers used computers. In 114 reports the diver recorded not using tables. However 43 of these used a computer leaving 71 (17% of those who answered the question) who definitely did not use tables or computer. This is a disturbing figure. Either the divers concerned:

- lacked suitable training and did not understand the need for depth/time calculations;
- or considered that depth/time calculations were unnecessary due to the depth of the dive;
- or had a "macho" attitude toward decompression;
- or they just forgot.

Fifty three (75%) of these 71 non-users of decompression procedures were basic or open water certified divers. In this group there was one diver who dived repeatedly to 30 m (100 ft). The tables recorded as being used are listed in Table 6.

TABLE 6

DIVE TABLES USED (IN ORDER OF FREQUENCY)

Table	Users	Approximate %
PADI	139	34
None	114	28
USN	49	12
DCIEM	29	7
BSAC	25	6
NAUI	22	5
Bassett	18	4
Other	14	3
Total	**410**	**99**

When did the incident occur?

Table 7 shows at which part of the dives the incidents occurred

These were 2 preparation incidents where the diver nearly drowned. Both involved walking towards a boat to load gear. Both divers had their weight belts on, one was fully kitted up, but without air turned on, and the other was not. One was knocked over by a wave and was unable to right him/herself, the other fell into a hole and had to be pulled out. Neither thought about dropping their weight belt.

Harmful incidents were mainly detected following the exit (49%) and during the dive (29%).

TABLE 7

WHEN INCIDENTS WERE DETECTED

Stage of dive	Incidents	%
Preparation	32	6.0
Entry	24	4.5
Descent	45	8.5
During Dive	176	33.0
Ascent	60	11.2
Exit	42	7.8
Following exit	154	29.0
Total	**533**	**100.0**

Contributing factors

The main contributing factors in all incidents are listed in Table 8.

TABLE 8

MAIN CONTRIBUTING FACTORS

Factors	**Incidents**	**%**
Error in equipment	133	25
Inexperience in diving	107	20
Poor dive planning	96	18
Inattention	80	15
Failure to check equipment	64	12

Table 9 lists the contributing factors which, when present, were causes of morbidity in the majority of incidents. These less common contributing factors, associated with diver harm, are similar to those associated with harm in the review of the first 125 incidents.[1] Of the 11 incidents associated with drug or alcohol intake 7 (or 67%) resulted in harm. Similar percentages were associated with the other factors.

TABLE 9

HARMFUL CONTRIBUTING FACTORS

Factor	**Incidents with factor**	**Incidents with harm**	**% with harm**
Drug or alcohol intake	11	7	67
Failure to understand table	26	17	65
Lack of medical clearance	22	14	63
Insufficient training	48	30	62
Poor physical fitness	53	27	50

There are certain people who are medically or physically unfit to dive who are escaping the medical net. This may be due to the fact that the diver lied (4 incidents) or the medical practitioners were ignorant of the medical requirements for diving (i.e. 5 asthmatics were allowed to dive). Consider the scenario where the diving instructor knows the medical contraindications to dive and the medical practitioner does not and the candidate is allowed to dive and comes to grief. Who is to blame? Both, I am sure, will be sued and both found negligent.

There were 4 reports of psychological problems, 3 resulting in panic. Two of these were associated with claustrophobia and one with agoraphobia. Psychological fitness to dive is hard to assess at the best of times, however there may be clues in the candidates background. Diving instructors are probably are best suited to judge a particular candidate's "water skills and water fitness."

Dive plan

The majority of the incidents did not change the dive plan (Table 10).

Even if the incident involved harm it had little effect on the dive plan. There were 167 (72%) harmful incidents where the incident did not change the dive plan, while the remaining 66 harmful incidents (28%) caused the dive to be aborted or the dive plan to be changed.

TABLE 10

INCIDENT INFLUENCED THE DIVE PLAN

	Incidents	**%**
No effect on dive plan	329	61.8
Delayed the dive	22	4
Changed the plan	58	11
Aborted the dive	123	23
Not recorded	1	0.2
Total	**533**	**100**

Equipment issues

One hundred and seventy five incidents (33% of the total) involved equipment (Table 11). Many of the incidents involved more than one piece of equipment.

Twenty three incidents (13% of the equipment incidents) involved using somebody else's equipment, while 69 (39%) involved equipment malfunction or fault. Nearly a third (24) of these were due to poor maintenance and servicing.

Buoyancy jackets

There were 57 incidents with buoyancy jackets (11% of total incidents). Many of the buoyancy jacket incidents involved more than one problem as can be seen in Table 12.

There were 16 incidents where no buoyancy vest was used. The buoyancy compensator/jacket/vest is often stated by diving experts to be a safety device. However, of the 57 reported incidents, 21 (37%) involved diver harm. All these harmful incidents, with 3 exceptions, were associated with rapid ascents and its consequences. There were 3 divers who developed evidence of pulmonary barotrauma and of CAGE who appear twice in Table 13, as do others, as it shows the diagnoses of those injured.

TABLE 11

175 INCIDENTS WITH EQUIPMENT

Equipment		Incidents
Buoyancy jacket		57
Anchor		7
Boat		7
Camera		3
Compressor		6
Computer stopped working or was inaccurate		2
Contents gauge		18
High pressure hose rupture	3	
Depth gauge		7
Maximum depth indicator	3	
Flag		4
Fins		10
J Valve		2
Mask		13
Oxygen equipment		7
Reel line		1
Regulator		30
Regulator hose rupture	6	
Safety sausage		3
Shot line		3
Scooter		1
Spear gun		1
Suit		15
Surface buoy		1
Tank		11
Watch		4
Weight belt		27
Weight belt dropped	12	
Weights		5
Weights dropped	4	
Exit ladder		5

TABLE 12

57 BUOYANCY JACKET PROBLEMS

Confusion between the deflate and inflate buttons	11
Confusion between the inflate and deflate buttons	1
Inflator spontaneously inflated the jacket	4
Inflation device not connected properly	8
Unable to vent the jacket to slow down	29
Jacket leaked	2
Jacket provided inadequate buoyancy	7
Jacket uncomfortable to wear	3
Unfamiliar with its use	19
Jacket used inappropriately	20

TABLE 13

21 BUOYANCY JACKET INCIDENTS ASSOCIATED WITH DIVER HARM

Diver damage	Incidents
Cerebral arterial gas embolism	14
Decompression illness (DCS)	10
Pulmonary barotrauma	6
Ear barotrauma (of ascent)	2
Salt water aspiration	2

One salt water aspiration incident was due to the vest providing inadequate buoyancy on the surface in rough sea. The other diver deflated his jacket instead of inflating it while on the surface.

Fortunately in these reports there are no fatalities recorded, however, rapid changes in buoyancy and depth clearly have the potential to cause fatal accidents.

Many vests have the power inflate and manual deflate buttons in close proximity on the vest's hose. These power inflators were added to the oral inflator and the vest's manual deflate device without any consideration of the potential harm this configuration could cause. Confusion between the inflate and deflate button featured in 11 (21%) of these buoyancy vest incidents showing that this configuration is ergonomically unsound. The inflate and deflate mechanisms should be separate, perhaps on opposite sides of the vest. Confusion between the inflate and deflate buttons is not only a problem for the diver, but also for the diver's buddy and would be rescuer.

Inflators that spontaneously inflate without activation are extremely dangerous. These incidents reflect either poor maintenance/servicing of these devices (very few divers have their inflators serviced or checked), or a design fault. A design fault would be indicated by a number of these incidents involving a particular type of vest and or model. Statistically, no particular vest inflator/vest model has been identified, although one particular model does feature repeatedly in the incidents reported (there is also anecdotal data suggesting there is a fault in this particular brand of vest). However, more reported incidents are needed and vests named in reports before conclusions can be reached.

Buoyancy jackets provided inadequate buoyancy due to:

i) inadequate tank pressure to fully inflate the jacket;

ii) low tank pressure so that the jacket inflated slowly or appears not to be inflating at all;

iii) incorrect size jacket for the diver concerned.

Like anaesthetists and pilots, divers should do an equipment check before water entry. This check should show how each piece of equipment works, its location and if it is not working correctly the fault should be corrected. Inability to vent the vest shows that this pre-dive check had not been done. A pre-dive check will also show if the inflator is connected correctly.

The function of each vest should be shown to each diver at purchase or when it is hired, as there were incidents reported where the diver concerned lacked the knowledge on how to inflate the vest, either orally or with the power inflator.

Frequent use of the power inflator to maintain buoyancy control was not a major cause of the out of air/low air situation, however, it has the potential to be. Better weighting of divers, emphasis on good buoyancy control and the use of oral inflation should perhaps be stressed more during training. Oral inflation, however, does require good co-ordination and frequent practice.

Regulator

There were 10 regulator incidents (6% of the total incidents), 6 of which which caused harm to divers (20% of the regulator problems). These and other regulator problems are shown in Table 14. It can be seen that many of the problems with regulators overlapped. For instance problems with the regulator despite frequent service was often associated with a free flowing second stage.

These data indicate that first stage problems occur as frequently as free-flowing second stages. However free-flowing second stages were associated with three episodes of salt water aspiration which caused panic.

The seven hose ruptures provided 23% of regulator problems. Hose maintenance is therefore important and a visual inspection should precede every dive.

TABLE 14

REGULATOR INCIDENT PROBLEMS

Problem	Incidents	Harm caused
Free flowing second stage	15	4
First stage problem	14	-
Problems with regulator despite frequent servicing	15	6
Hose rupture	7	1
Problems with mouth piece	2	-
Total	**30**	**11**

A disturbing feature is that in 15 incidents (50% of the incidents) the regulator had been recently serviced. Six of these (40%) caused harm. All divers should test their regulators after servicing **before** it is tested during a dive. Perhaps these data are a reflection on the poor standard of servicing offered by some dive shops!

Weight belts

There were 27 incidents involving a weight belt (Table 15). Twelve of these being dropped when the diver left the water. Other incidents included buckle problems, inadvertent release of tongue slipping through, and a combined incident of a weight slipping off during weight belt handling when leaving the water.

There were 4 other incidents involving weights. These were due to weight being dropped during handling while in the water during buoyancy adjustment.

Better designed weight belts and buckles are needed to avoid inadvertent release during a dive with the subsequent rapid ascent. Design changes are needed to stop weights dropping off the belt during exit from the water.

Better management procedures are needed for the handling of weight belts at exit.

TABLE 15

WEIGHT BELT INCIDENTS

Incidents involving weight belt		27
Weight belt dropped	12	
Incidents involving weights		5
Weights dropped	4	

Miscellaneous behaviour

The following featured prominently in the incidents reported:

1 Standard buddy separation procedures were rarely adhered to.

2 A trend is emerging which shows that more divers are doing their deepest dive last.

3 An absence of any "missed decompression regime".

4 Divers are still diving without any reference to tables or computer.

5 Lack of simple safety procedures:
   - a buddy check before a dive;
   - b lack of a boatman while divers are diving;
   - c unfamiliarity with equipment being used (buoyancy jackets, compressors);
   - d lack of safety lines in wrecks.

6 Lack of basic knowledge of the physics of diving i.e. not knowing that the deeper the dive the greater the air consumption.
7 Total ignorance concerning the symptoms of decompression illness/cerebral arterial gas embolism and of the importance of seeking medical advice concerning vertigo.
8. Lack of suitable knowledge of the first aid management of diving related disorders.
9 Poor entry procedures.
10 Poor management of the air supply in regard to retrieving an anchor at the end of a dive. (This may become a greater problem now that anchors need to be placed and retrieved carefully to avoid reef damage.) Anchor retrieval is another descent and ascent.
11 Lack of the ability to use the diving table correctly.
12 Lack of knowledge of what decompression sickness is.
13 60% of all rapid ascents resulted in harm.

Discussion

Similar trends were noted in these reports as were reported previously in the analysis of the first 125 incidents.[1]

Equipment problems predominate. Misuse, misassembly and lack of understanding of how the equipment functions is common. More emphasis is needed during training on equipment, maintenance, use, function, assembly and safety aspects.

Decompression procedures should be taught thoroughly during training. Divers should be taught **a set of tables** thoroughly. Eligibility to dive should be based on their use being correctly understood and demonstrated before certification. At present a basic decompression rule “deep dive first, shallow dive last” is being neglected. This trend is seen more in computer users. Omitted decompression procedures related to the particular table used should be taught and understood.

Basic understanding of the physics of diving is needed. If this is lacking then the fundamental knowledge of how long a diver’s air supply will last at depth can not be calculated.

Once again a correlation between the lack of medical fitness to dive and morbidity has been demonstrated.

Alcohol and diving do not mix safely.

This study correlates well with other studies in human error, particularly in medicine (anaesthesia) and aviation, in which the thorough checking of equipment before use is an important aspect of safety.

Weight belt problems at exit featured again. A planned exit from the water is always needed on every dive. Those responsible for divers diving from boats should discuss and plan the exit from the water with their divers, particularly when the conditions are rough. Special needs can then be sorted out and planned accordingly. There may be some physical limitations in elderly divers which would prevent them from entering and exiting the water in a fast and controlled manner in rough conditions. Those problems need to be identified and the diver stopped from diving if necessary. **Divers should always plan the exit and dive the plan.**

Other problem areas have been identified:

There is a lack of knowledge and recognition of the symptoms of diving maladies. Emphasis on the positive aspects of recognition are needed, and less on the negative side e.g. “You’re bent. You must have screwed up somewhere!” Decompression illness **is a diving related disease**, the more one dives, the greater chance one has of becoming a statistic. Divers do not have to have done “something wrong” to get decompression sickness, although if one does break the rules then one can expect trouble .

The incident reports show that some very basic rules are being broken. Some examples are:

Never dive if you have had a recent illness. Allow at least one or two weeks for recovery.
Never dive a computer or table to the limit.
Never dive while under the influence of drugs or alcohol.
Never dive while dehydrated.
Never save the deepest dive for last. (This includes diving for the anchor.)
Never dive without consulting a set of tables or reputable computer.
Never dive a “yo-yo” plan. Try to do only one ascent per dive. Remember that an ascent may be going from 18 to 9 m and back again.

Every ascent from every dive should be as slow as possible. A slow ascent needs good dive planning to carry it out.

Corrective strategies

PRE DIVE CHECK

Each diver should be responsible for his or her equipment and should test and inspect it before every dive. Each diver should also do a buddy check. A thorough check should only take a few minutes.

BUOYANCY COMPENSATORS

Check that the scuba feed is connected and will inflate and deflate.

Check the jacket for leaks when fully inflated.
Check oral inflation.
Check the emergency vent holes.
Check that the tank is secure in the back pack.
Check the position of the inflate and deflate buttons, test them and practice emergency venting of the jacket.
Perform the same inflate and deflate procedure on your buddy's jacket.

All buoyancy compensation devices (BCDs) need to be carefully and critically looked at. Poor ergonomic design of the inflator/deflator mechanism needs attention. Even more basic, however, is the testing to see if the vest will float an unconscious diver face down in the water. I know of no such testing that has been done on all the current buoyancy vests/devices. BCDs are supposedly "safety devices", however as these data show, if there are problems, then statistically the diver is likely to be involved in a harmful incident.

When a buoyancy compensator is bought or hired from a dive shop, it would be prudent for the dive shop to ensure that:

1) the diver knows how the jacket works;
2) that all the inflate and deflate mechanisms work correctly;
3) that the jacket fits the diver correctly and is comfortable.

REGULATORS AND CONTENTS GAUGES

1 Visually inspect all hoses before connecting the regulator to the tank. Inspect the hoses again after connection to the tank and when the air supply turned on.
2 When the air supply is on note the full position on the contents gauge.
3 Switch the air supply off.
4 Purge both second stages and check purge buttons.
5 Note the empty position.
6 Switch air supply on. Note full position again. Check that it correlates with No. 2.
7 Check, with the air supply turned fully on, that the diver is able to breath through both 2nd stages (if an octopus is fitted).
8 Check that breathing does not cause oscillation of the pressure gauge needle. If it does then the air supply should be checked to make certain that it is turned on fully.
9 Check that there is no positional free flowing of either second stage.
10 If the contents gauge is bumped before getting into the water, these checks should be performed again.
11 Check that the diver and the buddy knows where both second stages are, particularly the octopus.
12 Once in the water, do a surface check for any positional free flowing of the regulators.

WEIGHT BELT

1 Check the quick release.
2 Check the "tongue overlap".
3 Check whether the weights will fall off if the weight belt is handled incorrectly.
4 Think again about the "correct weight" and adjust the weight belt accordingly. Has there been a change of wet suit? Has there been a change of water environment, salt v fresh? A rough guide to weighting is:
1 kg weight for each mm thickness of wet suit;
1 kg extra for hood and "Long John" additions;
1 kg for aluminium tank;
1-3 kg for individual variation in buoyancy.

MEDICAL FITNESS

There is still a need for more medical practitioners trained in diving medicine. Courses are available at the Royal Adelaide Hospital (2 per year), HMAS PENGUIN, Fremantle Hospital (one a year) and the Diving Medical Centre, Brisbane, organises courses in the Eastern States. As more and more medical practitioners are trained, there will be little excuse for a diving candidate not seeking a knowledgable opinion.

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DIABETES MELLITUS AND THE SCUBA ENVIRONMENT

Mark Sullivan

Diabetes mellitus has been recognised as a lethal malady since the beginning of recorded history. It was first recorded in writing in the 1st century A.D. by Areteus, who described an illness characterised by a "melting down of the flesh to urine". He named the malady *diabetes* derived from the Greek word meaning "a siphon". The word *mellitus* was added in the 5th century by Susruja, to describe the sweet-smelling urine so often associated with diabetes mellitus. Until 1921, when Banting and Best first introduced insulin for the treatment of diabetes mellitus, there was no substantial remedy for this malady, and worsening cachexia and death were the inevitable result.

Before the advent of insulin therapy, any form of physical activity was rare, given the increasingly cachectic state of the patient. Following the introduction of insulin in 1921, the risk of sudden hypoglycaemia and seizure activity was generally deemed to preclude these patients from any major physical endeavours. However, when blood glucose monitoring sets became widely available in the 1970's, recommendations about these patients undergoing physical activity became sharply divided. This state of affairs has continued throughout the 1980's, often with blanket exclusions applied to many activities still common. For example, in 1986, Bove and Davis, in the textbook *Medical examination of the Sports Diver*,[1] made the comment that at that time, despite little justification, a complete exclusion of all patients with diabetes mellitus was appropriate, but that there would be likely to emerge in the future, a small sub-set of these patients suitable for recreational scuba diving. In this regard, the current SPUMS position paper[2] on this topic seems squarely rooted in the past, and fails to address the current aspirations of otherwise highly suitable fit patients with diabetes mellitus genuinely interested in recreational scuba diving.

My interest in diabetes mellitus is fourfold.

Firstly, two of my extended family are young women, both of whom have been treated with insulin for more than 10 years. They are very stable with current therapy, and enjoy skiing, sailing and swimming, but have no interest in scuba diving. They are also both graduates of the Faculty of Science at the University of Melbourne, and regard the current SPUMS position paper as ill-informed, inaccurate, pseudo-elitist and offensive in some statements. They cannot believe that this article was ever written, never mind published in an otherwise respectable international journal.

Secondly, for some years, I have been impressed with the attitude of Dr Ken Kizer, Professor of Community Health at the University of California at Davis, who has championed the prospect of fit patients with diabetes being accepted and encouraged to undertake training for recreational scuba diving. He is a past SPUMS member and has completed over 200 dives with his wife, an insulin-dependent diabetic.

Thirdly, I am currently involved in research into the pharmacokinetics of insulin during normothermic cardiopulmonary bypass, and comparing this with the hypothermic situation.

Finally, I and my two sons are members of the Scotch College Scuba Club, a club in which the boys are BS-AC trained and use the DCIEM tables. School boys with diabetes mellitus are welcome to learn to dive, and at the recent two week school "divefest" at Scawfell Island, off Mackay, two of the boys and one instructor were insulin-dependent diabetics, and the other divers were most impressed with the skill with which the two schoolboys managed blood testing, dietary matters and varying insulin dose to ensure that pre-dive and post-dive blood glucose levels were **always** within **normal limits**.

Given the vast improvements in accuracy, cost and availability of personal blood glucose monitoring equipment for the management of diabetes mellitus, in otherwise very fit patients, it would seem that the current SPUMS position is rather out of step with the situation in other active sporting organisations. The Australian Surf Lifesaving Association, the Victorian Ski Association, the Victorian Soaring Club and the Confederation of Australian Motor Sport all accept stable fit insulin-dependent diabetics into competitive and administrative activities. Blanket exclusion would now seem to be totally inappropriate. Following the stance taken by Professor Kizer, I have been encouraged to advocate and expand a group of pre-conditions to be fulfilled before dive training can be undertaken. In addition, a full physical examination, which must also include an exercise stress test to stage four on the modified Bruce protocol,[3-6] documented 6/9 vision unaided in both eyes and a baseline audiogram, should be performed.

Despite the major advances in the last decade related to the understanding and treatment of this common malady, many diving physicians often feel very uncomfortable and "out of their depth" when attempting to assess the suitability of a particular diabetic for recreational scuba training. The current SPUMS position does nothing to repudiate the misconception that all diabetics are fat, feeble, neurological crocks! This is quite erroneous and offensive, as many young patients with diabetes mellitus have achieved international fame in a number of highly competitive vigorous sporting activities. Many diving physicians would not be aware or interested in the very high level of education, motivation, management of variations in diet, insulin dose and exercise needed to render unheralded hypoglycaemia a thing of the past, or the regular participation of many diabetics in vigorous sporting activities in the air, on land or in the water.

In addition, many diving physicians feel threatened by the prospect of medico-legal action in the event of any untoward diving injury. I have approached the Medical Defence Association of Victoria on this matter, and they are quite prepared to extend full indemnity to a diving physician so threatened, provided that a written statement verifying the stability of treatment by the potential diver's endocrinologist is available before dive training is commenced.

A number of organisations monitoring morbidity and mortality have been approached to discover if there is any proportional increase in the number of incidents in divers with diabetes mellitus. The British Sub-Aqua Club and the Diver Emergency Service have not provided any evidence of reported morbidity or mortality, and Project

Stickybeak reported a death in a breath-hold diver in the distant past, as well as a report of a young man who committed suicide when told that he was automatically excluded from recreational scuba diving. There seems to be no current compelling evidence of increased morbidity or mortality in this cohort of divers, especially as it is widely accepted that many diabetics dive, and dive regularly and conservatively.

In summary, there are many good reasons to accept and encourage a small number of otherwise very fit, stable and well-motivated patients with diabetes mellitus to train for and enjoy the scuba environment. A change in the SPUMS policy would seem to be highly desirable, especially as the most recent edition of *Diabetes Conquest*, the national journal of Diabetes Australia, to which I submitted an article on scuba diving and diabetes mellitus,[7] was devoted entirely to highlighting discrimination against diabetics in the workplace, the sporting arena and society at large.

If the current SPUMS position on diabetes mellitus and recreational scuba diving does not change comprehensively, it may well be bypassed and be seen to be irrelevant, ignorant and possibly unlawful.

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ARTICLES OF INTEREST REPRINTED FROM OTHER JOURNALS

UHMS DIVE COMPUTER WORKSHOP

Bill Hamilton

Diver-carried computers (DCs) have been in use for nearly a decade, but their reliability in defining decompression for certain types of profiles remains controversial. A diversified group of experts was assembled for a workshop during the UHMS annual meeting in Halifax, Nova Scotia, to examine in particular the question of repetitive dives. Following up on earlier workshops, one by the American Academy of Underwater Sciences (AAUS) in 1988, which considered rational use of DCs in the scientific diving environment, and one in 1992 by the European Undersea Biomedical Society (EUBS), which looked at a variety of issues, particularly the track record of DCs in recreational diving, the workshop in Halifax addressed the use of DCs in repetitive diving from a variety of perspectives.

Initiating the discussion was an outspoken critic of dive computers, Dr Carl Edmonds from Sydney, Australia. By his calculations, dive computers cause "omitted decompression" when compared to the venerable U.S. Navy Standard Air Decompression Tables. Strictly speaking this is the case, but others point out that this is a consequence of the calculation methods and some inherent conservatism, or inefficiency depending on your perspective, of the Navy tables. Although there are small differences, this critique applies to virtually all present day DCs. In addition to his point about numerical manipulation, Dr Edmonds makes a more relevant point: very few DCs have been tested by the manufacturers before being placed on the market. Some DCs include warnings and suggest procedures for increasing conservatism, but Dr. Edmonds feels these factors should be put into the algorithms rather than be left to the user. One type of profile that he expects will produce greater problems with repetitive dives are closely spaced dives that are relatively deep.

Providing a partial answer to this criticism, Dr. Albert Bühlmann, now retired but formerly at the University of Zurich, described a new model that takes into account the water temperature in computing the decompression. Professor Bühlmann's models are used in several of the current dive computers (as well as in several commercially available PC-based programs that can be used for calculating special decompression tables such as those needed for "technical" trimix dives). Professor Bühlmann pointed out that perfusion changes drastically when a diver is cold, so Dr Bühlmann's model uses a colder water temperature to cut back on the theoretical outgassing rate. The new model also calls for more ascent time from deep dives, which Dr. Bühlmann feels will account for repetitive dives. With the limited ascents it will be difficult to carry out long, deep dives in cold water because of the longer decompression required.

Max Hahn of the German Sports Divers Federation presented more evidence for potential problems, showing that computers will allow "yo-yo" diving of the type performed by fish farmers, without compensation. He suggests keeping a running account of every msw (metre of sea water) of ascent, and using the total to limit the final ascent. This could be done in a way that would penalise the more aggressive yo-yo dives, but would not inhibit the familiar square and multilevel patterns that seem to be working.

Moving from theory to results, Guy Dear and colleagues of Duke University reported on recent data from the Diver's Alert Network. He noted that more divers are using computers, and compared "table dives" with "DC dives." In the early days of DCs only the more aggressive divers had them, but DC use has spread to the garden variety diver and now more dives are done with computers than without. Even so, the computer dives tend to be deeper, and the divers using computers are more likely to be older and male. The proportion of DCS is higher in table dives than DC dives, but there is no difference in symptom severity; delay until treatment is the same. The data base is not large enough to allow repetitive dives to be evaluated. As with other survey data of this sort, a hard denominator is still missing, (which is why DAN is instituting a massive program to collect accurate dive profiles, Doppler scores, and outcome from a million dives).

Next, Jon Hardy of Avalon, California, reported on a comparative evaluation of available dive computers sponsored by *Rodale's Scuba Diving*. DCs are primarily a tool of recreational divers, and work best for multilevel dives; they uniformly give a more conservative decompression for a "square" dive. The recreational diving community needs to admit that "decompression diving" is being done. Measurements of time and depth are all of excellent quality. Mr. Hardy compared a number of repeated dives, watching when each of the computers would "give up." He offered a list of improvements that dive computer manufacturers could incorporate. Do not switch different types of information in the same location in the graphic display, do flying-afterdiving calculations based on the exposure, and allow the user to add a safety factor. The workshop chairman reminded him of the importance of including a dive logger, with which he agreed.

Bret Gilliam of Bath, Maine, offered suggestions on how to use DCs. He pointed out their excellent information on depth and time and their overall reliability, but also noted that even "no-stop" multilevel diving is a type of decompression. First, a diver needs to know how to use the computer. Ascent rates need to be controlled and provocative exposures avoided. Limit dives to 2 to 4 per day, with at least 1.5 to 2 hours between them. Novice divers should stick to nostop dives, and all divers should avoid pushing their computer to its limit. No decompression procedure is completely "safe," so include the same sort of buffers or J-factors as one would with tables.

Dr Russ Peterson of West Chester, Pennsylvania, explained how the UHMS Validation Workshop (1989) could be used as guidelines to accomplish some of the dive computer testing called for by Dr Edmonds. Chamber testing may be useful for "disaster prevention," but it is an impractical way to define low predicted DCS incidences at high levels of confidence. If the domain of experience is relevant to the new procedures, then existing experience can be used for validation. Dr Peterson pointed out that a court would consider a "valid" procedure to be one deemed so by experts in the field. This is not a free license and has to be defensible to peers, but it offers another option.

Captain Ed Thalmann of the Naval Medical Research Institute (NMRI) in Bethesda, Maryland, treated this audience to a preview of the algorithm that will be used for the new USN Air Tables, and showed in some detail the clever statistical methods used to develop them. NMRI researchers used extensive chamber testing as well as a massive data base of Navy diving experience as a baseline. Assembling the data base was constrained by several factors: self reporting of outcome was not acceptable and all dives used had medical assessment. The predictive algorithms worked well on dives similar to those in the data base and were satisfactory on some unusual profiles not in the data base. The resulting algorithm is available to a commercial computer manufacturer who wants to develop it in a DC. Comments were hot and heavy throughout the workshop. Some participants mentioned that the training institutions should recognise that divers are doing this type of diving and are using computers. The DCs are not "diver-proof," the human needs to control the device, not the other way around: and avoid "computer narcosis." Workshop chairman, R.W. "Bill" Hamilton, is preparing the workshop proceedings which will be ready by mid-1994.

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THOSE IN PERIL ON THE SEA...

Tim Parish

More thorough reporting revealed a truer picture about diving incidents around Britain last year. There were at least four incidents every month, rising to a peak of 45 in the summer, many involving boat and surface problems.

Compared with 1992, the 1993 British diving year looks, at first glance, to have been a poor one in terms of safety, with an overall incidents tally of 263, as against 149 the previous year. However, with over 360 reports, covering 263 incidents, the 1993 data shows a higher than average recording accuracy. Last year's data was supplied by the British Isles Group of Hyperbaric Therapists (BIGHT), the Diving Diseases Research Centre (DDRC), the Institute of Naval Medicine (INM) and HM Coastguard, together with the usual British Sub-Aqua Club (BS-AC) Incident Reports.

There was a total of 9 diving fatalities in Britain in 1993, a dramatic drop from the 17 of 1992. Of these, only 3 fatalities involved BS-AC members.

One BS-AC incident involved a branch which was running an introductory diving course at the local swimming-pool. This incident was very upsetting for all members of the club concerned. The deceased man, who died of a heart attack, had enrolled on the course and signed a Declaration of Fitness To Dive. The man was in his mid-30s, overweight, a heavy smoker, and had had two previous heart attacks and a triple heart by-pass operation during the previous 3 years. He hid his operation scars in the changing room and pool by wearing a dark T-shirt. The club itself was found to be blameless in this fatality and the members were actually praised by the rescue services for their attempts to resuscitate the man. This particular fatality highlights the need to ensure that fitness declarations are signed before taking any non-member into the water. Failure to do so could be seen as being negligent, thereby allowing the BS-AC's insurers to withdraw cover.

A female diver (not a BS-AC member) disappeared from the shotline during the ascent from a 56m dive on a wreck off Portland Bill, after having had to abort the dive due to nitrogen narcosis. The woman was carrying oxygen for decompression and it is suspected that she may have breathed from her oxygen cylinder in error during the ascent, causing her to lose consciousness.

The use of oxygen for decompression is not recommended by the BS-AC because of the dangers of loss of consciousness under the surface. Occurrences of this have been recorded by military divers, but even they are not allowed to use oxygen under water without full-face equip-

TABLE 1

DIVING INCIDENTS FOR THE 12 MONTHS OCTOBER 1992 TO SEPTEMBER 1993

Year	Month	Incidents
1992	October	4
	November	7
	December	6
1993	January	9
	February	12
	March	12
	April	22
	May	27
	June	45
	July	45
	August	42
	September	12

These figures are taken from a bar graph in the original paper. The total is 243, not 263 which appears in the text and beside a pie chart in the original. The originals are in colour and have been converted into tables to avoid the problems of printing colour originals in black and white.

TABLE 2

BOATING AND SURFACE INCIDENTS

Incident type	**Number**
Late return	1
Propeller injury	1
Egress	2
Collisions	3
Sinking or capsize	4
Rocks	6
Engine failure	19
Lost divers	37

Analysis of boating/surface incidents shows the preponderance of lost divers and engine failure.

TABLE 3

FACTORS INVOLVED IN DECOMPRESSION INCIDENTS.

Factors	**%**
Within limits	36
Deep diving	32
Rapid ascents	16
Misuse of tables	7
Repetative dives	5
Missed decompression stops	4

ment and support divers at the stop depths. The use of oxygen for decompression is definitely not appropriate for the recreational diver.

Following a fatality off Chesil Cove in April, the Coroner' Inquest returned a verdict of Lack Of Care against the diving school/instructor under whose care the trainee had entrusted herself. I should stress that this was not a BS-AC school. This verdict opens up the defendant to punitive compensation claims from third parties. This is an important, and worrying, verdict. It is the first time such a verdict has been reached in a diving fatality. Should this become more prevalent it is important to remember that branch officers are responsible for the safety of members and could, therefore, be the subject of such a law suit them selves. This is an area which I, and other members of the National Diving Committe and Council, will be watching with interest.

The good news is that the BS-AC's underwriters are currently satisfied with our procedures and are not likely to withdraw cover from a member without very good reason, provided that the recommended procedures have been followed. This includes checking the validity of medical certificates or declarations of fitness, completion of Incident Reports for the incident concerned and, of course, observing our all-important "duty of care".

Following 1992's low number of documented decompression incidents, largely caused by a lack of information in time for the report deadlines, 1993 has seen figures back up to the level at which they stood in 1990/1991. The breakdown of major contributory factors leading to cases of decompression illness (DCI) shows a continuation in the trend of around 40 per cent of DCI cases having been within tables or computers (this year's figure was actually 36 per cent). While many of these cases were later proved to show evidence of a Patent Foramen Ovale (PFO), many were not. Further analysis of possible causes shows the usual known factors of dehydration, repeat diving over several days, tiredness, all factors mentioned many times during diver training. It is vitally important to remember that these factors do have an influence and must be taken into account during dive planning.

It is up to the individual diver to assess his or her own current state of fitness, and admit to it when planning the dive to be carried out. If you believe that any of the known risk factors apply to you, move down a table (eg, dive on Table B rather than Table A) or plan to surface with a Surface Code of E or less. Don't push your body beyond its limits. Other significant factors involved in DCI incidents in 1993 were deep diving (32 per cent) and rapid ascents (16 per cent).

TABLE 4

SOURCES OF INFORMATION ABOUT INCIDENTS.

BS-AC	160
HM Coastguard	120
Diving Diseases Research Centre	25
Institute of Naval Medicine and BIGHT	51
Newspapers	6
Verbal	1
Total reports	363
Total incidents	263

Last year we received far better information from the Coastguard, causing an apparent increase in the number of boating and surface incidents. This is an area in which the BS-AC are aware that divers are notoriously bad at reporting incidents. There were 73 diving incidents which occurred either in boats or on the surface last year, a far more significant number than has previously been recorded. Most concerning was the rise in the number of missing divers, usually recorded as around 5-10. With the addition of the Coastguard information, this figure rose to 37 cases in 1993. Many of these required the launch of a Lifeboat and an SAR helicopter to assist in the search, an expensive exercise to compensate for what is, in most cases, carelessness by the cover boat and/or the divers themselves. The second highest figure was that for mechanical failure, with 19 occurrences throughout the year. Most such incidents could be avoided with regular outboard motor maintenance.

The trend towards the average club dive being deeper than it was continues, driven by the availability of good-quality equipment and the desire to carry out more adventurous dives. While the purchase of good-quality equipment can give you the capability to carry out a deep dive, it cannot and will not give you the training and experience to do so. Thorough dive planning, the use of shot lines for the ascent, use of bottom lines, a redundant air supply and suitable work-up dives, are all vitally important considerations prior to a deep dive.

Before embarking on a deep dive it is vital that you have received appropriate training and built on that with a gradual assimilation of experience at increasing depths. Furthermore, it is important that an adequate number of work-up dives has been carried out, to help build up resistance to the inevitable narcosis. Finally. wherever possible, dive with a more experienced buddy and take the opportunity to learn from them. Deep dives are not a challenge to be taken lightly but can be very rewarding provided that the correct preparation and planning is carried out first.

As already mentioned, Coastguard reports have caused an apparent jump in the number of occurrences of divers losing contact with their cover boat. This is a sad testimony to the lack of importance which some divers apparently place upon the safety of their club-mates. Very few incidents where divers are lost on the surface can be put down to chance; most occur through carelessness or a lack of thought on the diver's behalf either during dive planning or the execution of the dive. The following are a few of the procedures which are apparently being forgotten or ignored when carrying out drift dives:

- Use surface marker buoys on all drift dives,
- Drift with the current. Don't swim across it,
- Do not put too many divers in the water at any one time,
- Ensure that the surface cover pays attention at all times,
- Keep the cover boat between the sun and the divers,
- Carry recall signals and don't be afraid to use them,
- Carry a radio and, should the worst still happen, contact the Coastguard.

Last year was also notable for the number of reported successful airsharing ascents following a loss of air supply under the surface. All but a couple of these were accomplished using the buddy's alternative air source (AAS), highlighting the necessity of every diver's carrying such a device. It is notable how many divers are now carrying an AAS, but sadly a number of divers do not appear to be using much thought as to its positioning and ease of use.

An AAS, whether an octopus regulator or a regulator attached to a pony cylinder, should be set up so as to allow the buddy to use it without kinks or S-shaped bends in the hose, not for the diver himself. When another diver needs your AAS he or she is likely to be on the verge of panic. If they cannot reach air easily and without straining to keep the mouthpiece in their mouth, the situation is exacerbated, not relieved. Should that happen, you should not be surprised if they grab the mouthpiece that they know works, the one in your own mouth! An AAS is not just there to save someone else's life, it is also there to ensure that your mouthpiece can stay in your own mouth, and that both divers can make a safe controlled ascent.

In the minority of occasions where a diver needs to use his own AAS (and that should only be necessary if his buddy does not carry an AAS), he is far more likely to be in a calm state of mind. He knows he has a back-up system. has practised its use (hasn't he?), and is far more able to cope with a kink in the hose or a slightly awkward angle. In the case of an octopus regulator, of course. positioning the AAS so that you can use it yourself is a total waste of time. You are breathing from the same air cylinder as your main regulator, therefore if you run out of air both second stages are affected. If you have a free-flow, the free-flowing second stage will eventually cause the first stage to freeze, causing the AAS to free-flow as well.

Look carefully at your AAS equipment and how it is set up. Does it really carry out the function for which it is required, or is it an expensive fashion accessory?

As some of this year's incidents, and their aftermath, have shown, one of the most important things to remember is that every diver, when he or she enters the water with a buddy, owes a "duty of care'" to his or her buddy, to ensure that they both surface none the worse for the experience. Whenever you dive with someone there is a mutual bond of trust to the effect that, if anything goes wrong during the dive, your buddy can, and will, assist you to safety. As BS-AC divers, you are trained to enable you to carry out that commitment without undue risk to yourselves.

Tim Parish is the BS-AC's Incidents Adviser.

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BREATHLESS IN JURASSIC PARK

Bob Halstead

"There I was, alone, 30 meters down the drop off. Grey reef sharks were approaching to my left then, to my right, a huge tiger shark swam straight for me, pectoral fins down and mouth agape. Suddenly a giant tentacle reached up from the deep and grasped me around my ankle. Just then I realised no more air could be drawn from my regulator .... "

By the way I've just seen Jurassic Park. Do you know what the scariest creature in the movie is? Yeah, you got it, a computer operator. He's a big guy, and not even jolly.

Let's try again.

"There I was alone, 30 meters down the drop off. Grey reef sharks menaced my left, their chilling eyes glued to my succulent thighs. Then, to the right, I was stunned to see a huge Tiger shark, jaws agape, lunging towards me. Suddenly a giant tentacle reached up from the deep and grasped me around the ankle. Just as I realised that no more air could be drawn from my regulator, I was engulfed in a frenzy of bubbles .... Oh No!! Looking down I was horrified to see ....A DIVER!!! Aaaarrgghhhhhhh ..."

Cut to scene of butterfly fish flitting around coral gardens and causing typhoons in the China Sea.

Alright, I know you real divers love sharks and sea monsters and have learned that most of the danger from these beasts exists in the imagination. Some of you also might believe my observation that the circumstance most likely to lead to injury is being with other humans, the message was quite clear in the movie, by Neptune! But I have a feeling that most of you might get a nasty creepy shiver thinking about "no more air could be drawn from my regulator." Which is why I am going to devote this enlightenment to "Emergency ascents" of which more nonsense is spouted by diving instructors than even, well, for example, the buddy system.

It has taken me a long time to come to my senses on this topic so to all whom I have taught buddy breathing, octopus ascents, emergency swimming ascents, breathing from a BC, buoyant ascents and other assorted dumb techniques: I APOLOGISE.

I got suckered in to these crazy ways of sucking for survival because they are all theoretically possible and, even better, they generally involve complex and difficult skills that require continual practice to master and remember. Even better still, the procedures are so dangerous that we are told they should never be practised except in conditions in which they never will be needed. So diving students spend hours buddy breathing etc. in swimming pools and shallow ocean but never from the sort of depths that divers actually run out of air in. Let's make this crystal clear. You find yourself, through bad luck, or your own stupidity, or whatever, at 30 m with no air. To survive you are now supposed to use a procedure that is so dangerous that you have been advised never to practise it in the circumstance that you now find yourself. I would imagine, since I have never been in that circumstance myself, that the thought would be enough to bring you close to pushing the panic button. Is this intelligent advice we are considering here or something more appropriate to the Jurassic era? Emergency swimming ascents from 30 m have become drills for consenting heroes in private oceans. They are skills that you just know the old pros can do, a nod is as good as a wink here, but it is not something they are going to admit to practising, especially to mere mortals. OK, we do not encourage pilots to practice actual crash landings in airplanes so I suppose some smarty is going to use that argument against me, but, tough luck mate, with diving there is a solution so simple that we do not have to learn or practice buddy or octopus breathing or 30 m Emergency Swimming Ascents at all because, if we are smart, we will NEVER have to use them EVEN with "no air at 30 m".

I CONFESS, (Oh forgive me, Neptune) that I have been prepared to risk all to learn these elite skills and having them mastered has made me feel superior, perhaps even super-human. This meant I could boss other divers, particularly beginners, and generally make them feel insecure and inadequate which I needed to boost my own self esteem. Yes, I too was a sinner. Those that were able to survive my assault style diving classes and cruises inevitably felt the same way about these skills, and so they became part of diving lore. I must say I was not alone, merely a sardine in the big school of diving instructors who believed that diving has to do with doing things the "true" way rather than the logical way.

Which reminds me. OF COURSE it is much better not to get yourself in an *out-of-air* situation at 30 or even 5 m but you know, it happens, and is a principal cause of diving injuries particularly decompression illness. And it is not always carelessness, my survey of experienced divers revealed that 21 % of them had suffered sudden regulator failure, producing no air, at least once in their diving careers.

I first started to feel uneasy about octopus and buddy breathing when I noticed more and more discussions and published opinions about whether the donor should be in front or to the side, how many breaths to take, which regulator should be passed and where the octopus regulator should be carried and which hand should go where and .... well you know what I mean. You see, I was still trying to figure out how I was going to find my buddy. I was recently assured that the correct emergency procedure if my buddy was closer to me than the surface was to swim to the buddy (20 m?) then make an octopus/buddy breathing ascent to the surface (30 m?). Are your eyes watering, they should be, this is better than Laugh In.

So I became the expert on Emergency Swimming Ascents, (or Buoyant Ascents, for wimps). This was really good because to survive these you need terrific breath control and tolerance for carbon dioxide build up, and you got these by practising skin diving. I am a pretty fair skin diver so coined the rule "Never dive deeper than twice the depth you can skin dive to". This has since been taken seriously and published in a book on solo diving. Wow. By the way, Compressor King and long time diver and friend Brian Hotton from New Zealand, to whom you can all be grateful for all those great clean air fills that you get from Telita and Tiata, wrote and told me that it was not a good rule because in New Zealand all the divers can skin dive to at least 30 m and he did not approve of scuba diving deeper than 60 m. There is a response to this, and it has to do with sailing and a certain cup. The trouble with these ascents was that although I was confident I could reach the surface after "no more air could be drawn from my regulator" I could not figure a way of doing a decompression stop on the way up, after all it would be unlikely that the regulator would fail or I would run out of air directly beneath the boat and a hanging bottle. Since I truly believe that old, bold divers must consider EVERY dive to be a decompression dive this produced an impasse. If you could think of a way of making a stop it would be the answer to an impasse-able dream, and make an impassible dive.

And although I practiced rebreathing air from my BC, and even breathing from a tank with no regulator, even as silly as I am, I never supposed that any one in a real emergency situation would be stupid enough to actually try to do that. I mean, CRAZY or what!

So I moved on to trying one of those neat bottles, with a single stage regulator built in, as a source of emergency air. This, I thought initially, is a clever little device. Small, easy to carry and fill and a totally independent air supply with a handy mouthpiece on top.

Dinah and I bought one each and used them for a year. We discovered:- (a) They leak; (b) Sharks like to bite them (Dinah had a Grey reef shark bite one on her waist with no baits in the water and another diver who was using it as a shark billy got his bitten with baits in the water. We painted ours red and this seemed to solve that problem.); (c) People in distress drop them and (d) They have not got enough air. If you are diving with a standard tank of about 80 cu ft you need a minimum of 10 cu ft for shallow diving and 20 cu ft for deep diving to make a compete and NORMAL ascent including a decompression stop. It is a pity the idea was not developed further but it wasn't.

SO, and thank you for your patience:-

"Reaching down and backwards I grasped the valve of the PONY BOTTLE attached to my main tank and turned it on. I then pulled the pony bottle regulator from its clip on my chest and placed it in my mouth, purging before breathing normally and starting my ascent, using my middle finger to signal "UP" to the creatures in Jurassic Underwater Park".

Diving instructors stress the importance of "Normal" breathing while using SCUBA. They do allow that breathing can be used to control buoyancy but frown on photographers holding their breath in order to get that close fish shot. They then go on to teach the very abnormal breathing required in emergency ascents. Am I missing something here? If normal breathing is important then, surely, that must especially be used in an emergency. And the only method that uses a normal ascent (not hanging on to another diver) and normal breathing, is using a sufficient independent air supply that you carry with you. Divers using double tanks can achieve this by means of manifolds and twin regulators. Other divers need a PONY BOTTLE WITH REGULATOR.

And can you practise the use of a pony bottle in the circumstances that you are likely to need it? Yes! It is so simple and easy the only drawback is that I cannot brag about being able to do it....

Now you might think that carrying a pony bottle with regulator attached is awkward and will add drag, and so did I, but I have been pleasantly surprised. You can get rid of your octopus from your primary regulator (keep it and use it with a long hose and a new first stage to make up your pony bottle regulator), exchange the sea anchor that you call a buoyancy compensator for one which fits and has only one (small) pocket for your safety sausage, ditch your snorkel and tidy up the rest of your scuba gear. I have made a very simple clamp which fixes the pony bottle upside down on the right (or left) of my main tank. At the start of the dive I use a gauge to check the pony is full, attach the regulator, pressure the system and check it, then turn it off (leave it pressurised). I know that I do not have to worry about running out of air or my regulator failing. Of course I still aim not to run out of air. One of the techniques that I have used for many years is to predict how much air is in my tank BEFORE I check the gauge. Now I am very accurate in my predictions. I know how much air is in my tank without looking at the gauge. Obviously regular diving is a help here. I also do not intend to make crazier dives just because I have extra air. Lack of sufficient air supply has not been the limiting factor for the deep dives I have been making anyway.

There may be those that will now argue that there will be divers who submerge with an empty pony bottle or whose pony regulators will have solidified with corrosion and that these divers will one day perish as a result. Alas this is true. But in these days of eco-love and appreciation of nature should not we just let natural selection take its course instead of trying to out smart it all the time? Let's face it, I bet you are glad that natural selection worked for the dinosaurs, just imagine how tedious it would be having to watch out for tyrannosaurs every day on the way to work, so what is wrong with it working for turkeys? So there we have it. Get yourself a pony bottle rig. If enough interest is shown we will soon see compact pony bottles with neat clamps and miniature "pony regulators" on the market. Forget all this other nonsense about buddy breathing and emergency swimming ascents, and the only octopus you should want to see is one with eight giant tentacles, 20 m across, and with a beak capable of ripping the flesh off a diver in less time than it takes to draw your hand across your throat.

Reprinted from Telita Cruises Newsletter December 1993 by kind permission of Bob and Dinah Halstead. Their address is PO Box 141 Earlville, Cairns, Queensland 4870, Australia.

OCEANIC REGULATOR PROBLEM

Oceanic has issued a "Quality Alert" regarding the high pressure first stage pressure seat in their diaphragm regulators. Shipped to dealers between April and June, 1993.

When used with tanks filled over 3,200 psi this seat could shift and alter the intermediate pressure from the first stage to the second stage regulator. If the pressure gradually increases, then the regulator will eventually free-flow. If the pressure decreases, the regulator becomes increasingly difficult to breathe. The problem was determined to be the material in the seat. While seeking the cause, Oceanic found a better material for this seat and alerted their dealers of a change in material and also supplied new seats for those regulators in stock.

Peter Radcliff, marketing manager for Oceanic, told us, "This was in no way a recall. The shift in intermediate pressure is not life threatening."

Those concerned about their diaphragm first stage regulator should take it to their local dealer and have the intermediate pressure checked.

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

GLEANINGS

Plasma catecholamine levels during exposure to an environment of hyperbaric oxygen

Tremellen KP, Williamson JA, Frewin DB and Russell WJ. *Clin Autonomic Res* 1993; 3: 91-93

Abstract.

Plasma catecholamine levels were measured before, during and after hyperbaric oxygen therapy in nine subjects. Adrenaline levels were elevated immediately prior to hyperbaric oxygen therapy, but then fell and stablizied once treatment commenced. No significant fluctuations in plasma dopamine or noradrenaline levels were noted during the treatment period.

The study does not support the premise that there is a suppression endogenous plasma catecholamine levels during hyperbaric oxygen as has been previously reported. The observed initial increase in adrenaline can be attributed to stress/anxiety and the subsequent decline in this stress, rather than the result of the hyperbaric oxygen treatment itself.

MEDICO-LEGAL DIVING SOCIETY

A new diving medical society, the Medico-Legal Diving Society (MLDS), was formed in the U.S.A. in 1993. It plans to publish a quarterly newsletter and hold meetings in places where there is good diving. Membership is $US 35.00. The first issue of the MLDS Journal was Fall 1993. It contained papers on coral cuts, litigation after decompression illness and diving emergency services in California.

For further details contact
Medico-Legal Diving Society
3600 South Harbour Boulevard, Suite 430
Channel Islands, Californian 93035, U.S.A.
Phone (1) 805-985 0685 extension 4
Fax (1) 805-984 0593

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(DIVING MEDICAL CENTRE)
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This practical course is for those who may be required to respond to a diving-medical emergency: in particular, doctors who are involved with recreational divers and those who have a responsibility for professional divers. It will be similar to the two previous international courses held by the Royal Netherlands Navy in 1990 and 1992 and will provide some 25 hours of tuition and much in-water activity, using different types of breathing apparatus, and practical chamber work. In addition to the decompression illnesses, special emphasis will be placed on the medical aspects of nitrox diving, diving with closed circuit breathing apparatus and other specialised diving techniques.

The course fee will be N.fl. 2,000 (approximately £750; $US1,125; $Aust 1,500) if paid before 31st March 1994 after which it will be N.fl. 2500 (£930; $1400; $Aust 1,870). Places will be allocated on a firstcome first-served basis.

For further details contact
Biomedical Seminars,
7 Lyncroft Gardens, Ewell,
Surrey KT17 IUR, England.
Phone 44-81 393 3318
Fax 44-81 786 7036,

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HMAS PENGUIN,
Balmoral Naval P.O, New South Wales 2091
Telephone (02) 960 0333

DIVING SAFETY AND PHOTOGRAPHY SEMINAR
2nd-8th October 1994
Kona Village Resort, Hawaii.

For further details contact
Dr Chris Dueker MD
Diving Safety Digest
P.O.Box 2735, Menlo Park
California 94025, U.S.A.
Fax (1)-415-322-2476

UNDERSEA AND HYPERBARIC MEDICAL SOCIETY
ANNUAL SCIENTIFIC MEETING 1994
will be held at the Westin Hotel, Denver, Colorado, U.S.A.
from 22nd to 25th of June 1994

For further details contact
UHMS, 10531 Metropolitan Avenue,
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Tel: (1) (301) 942 2980
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6th ASEAN ORL (ENT) CONGRESS
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