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REPORTS OF INTEREST, COURSES AND MEETINGS ARE DETAILED ON THE BACK COVER

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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.

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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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Minimum Requirements for Manuscripts

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.

Consent

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

Editing

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) 9819 4898, or Dr John Williamson (08) 224 5116.

ARTICLES OF INTEREST REPRINTED FROM OTHER JOURNALS

SAFE LIMITS: AN INTERNATIONAL DIVE SYMPOSIUM

GLEANINGS FROM MEDICAL JOURNALS

MEETINGS AND COURSES

STOP PRESS

SUB OCEAN SAFETY

Bob Izdepski has formed a non-profit organisation, Sub Ocean Safety (SOS), to help bring diving safety to theMiskito lobster divers (*SPUMS J* 1995; 25 (1): 45-52). SOS has made useful contact with a lobster boat owners association, which rejoices in the name Coping, who took on board the message that safer diving leads in the end to greater profits and worked with SOS towards mutually beneficial solutions.. With their help a chamber has been relocated from Guanaha Island to the Moravian Mission Clinic at Kalquira. Unfortunately it still requires an air compressor and other equipment.

CHRISTCHURCH, NEW ZEALAND, RECOMPRESSION CHAMBER

After four years of negotiations, a decision on the medium-term future of the Christchurch recompression chamber has been reached. Both the Southern Regional Health Authority (the funding provider) and the Canterbury Health Authority (which runs Christchurch Hospital) have agreed on the terms of a five year contract for the provision of an acute hyperbaric service. This means that the transfer and upgrade of the existing facility into the Christchurch Hospital, at a cost of less than $NZ 250,000, will hopefully be completed before the end of 1995.

DIVER EMERGENCY SERVICE
NEW NUMBERS 1-800-088-200 (Australia) 61-8-373-5312 (International)

The DES number 1-800-088-200 can only be used in Australia.
For access to the same service from outside Australia ring ISD 61-8-373- 5312.

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.

DIVING INCIDENT MONITORING STUDY (DIMS)

DIMS is an ongoing study of diving incidents. An incident is any error or occurrence which could, or did, reduce the safety margin for a diver on a particular dive. Please report any incident occurring in your dive party, but do not identify anyone. Most incidents cause no harm but reporting them will give valuable information about which incidents are common and which tend to lead to diver damage. Using this information to alter diver behaviour will make diving safer.

To obtain Diving Incident Report forms write to DIMS, GPO Box 400, Adelaide, South Australia 5000.

The Editor's Offering

The Annual Scientific Meeting at Castaway Island Resort, Fiji, from May 21st to 27th was the best attended ever. It is too soon for the papers from that meeting to be published in the Journal and some speakers have not yet provided their papers. This is a continual problem for the Editor as many slow providers turn out to be non-providers and so their, often very interesting, presentations cannot be made available to the majority of members. As the Journal is the only avenue of communication to all members these short comings do matter.

A matter raised in the President's report, to be printed in the next issue, was the need for volunteers to share in the work of producing the Journal. We need people who are willing to referee papers, edit papers to turn them into readable English which can be understood by any diver, to proof read articles (and return them quickly so that printing deadlines can be met) and drum up advertising. At present a few people are carrying the total load and, while that is good for the ego, this is throwing too big a load on the willing horses. A society is a team effort and so is a good Journal. The committee does not know the qualities and capabilities of all the members. It is up to the members to volunteer, or to quote our President "volunteer someone else".

Actually members have plenty of time to think it over as the Editor will be out of Australia from July 10th to October 18th. The September Journal will have been put to bed before he goes and should reach members on time. The Editor's fax and telephone will be attended to by family members who have no knowledge of diving medicine, so callers should direct their enquiries to the Secretary of SPUMS, Dr Cathy Meehan, whose fax is 070-58-1285.

In this issue we start reprinting papers from the Safe Limits symposium, organised by the Queensland Diving Industry Workplace Health and Safety Committee, held in Cairns in October 1994. Des Gorman's opening address and Terry Cummins view of diving in Australia set the scene for the other papers, which will fill most of the next issue of the Journal.

What came most clearly out of the Annual Scientific Meeting was that most decisions about fitness to dive are not based on any large data base. It was clear that efforts must be made to gather facts rather than continue to rely on theoretical reasoning about risks. The meeting was told that at least one dive club, whose members volunteered to help provide facts, has approximately the same proportion of asthmatics as the general population, who dive without incident. It is from surveys like this one where a group of divers is studied that we will learn about the risks for asthmatics who dive. Certainly a number of asthmatics develop symptoms which are incompatible with safe diving during their training or afterwards and drop out of diving.

But so do about one third of all divers who are certified and they do it almost immediately after the course. Another third only dive for about twelve months after certification leaving one third who dive for a few years or for many years. These rough figures have been known for many years. What is not known is how many people really continue diving regularly, more than 20 dives a year, for five years or more. The definition of diving regularly used in North American surveys is often one dive a year which is laughable. No one would class a person who drove a car once a year as a regular car driver. Most people would have reservations about trusting themselves to the skills of someone who only drove once a week.

Australian divers are not great club formers, unlike the British. Most Australian diving is done from commercially operated boats. Some dive shops run dive clubs but most just provide the boat and take out all comers, of course mostly those that the shop has trained. Here is an opportunity for members and associates to help remedy our lack of knowledge.

It is possible to get divers to co-operate with doctors in a health and safety survey. What is needed is a doctor who is trusted by the divers involved, divers who want to help quantify the risks of diving with medical problems and a guarantee by the doctor that, although the overall results will be published, no details of any individual will identifiable. The first thing that is needed is a data base of divers and their disabilities, such as asthma, so that the diving population can be compared with the general population. This is one of the objectives of Project Proteus (*SPUMS J* 1995; 25 (1): 23-24). Readers should get in touch with Dr Douglas Walker, PO Box 120, Narrabeen, New South Wales 2101, for further information.

We live in a rapidly changing world and we need to be flexible enough to bend with the changes. The changes have even reached the assessment of fitness to dive for commercial, now known as occupational, divers. The proceedings of the Edinburgh conference on fitness to dive have been published as *Medical assessment of fitness to dive*, reviewed on pages 72-73. Again the lack of firm data was emphasised. We in Australasia, where there are many doctors who dive, have a great opportunity to work together with our diving friends to establish a baseline of the incidence of common diseases in the diving community. Even small surveys contribute when combined with others to reach statistically significant numbers. This is where a central repository, like Project Proteus, can be invaluable as a co-ordinator.

ORIGINAL PAPERS

DOPPLER DETECTION OF CIRCULATING BUBBLES IN ATTENDANTS, DECOMPRESSED ON OXYGEN, FOLLOWING ROUTINE HYPERBARIC TREATMENTS.

Margaret Walker, Roger Capps, Christy Pirone and Robert Ramsay.

Abstract

A pilot study was carried out to examine the incidence of doppler-detectable circulating bubbles in hyperbaric chamber attendants following routine chamber treatment profiles. Bubbles were detected in 44% of exposures at 2 ATA, and 68% of exposures at 2.8 ATA, however most were of low grade only. The consequences of chronic exposure to low-grade circulating bubbles require further investigation.

Introduction

In Hyperbaric Medicine Units around the world, recompression chamber attendants are regularly exposed to increased ambient pressure, sometimes for prolonged periods, and sometimes more than once daily. The treatment tables which are in widespread use have been empirically developed over a number of years, based on both their therapeutic efficacy, and their safety for the attendants. For most conditions treated with hyperbaric oxygen, a pressure of between 2.0 and 2.8 atmospheres absolute (ATA) is used in order to provide optimal therapeutic oxygen partial pressures, and the time of exposure of air breathing attendants to these pressures is limited to comply with the "no-decompression" bottom times quoted in the more conservative dive tables. In some units, including the Royal Adelaide Hospital, the attendant also breathes 100% oxygen during the ascent to facilitate off-gassing of the nitrogen load accumulated during the period of breathing air under pressure.

The reported incidence of clinical decompression illness (DCI) in chamber attendants exposed to these treatment tables is very low. At the Royal Adelaide Hospital Hyperbaric Medicine Unit, 3900 treatments were performed between 1985 and 1991, and two cases of DCI occurred in the chamber attendants. However, a review of the literature shows that using doppler ultrasound, bubbles have been detected in the circulation of subjects exposed to pressures of the order of those routinely used as treatment tables. Eckenhoff[1] found that all subjects exposed to 1.7 ATA pressure for 48 hours developed doppler-detectable circulating bubbles after decompression over 2 minutes (3.5 m (11.5 ft) per minute , although none developed clinical symptoms of DCI. At the Defence and Civil Institute of Environmental Medicine (DCIEM) in Canada, where doppler studies have been performed on all their routinely used diving tables, circulating venous bubbles have been detected in nearly all the recommended "safe" dive tables. They consider that dive tables which produce bubbles of grade 2 or less in 50% of the subjects constitute an acceptable risk, as the reported incidence of decompression illness associated with bubbles of this grade is very low.[2]

Many human studies have been carried out attempting to define a relationship between circulating bubbles and clinical manifestations of DCI. It was initially thought that doppler monitoring could be used to control the decompression profiles and prevent DCI, but the studies performed by Eatock and Nishi[2,3] showed that bubbles tend to be detected after the decompression has been completed, usually up to an hour later, with a peak incidence at 2 hours after decompression.

The implications of subclinical bubble formation are not well understood. It has been suggested that repeated exposure to circulating bubbles may produce cumulative deleterious effects over time, especially in the central nervous system.[3-5] This may occur in the absence of any acute symptoms of DCI as an insidiously progressive loss of higher mental function, such as has been reported in some occupational (professional) saturation divers.[5]

The pathophysiology of DCI is now thought to be complex and involve bubbles both in the blood and tissues, as well as complement activation, vascular endothelial effects, histological and haematological changes. The detection of intravascular bubbles is only an indicator that a decompression stress has occurred. Intravascular bubbles do not mean that clinical DCI will occur.[3,6,7] Susceptibility to DCI appears to be an individual matter, as some people will develop DCI with low-grade or no detectable bubbles, whereas others have higher-grade bubbles with no evidence of clinical DCI.[3]

Although most hyperbaric treatment profiles are of much shorter duration then those studied by Eckenhoff, the pressure to which our attendants are exposed is greater, 2.0 - 2.8 ATA. We were interested to discover if any circulating bubbles were detectable following decompression after our routine chamber treatments, as at the time of planning this investigation (1992) we had been unable to find data about the incidence of bubble formation following short-term exposures at these pressures. A study was performed to examine recompression chamber attendants after their routine hyperbaric exposures, to determine if circulating bubbles are induced following existing treatment tables.

Method

The study, carried out in 1992, was approved by the Royal Adelaide Hospital Human Ethics Committee. Subjects were the nurse attendants and medical staff who were then carrying out the routine chamber treatments. All subjects were passed fit for hyperbaric exposure by the hospital's Occupational Health and Safety Unit, and entered the study with informed consent. None of the subjects had had a hyperbaric exposure for at least 24 hours before the monitored exposure.

The subjects were assessed with a non-invasive doppler probe before each "dive", to obtain a baseline recording of background sounds. The sites used for the doppler recordings were:

1 Over the left sternal edge in the fourth intercostal space, where pulmonary artery flow is best heard.
2 Over the right and left subclavian veins.

Doppler recordings were taken at the precordial site for one minute at rest, and then for 30 seconds after each of three deep knee bends, and at the subclavian sites for 30 seconds at rest, and then for 15 seconds after each of three hand clenches. All doppler records were taped on audio-cassettes.

No subject had any doppler-detectable bubbles before their hyperbaric exposure and all subjects were used as their own controls.

The subject then carried out a routine treatment dive in the recompression chamber. This consisted of either

10:90:30. (2.0 ATA (10 m) for 90 minutes on air followed by a 30 minute ascent to surface (1 ATA) on 100% oxygen.)

or

18:60:30. (2.8 ATA (18 m) for 60 minutes on air, followed by a 30 minute ascent to surface (1ATA) on 100% oxygen).

After the treatment had been completed, the subject was monitored again using the same procedure. Recordings were made immediately on leaving the chamber, and at 30 minutes, one hour and hourly intervals thereafter until no bubbles could be detected. No participating attendant was exposed to pressure more than once in 24 hours.

Two blinded observers individually assessed the tapes and any bubbles detected were quantified using the method of Kisman and Masurel (K-M code).[2,8]

Results

Tape recorded doppler sounds were obtained from 37 chamber treatments, with a total of 21 subjects. There were eighteen 10:90:30 runs, and nineteen 18:16:30 runs. The doppler findings are shown in Table 1. During the study one subject, who had no doppler-detectable bubbles at any time, developed clinical static neurological DCI, manifested by short term memory loss and higher mental function impairment (especially calculation skills), headache and impaired co-ordination, which was successfully treated.

TABLE 1

SUBJECTS WITH DETECTABLE BUBBLES AFTER EXPOSURE TO PRESSURE

Treatment	Number of subjects	Maximum Bubble Grade 0	I	II	III	IV
10:90:30	18	10	4	3	1	0
18:60:30	19	6	7	4	2	0

Discussion

These results show that circulating bubbles are formed in RCC attendants following routine treatments. Bubbles were formed in 8 of 18 exposures (44%) at 2 ATA, and 13 of 19 exposures (68%) at 2.8 ATA. These bubbles are mostly of low grade only (grade 1 or 2) and in the one case of DCI recorded, no bubbles were detected at all. No bubbles or bubbles of grade 2 or less were found in 17 of 18 exposures (94%) at 2 ATA, and 17 of 19 exposures (89%) at 2.8 ATA, which fulfils the DCIEM criteria for a decompression profile with an acceptable risk of DCI.

A Chi-squared analysis comparing the incidences of bubbles detected in the 10 and 18 m tables showed no significant difference. The sample size was too small to detect a difference. A difference, if any, would be not be detected until the sample size approached 150.

It is interesting that bubble formation has occurred following these very conservative tables, indicating that a significant decompression stress has occurred. Those subjects with detectable bubbles, even of a higher grade, reported no symptoms of DCI. The single subject with clinical DCI had no doppler-detectable bubbles.

This pilot study shows that with conservative treatment tables, in more than half the attendants exposed, doppler-detectable bubbles are occurring, although they are of low grade. This may have important consequences regarding the safety of repetitive chamber "diving" by hyperbaric attendants. It would seem prudent to adopt work practice standards which minimise the exposure of chamber attendants to even low-grade circulating bubbles, as the consequences of long term repeated exposure to asymptomatic low-grade bubbles are still unknown. It is the practice at the Royal Adelaide Hospital to limit the number of dives in the chamber to one a day for each attendant, on a maximum of 4 days a week. Certainly, more than one hyperbaric exposure per day would not be recommended, although we have not examined the incidence of Doppler-detectable bubbles under this circumstance.

Further investigation is warranted examining other treatment tables currently in common use. More detailed higher mental function testing may be useful in excluding any "subclinical" deleterious effect of exposure to these low-grade bubbles, and confirming the safety of the treatment tables currently in use.

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FUNCTIONAL ENDOSCOPIC SINUS SURGERY IN DIVERS WITH RECURRENT SINUS BARO-TRAUMA.

Jim Bartley

Abstract

Advances in endoscopic technology combined with computerised tomography have dramatically changed our understanding of sinus disease. Functional endoscopic sinus surgery (FESS) significantly enlarges the maxillary sinus ostia, the drainage pathways from the frontal sinuses and removes obstructed or diseased ethmoid cells. If necessary, the ostia of the sphenoid sinuses can also be enlarged. FESS techniques have treated successfully aviators with recurrent sinus barotrauma. Divers who suffer from recurrent sinus barotrauma should also benefit from these techniques. This paper documents early FESS experience with two divers suffering from recurrent sinus barotrauma.

Introduction

Divers are at risk of developing sinus barotrauma while diving due to repeated large fluctuations in pressure. Acute sinus barotrauma which commonly occurs following a recent viral upper respiratory tract infection responds to conservative medical management and is usually self limiting. Infrequently, recurring attacks of sinus barotrauma may occur. Recurrent sinus barotrauma may be refractory to conservative medical measures. Newer endoscopic sinus surgical techniques have treated successfully aviators with recurrent sinus barotrauma.[1] FESS techniques should also be useful in divers suffering recurrent sinus barotrauma. Early experience using FESS with two divers is reported.

Case Histories

CASE 1

This 49 year old male patient had suffered intermittent sinus barotrauma for many years. Pain over the left frontal sinus occurred frequently on descent. Discomfort also occurred on ascent over the frontal region and the bridge of the nose. This discomfort often persisted for several days following a dive. Occasional episodes of epistaxis also occurred.

Nasal endoscopy with a 4 mm 30 degree Hopkins rod telescope showed a septum deviated towards the left middle meatus as well as polyps arising in both middle meati. CT scan confirmed the above findings as well as showing diffuse bilateral ethmoid disease, opacification of both frontal sinuses and mucosal thickening in both maxillary sinuses. Under general anaesthesia a septoplasty was performed followed by bilateral endoscopic sinus surgery. Polyps were cleared from the ethmoid sinuses on both sides. The maxillary and frontal sinuses were opened. Three months later revision surgery was performed under local anaesthesia because of scarring on the right side. When last examined , with a 4 mm 30 degree telescope in the clinic, openings to both frontal and maxillary sinuses were easily visualised and widely patent.

Following surgery the patient has continued to dive on a regular basis with no further problems.

CASE 2

This 24 year old male presented with a 6 month history of chronic nasal discharge, recurring sinus infections, nasal obstruction, a reduced sense of smell and facial pain. The facial pain was present over both zygomas, the nasofrontal area and both maxillae, radiating into the teeth. The pain occurred on descent and it was difficult to equilibrate the middle ears. Conservative management had included numerous prolonged courses of antibiotics as well as a reducing course of steroids. He was unable to continue work which involved repeated diving on a daily basis.

Nasal endoscopy with a 4 mm 30 degree Hopkins rod telescope was unremarkable apart from narrowed middle meati. CT scans showed bilateral thickening of the maxillary sinus walls and occlusion of the right infundibulum. Bilateral endoscopic sinus surgery was performed under local anaesthetic with intravenous sedation. Bilateral anterior ethmoidectomies were performed. The normal maxillary ostia were widely opened. Thick mucus was present in both maxillary sinuses. In the absence of pathology the frontal sinuses were not surgically opened. The opening to the left frontal sinus however was readily identified. The openings into the left frontal and maxillary sinuses were easily visualised when last examined with a 4 mm 30 degree telescope in the clinic.

Post-operatively diving was resumed on a regular basis without further problems. His difficulties equilibrating the middle ears have also ceased.

Discussion

Advances in endoscopic technology combined with computerised tomography have dramatically changed our understanding of sinus disease.[2] Conventional sinus surgical techniques focused on the larger maxillary and frontal sinuses. Such procedures include Caldwell Luc procedures, naso-antral windows, frontal sinus trephinations and intranasal and external ethmoidectomies. However research and analysis of these procedures in the treatment of recurrent sinus barotrauma is lacking.[1] Newer, minimally invasive, techniques preserve as well as restore the natural mucociliary clearance mechanisms enhancing the drainage and aeration of the sinuses while retaining as much of the normal anatomy as possible. On the basis of these principles endoscopic sinus surgery has revolutionised the management of sinus disease.

The management of recurrent sinus barotrauma in divers and aviators has received little attention in the literature. Recurrent sinus barotrauma is a problem for some divers.[3] Endoscopic surgical techniques are successful in aviators suffering from recurrent sinus barotrauma.[1] If conservative medical measures fail, similar surgical techniques would appear useful in divers. The surgery can often be performed under local anaesthesia using intravenous sedation. Most patients find the lack of nasal packing, absence of external scars, and short hospital stay a far less daunting proposition than conventional surgery. In experienced hands the complication rate is very low.

Although the surgery is relatively simple, accurate diagnosis is important. Myofascial pain referred from the neck or temporomandibular joint also needs to be considered in the differential diagnosis. Cold water, the extended position of the head and the clenching of the mouthpiece during diving can all aggravate myofascial pain.[4,5] Chronologically the facial pain in sinus barotrauma occurs with pressure changes and predominantly over the frontal region with the ethmoid and maxillary being less common.[6] Pain usually occurs and increases on descent and is relieved by ascent when blood may be noticed. Sometimes descent is normal but pain develops on ascent (reverse block). Congested nasal mucosa at depth presumably blocks expanding gas during ascent.

Clinically the pain is believed to be related directly to the affected sinuses themselves. Experimentally however pressure changes have been demonstrated to be inadequate stimuli for producing serious discomfort in these cavities.[7] The pain is probably referred from the more pain sensitive sinus ostia, infundibulum and turbinates. This explains partly why the clinical referral patterns in Fagan's series[6] did not correlate radiologically with the affected sinuses.

The surgical management of recurrent sinus barotrauma is rarely discussed. Edmonds reported that 12% of cases in his series required surgery. Endoscopic surgery was mentioned as showing promise.[3] The predisposing factor for recurrent sinus barotrauma is ostial insufficiency. FESS opens affected sinuses, usually with minimal patient morbidity. Early experience indicates that FESS is a useful technique in divers suffering from recurrent sinus barotrauma if surgical intervention is being considered.

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THE WORLD AS IT IS

THE 1994 HYPERBARIC TECHNICIANS AND NURSES ASSOCIATION MEETING

Robert Borer

The Hyperbaric Technicians and Nurses Association (HTNA) held their 2nd Annual Scientific Meeting on Diving and Hyperbaric Medicine in Fremantle, Western Australia in early September 1994. The Esplanade Hotel was a superb venue, satisfying all the Meeting's requirements, as well as providing a pleasant place for old and new colleagues to discuss hyperbaric activities occurring throughout Australia.

The program highlights were the four presentations from the invited guest speaker, Professor Jon T. Mader, former president of the Undersea and Hyperbaric Medical Society (UHMS) and current Head of Internal Medicine and Marine Medicine at the University of Texas, Galveston, Texas, USA. There was an even balance between medical and diving related topics in the papers presented during the two day meeting. Scattered within each session were reports and technical papers that provided information on unique diving practices such as; wreck location with magnetometry and side scanning sonar, medical hyperbaric chamber design, training and operations of police divers, marine archaeology and hyperbaric aspects of extra-vehicular activity in space.

The first day, medically oriented program, was begun by Professor Mader presenting a clear description of the mechanisms by which adjuvant hyperbaric oxygen (HBO) enhances recovery from chronic infections such as osteomyelitis. Subsequent papers reported on the adjuvant use of HBO in mucormycosis, chronic inflammatory otolaryngological problems and soft tissue injury caused by radiation therapy. Two papers described toxicity risks; the first, carbon monoxide poisoning in new Asian immigrants using charcoal briquettes indoors; and the second, a seven year incidence of acute CNS oxygen toxicity during chamber operations with 2.8 bar 100% oxygen exposure. Aural barotrauma in a general practice was presented with cases illustrating pitfalls in assessment and diagnosis. Jon Mader concluded the medical presentations with a comprehensive review of the adjuvant use of HBO in chronic non-healing diabetic wounds of the foot.

The second day, with the diving oriented program, attendance was doubled, with participation from recreational diving professionals (instructors). Three presentations from different regions of Australia related experiences in divers working in commercial aquaculture; pearling in Broome, Western Australia, salmon farming in Tasmania and tuna farming based in Port Lincoln, South Australia. Descriptions of these industries and the incidence of decompression illness (DCI) in this workforce revealed the successes and future challenges in improving safe diving practices. Fremantle Hospital Hyperbaric Unit reported a 16% incidence of residual symptoms, during a four and a half year retrospective review of sports divers receiving recompression therapy for DCI. The dangers of nitrous oxide anaesthesia or analgesia causing DCI in a diver undergoing an operation soon after diving showed up the general lack of knowledge in the medical community of gas load risks. A preliminary report of in-water Holter (cardiac) monitoring of experienced recreational divers raised questions about cardiac related diving risks and their identification. Professor Mader described a rare case of acute progressive pulmonary decompression illness with pulmonary œdema and its response to recompression treatments. A lively discussion resulted from the presentation of risks vs. benefits of nitrox diving by recreational divers.

In addition to the formal program, the participants were provided with tours to the submarine escape training facility at HMAS STIRLING and the Fremantle Hospital Hyperbaric Medical Unit. All observers were awed by the perfectly controlled slow ascent from an air lock at 20 m to the surface using only the gas volume of the lungs for buoyancy control by a submarine escape instructor.

Congratulations to the Fremantle Hospital Hyperbaric Unit staff, especially Sharon Keetley, the HTNA and the generous sponsors for organising an excellent scientific and social program. All the presentations kept to time, the audiovisual support worked well throughout, and it was encouraging to hear good quality papers from the HTNA members as well as from the medical community.

I look forward to the HTNA's 3rd Annual Scientific Meeting on Diving and Hyperbaric Medicine in Melbourne, September 22-23, 1995, at the Carlton Radisson Hotel, organised by the Hyperbaric Medicine Unit of the Alfred Hospital. For those interested in the 1995 meeting, contact Kevin Fabris or John Houston: (03) 2760-2323, fax: (03)276-3780.

Dr Robert C. Borer, Jr. is a Visiting Fellow at the Hyperbaric Medical Unit, Department of Anaesthesia and Intensive Care, Royal Adelaide Hospital, North Terrace, Adelaide, South Australia.

DIVING DOCTOR'S DIARY

DIVING IS A PAIN IN THE GUT

Carl Edmonds

Case report

JD, a male aged 31, had been scuba diving for two years, logging 110 hours over 160 dives.

He had no difficulty for the first couple of days of any diving trip, but then would develop a burning pain in his epigastrium, and the right hypochondrium. It would last for four or five days. He would be forced to suspend diving.

Food aggravated the discomfort, mild antacids relieved it. He tended to sleep propped up at night during these episodes. Sometimes donning the diving equipment (double tanks, wet suit, weights etc.) also aggravated the disorder. He commented that he often belched when ascending the diving ladder.

On the most recent diving trip he only lasted until the second day before the abdominal pain caused the dive to be aborted. On reaching the surface he vomited (although this tendency was actively suppressed whilst underwater). There was no history of motion sickness, the seas were calm and there was no alcohol intake. (They do not make divers like they used to.)

Apart from the pain being observed in association with diving activities, he had no other clinical problems.

Provisional diagnosis

A provisional diagnosis was made of ascent gastrointestinal barotrauma and reflux oesophagitis. Referral to a gastroenterologist was arranged.

Discussion

The symptomatology was easily explained, with reference to both the diving technique and also the oesophagoscopy.

Like many other divers, he tended to perform a head-first descent, using Valsalva manoeuvre to equalise his middle ear spaces. With the increased oro-nasal pressure in the inverted position, gas can move more easily up the oesophagus, into the stomach.

He had noted the abdominal discomfort and distension on previous occasions, during or immediately after ascent. The gas would expand, causing eructation, occasional vomiting and oesophageal discomfort when the gastric contents move through the oesophageal sphincter. Subsequently, exertion from the effort of donning diving equipment, aggravated the existing oesophagitis.

In this particular case an oesophagoscopy was performed because of the persistence of the symptomatology for many days after the diving. There was 3 cm of gastric epithelium observed (Barrett's epithelium). This usually follows gastro-oesophageal reflux, in this case without the presence of an obvious hiatus hernia.

By utilising the correct diving technique, no further symptoms were experienced.

Review

Abdominal pain and discomfort, bloated sensations, nausea, vomiting or eructation during or following ascent, all are features of the gastrointestinal barotrauma syndrome. There have been about half a dozen such cases in which abdominal viscera have ruptured, sometimes causing death.

There have also been a couple of cases in which the persistence of symptoms, as happened in the above case, would sometimes be misdiagnosed as decompression sickness. A diver with a similar history to this one received hyperbaric treatments for this disorder, without a great deal of success, in one of Australia's more prominent hyperbaric units, and the large gas shadows on abdominal x-ray were interpreted as partial ileus due to decompression sickness! Relief with recompression was considered as verification of the diagnosis. The latter was only clarified after further clinical episodes were terminated by preventative measures.

As regards first aid procedures available to the diver, the symptoms during ascent can be reduced by relieving abdominal restrictions, e.g. removing the weight belt, undoing the harness and unzipping the wet suit. These simple measures have sometimes allowed divers to reach the surface in safety.

After the initial presentation and symptomatic treatment, the only effective prevention is to change the diver's habits. Performing the Valsalva manoeuvre, or Toynbee (swallowing), in the inverted position, is a precursor to most of these cases. Feet first descent clears these complaints up.

Occasionally similar symptomatology can be precipitated by taking gaseous liquids, especially if they are consumed in large volumes, whilst under pressure (i.e. prior to decompression, as in a compression chamber or a caisson).

One example of the latter comes to mind. A gas gangrene patient (following a mauling by a tiger) celebrated his final hyperbaric treatment by drinking a whole bottle of carbonated beverage, at a depth of 15 metres in the recompression chamber. Apart from complaining that the "drink was flat", he suffered mightily on ascent to the surface, as the gas came out of solution and distended his stomach.

Dr Carl Edmonds' address is Diving Medical Centre, 66 Pacific Highway, St Leonards, New South Wales 2065, Australia.

Gleanings from Medical Journals

continued from page 120

TRISMUS INTERFERING WITH DIVING

Trismus in a naval diver as a complication of inferior dental nerve block.
Cooper NK. *Dental Corps International* 1994; 1: 7-8

An illiterate Omani leading seaman diver, with a good command of spoken English and employed as an instructor, had two left lower molars filled under local analgesia. During the inferior dental block injection he complained of a severe burning sensation in his left jaw and left side of his face. This distribution of pain indicated that the local was injected into the maxillary artery.

After the fillings he was unable to open his mouth more than 5 mm. This made eating solids and inserting a diving mouthpiece impossible. His doctors were unable to help and decide that he had psychogenic trismus. After six weeks, having lost 10 kg, he was seen by the author who made the correct diagnosis and arranged for manipulation and physiotherapy in the oral surgery department of a London teaching hospital. After some eight weeks he returned to Oman and was diving two months later.

Abstract prepared by SPUMS Journal

SPUMS NOTICES

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.

CORRECTIONS

In the paper, ***Asthmatic amateur divers in the UK***, by P.J.S.Farrell (1995; 25 (1): 22) the references were given wrongly. They should read

1 Bove AA, Neumann T, Kelsen S and Gleason W. Observations on asthma in the recreational diving population. *Undersea Biomed Res* 1992; 19 (Suppl): 18

2 Corson KS, Moon RE, Nealen ML, Dovenbarger JA and Bennett PB. A survey of diving asthmatics. *Undersea Biomed Res* 1992; 19 (Suppl): 18-19

In the paper, ***The regulation of recreational scuba diving in Queensland***, by Rob Davis (1995; 25 (1): 10-18) the sentence on page 12 "In addition, r260 requires that scuba instructors conducting entry level certification ensure the student is certified fit to dive in accordance with the *AS 4005.1-1992 Training & Certification of Recreational Divers*." should have read "In addition, the former r260 and the current *Code of Practice for Recreational Diving* require compliance with *AS 4005.1-1992 Training & Certification of Recreational Divers* in certain cases"

SPUMS ANNUAL SCIENTIFIC MEETING 1996

PARADISE ISLAND, THE MALDIVES
20th to 28th APRIL 1996

Theme
Technical Diving

The guest speakers will be Professor David Elliott (UK) and Dr Bill Hamilton PhD (USA). Professor Elliott's background is in naval and commercial diving and diving safety as well as co-authoring *The physiology and medicine of diving*. Dr Hamilton is a diving physiologist with special interest in decompression schedules. His advice has been sought, and taken, by many of the growing company of "technical divers" in the USA.

The conveners will be Drs Chris Acott and Dr Guy Williams. Intending speakers should contact Dr Williams at 8 Toorak Street, Tootgarook, Victoria 3941, Australia. Phone (059) 85 7161. Fax (059) 81 2213.

The official travel agents are
Allways Dive Expeditions, 168 High Street, Ashburton,Victoria 3147, Australia.

MINUTES OF THE EXECUTIVE COMMITTEE TELECONFERENCE

held on 26/2/95

Opened 1000 Eastern Summer Time

Present

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

Apologies

Drs M Davis (New Zealand representative) and J Williamson.

1 Minutes of the previous meeting

Accepted as a true record. Proposed Dr Slark. Seconded Dr Williams.

2 Business arising from the minutes

2.1 Venue for 1997 ASM. It is essential that the committee members have researched and formulated ideas about suitable alternatives for this before the committee meeting to be held during the ASM in Fiji.

It was suggested having a two staged tender in future. The first to suggest suitable venues at the desired destination with a skeleton costing only and a second stage to have firm costing of what has subsequently been chosen as the desired venue. It was noted that due to the nature of some destinations this would not always be necessary.

2.2 With regard to item 2.2 of the minutes it was noted that the problem associated with a "wage slave" to help with the routine work of the Treasurer and the Secretary was that the wage slave would either need to have access to their houses and computers or would need to have a computer supplied to them. This needs to be discussed again in the future.

3 Treasurers Report

Accepted. Proposed Dr Gorman. Seconded Dr Acott.

3.1 Subscription fees for 1996. Suggestions were made to raise the membership fee to $90 and the associate fee to $ 45. Although the financial situation of the Society is sound, there are a lot of extra expenses forecast for the coming year. These include the extra cost of the Honorarium for the Editor and the upgrading or replacement of the Treasurer's computer as well as the cost of the extra support needed by the Treasurer and Secretary with the routine work involved in their positions.

3.2 The Treasurer is to present a budget to the Committee at the May meeting so the subscription fee can be decided on and announced at the AGM.

4 Fiji ASM 1995 update.

4.1 More papers are needed at this time.

4.2 A separate children's program is being formulated.

5 Tenders for the 1996 ASM in the Maldives

5.1 Unanimously decided to accept the Allways tender to Paradise Island. The tender from Interact was recommended for its professional presentation.

5.2 Dr Gorman to notify Allways Dive Expeditions, in writing, of their successful tender with the following four points to be clarified in writing.

1 Booking fee to PADI.
2 Afternoon tea costs to be renegotiated.
3 Upgrade situation (shown in other tenders) to be clarified.
4 Costing of travel arrangements for the guest speaker, Singapore Airlines versus Air Lanka

5.3 Timing of the 1996 ASM proposed for April 22nd to avoid the bad weather and to follow on from the World Congress of Anesthesiology that is to be held in Sydney from 14/4/96 to 20/4/96.

5.4 Dr David Elliott and Dr Bill Hamilton have both accepted invitations to speak at the 1996 ASM in the Maldives. Dr Acott will be attending the EUBS AGM and will there invite the members to the SPUMS AGM in the Maldives for cross fertilisation between the two societies.

6 Correspondence

6.1 Proposal from Jeff Wilks for our comments. SPUMS has given endorsement. Dr Gorman will write officially to notify Dr Wilks.

6.2 Letter from Queensland Health. Dr Gorman will follow this up

6.3 Letter from John Lippmann inquiring about full membership. The necessary changes to the constitution to be discussed and guidelines for future criteria decided in Fiji.

6.4 Letter from Michael Bennett. Dr Meehan to clarify.

7 Other business

7.1 Sponsorship (Dr Williams). Dr Williams to follow up.

7.2 Advertising in the Journal (Dr Williams). Dr Williams to follow up.

7.3 Notice in February Dive Log (Dr Williamson). Dr Gorman to find out the source document.

LETTERS TO THE EDITOR

TRANSCRANIAL DOPPELER MONITORING

Department of Medicine and Therapeutics
Gardiner Institute, Western Infirmary
Glasgow, G11 6NT
2/5/95

Dear Editor,

In the December edition of SPUMS Journal Mark Sullivan referred to transcranial Doppler (TCD) and wondered if it could be used to establish the true incidence of patent foramen ovale (PFO). In fact the technique is known to be the most sensitive and specific non-invasive test for detecting shunting particularly when combined with provocative manoeuvres such as coughing and Valsalva's. The gold standard is transoesophageal echocardiography but obviously this is not suitable for screening healthy subjects. The incidence of PFO by TCD is higher than by transthoracic echocardiography.

We recently used TCD to investigate commercial divers and found the technique to be a simple and convenient screening test for healthy individuals. We also monitored the divers' cerebral circulation after surfacing and found that subjects with PFO did not have silent arterial gas emboli during decompression from a variety of dive profiles. This suggests that the importance of shunting may have been exaggerated. Previous studies of venous gas emboli found only limited correlations with the incidence or severity of decompression sickness. Arterial emboli have not yet been investigated to the same extent because they were more difficult to study. It may be that arterial counts are more specific and thus clinically relevant. TCD may also be used inside decompression chambers with only minor technical changes. This is relevant to divers where the monitoring of cerebral gas embolism by TCD has obvious clinical attractions. TCD has enormous potential in hyperbaric medicine.

Stephen Glen
James Douglas

References

1 di Tullio M, Sacco RL, Venketasubramanian N, Sherman D, Mohr JP and Homma S. Comparison of diagnostic techniques for the detection of a patent foramen ovale in stroke patients. *Stroke* 1993; 24: 1020-1024

2 Glen SK, Georgiadis D, Grosset D, Douglas JDM and Lees KR. Transcranial Doppler ultrasound in commercial air divers: a field study including cases with right-to-left shunting. *Undersea & Hyperbaric Med* 1995; 22 (2): 129-135

Dr Stephen Glen's telephone number is +44 (UK) 141 211 2020 and fax is +44 141 339 2800.

Dr James Douglas' address is Tweeddale Medical Practice, High Street, Fort William, Inverness-shire, PH33 6EU, Scotland.

IN-WATER RECOMPRESSION

255 Stanmore Road, Stanmore
New South Wales 2048
30/3/95

Dear Editor

The practice of in-water recompression (IWR) as emergency first aid for decompression illness (DCI) has provoked considerable discussion in the hyperbaric communities around the world for many years. This discussion has become even more vocal in recent years now that technical diving has "emerged from the closet" and is undergoing rapid metamorphism as new technology becomes available and affordable to recreational divers.

In Australia, the recompression of a diver with gross decompression violations off Sydney in February 1993 sparked considerable debate in Dive Log Australia and other correspondence, which was mostly inaccurate, misinformed and based on third hand information.

Richard Pyle, deep diving ichthyologist at Bishop Museum Hawaii and Dr David Youngblood, who needs no introduction in the hyperbaric community, have recently written a paper titled *In-water Recompression as an Emergency Field Treatment of Decompression Illness*. The paper discusses 13 case histories and states "evidence from available reports of attempted IWR indicates an overwhelming majority of cases in which the condition of DCI victims improved after attempted IWR." The authors state that "we do not necessarily endorse IWR; however we see an increasing need by technical divers to become aware of the information available on this topic".

There is also an increasing need for the hyperbaric community in Australia to come to grips with this problem. The theoretical risks associated with returning a diver suffering from DCI into the water need to be balanced with practical field experience.

Perhaps Richard Pyle or David Youngblood should be invited to chair a workshop on IWR at the 1996 SPUMS Scientific Meeting on Technical Diving. In the meantime, any SPUMS member who would like a copy of the paper can contact me at the above address.

Robert Cason

BOOK AND VIDEO REVIEWS

MEDICAL ASSESSMENT OF FITNESS TO DIVE

Edited by David Elliott
ISBN 0-9525162-0-9
Biomedical Seminars, 7 Lyncroft Gardens, Ewell, Surrey, England KT17 1UR. Fax (44) 181 786 7036
North American distributor
Best Publishing Company, P.O.Box 30100, Flagstaff, Arizona 86003-0100, U.S.A.

Price from the publishers £26.00 plus postage & packing.
Special prices for Australasia

$Aust 55.00 per copy for a minimum of 3 copies on one cheque then post free and Biomedical Seminars will absorb the bank charges.

For 10 copies, paid for by one cheque, the price is $Aust 50.00 each, post free.

This book is the proceedings of an international conference, originally entitled "Fitness to Dive", held in Edinburgh 8th-11th of March 1994. Not only does it contain all the presentations but also the discussions at the end of the sessions and commentaries on the sessions and a general summing up at the end of the decisions of the conference and the workshop of the European Diving Technology Committee held in Luxembourg a month later. Just to reproduce the contents pages would take a full column of this review. As no one from Australasia attended the meeting this book is the only way that SPUMS members can learn what is going on about diving medical standards on the other side of the world.

This, value for money, book should be required reading, along with John Parker's,[1] for all those who take an intelligent interest in diving medicals as it shows clearly how small a part checkable data contribute to the standards laid down. Most still represent intelligent assumptions from basic facts backed up by some lessons from diving accidents. This prescriptive approach has protected divers from themselves but with the new desire to deregulate the lack of evidence that all the criteria are the minimum required has introduced uncertainty about the justification of some standards.

The conference was mainly concerned with professional divers, or, to use the new terminology, occupational divers, which in the UK now covers diving instructors. However the second session was devoted to recreational divers.

The first session covered the basis for medical examination of the diver. This included consideration of the need for such examinations, the relevance of the examination to the individual's in water safety and long term health, the effects of aging on a diver, whether all divers should be examined to the same standard, existing regulations in various countries, international differences in standards and whether harmonisation of standards is appropriate or whether all existing national standards should be internationally acceptable. This last question was clearly answered in the negative on the grounds that the diving industry is world wide and diver safety requires international health and safety standards. The French do not issue certificates of fitness to dive but certificates of "no contraindications", which is what other nations mean when they say fit to dive. Unfortunately this session was given inaccurate information about diving regulations in Australia. For some reason the Australian Medical Association was credited with reviewing the Australian Standard AS2299-1992. The organisations reviewing this document are Standards Australia and Worksafe Australia. Off shore diving is covered by the Petroleum (Submerged Lands) Act not the UK regulations, although they are very similar. The statement that "There is a move to apply the new standards from 1994 onwards. The South Pacific Underwater Medicine Society has been in debate with the AMA over the preparation of this uniform document." presumably refers to AS 4005.1-1992 and the struggle SPUMS, represented by the reviewer, had to convince the AMA to back the requirement in the standard that doctors who do diving medicals should have proper training in underwater medicine. No mention was made of the constitutional problems of a federation, which mean that an Australian Standard only becomes a legal requirement in those states which have so legislated.

The recreational diver session showed up the differences between the various countries, but the similarities were more impressive. In spite of the BS-AC allowing diabetics and asthmatics to dive there seems to have been considerable reservations on the part of other diving medical specialists. The attitude could be summed up as "You do it and keep good records and we will think about it when you have adequate data".

This attitude showed up again, but more positively in the cardiology and physical fitness and the pulmonary sessions. Here there were interesting and informative discussions. The conference saw no need to adopt Dr Peter Wilmshurst's advice to screen all new professional divers for patent foramen ovale. The Health and Safety Executive (HSE) advice to echocardiograph divers only after two or more episodes of neurological decompression illness was preferred. Dr Wilmshurst's reply to a question about ascent rate differences between professional (10 m/min) and recreational divers (20-40 m/min) and decompression illness rates seems a touch naive. "I am not aware of any commonly used sport diving decompression tables which use such rapid ascent rates. I assumed that the predominance of decompression illness in sports divers is the fact that there are considerably more dives by sports divers than by professional divers." Perhaps UK sports divers never exceed the laid down ascent rate, but they would be supermen (and women) if that was true. Luckily this is the one silly statement in the book.

The number of exercise tolerance tests for divers shows that none of them is a reliable predictor of the ability to cope with exercise underwater. The USN now uses specific simple tasks, such as lifting a 100 lb descent line up 1 m, carrying a 83 lb scuba cylinder 30 m repeated 6 times, swim on scuba (air) and carry a 50 lb toolbag 15 m repeated 4 times, in the same gear tread water for 2 minutes by finning, pulling a 100 lb umbilical line a distance of 45 m and in Mark-12 diving gear breathing air descend and ascend a 4.3 m vertical ladder, as basic exercise tests on entry. Other authorities demand a minimum oxygen uptake but one speaker showed that oxygen uptake did not correspond well with the time taken to swim 1 km in a pool.

It is a fascinating difference between the UK and Australasia that the only ENT surgeon attending was the speaker, W D McNicoll, an ex-RN MO whose paper in 1975 drew attention to the almost magical effects, 98% success, of nasal septum straightening in those who were unable to clear their ears.[2] After the flexibility evident earlier, his contribution was didactic and authoritarian. He is an advocate of early surgery in all cases of possible rupture of an inner ear window. But surprisingly, he allows divers whose round window has been repaired successfully to dive again. In the discussion about hearing standards he claimed that hearing loss was "not acceptable because one must start with the highest possible level of hearing. Anyone who has a 20 db loss when they are starting shows that they already have a problem." Unfortunately affluent societies are noisy places. In Australia a 20 db loss is common in young people wanting to scuba dive, especially if they are addicted to loud music.

The sections on neurology and mental fitness and return to diving after unfitness should be read by everyone involved in treating divers. The section on the future health of divers discusses how we can provide a better medical service to divers and what should be recorded for epidemiological purposes at the annual (or whatever) medicals so that data can be gathered and acted upon.

John Knight
SPUMS representative on AS Committee SF/17
(Occupational diving)

1 Parker J. *The Sports Diving Medical*. Melbourne: JL Publications, 1994
2 McNicoll WD and Scanlon SG. The nose-ear distress syndrome. *J Roy Nav Med Service* 1975; 61: 27-29.

AN INTRODUCTION TO TECHNICAL DIVING
Rob Palmer
Underwater World Publications Ltd., 55 High Street, Teddington, Middlesex TW11 8HA, UK.
UK price £17.95 plus postage

Australian distributor, JL Publications, P.O.Box 381, Carnegie, Victoria 3163, Australia. Australian price $Aust 43.00 including postage.

This book has a subtitle, A guide to the world of Technical Diving and its specialised training procedures and equipment. The author has achieved this. As he states the book is not a training manual. It is however a good introduction to the extra risks and equipment needed for Technical Diving which he defines as diving beyond the limits of normal recreational diving and beyond the training normally offered.

It is encouraging to find basic rules of diving on page 1 of chapter 1. It is a short list; breathe in, breathe out, slowly and regularly; breathe out when you come up; come up slowly; carry enough of the proper gas; stay warm. Again it is good to see that the author stating that "wanting to go deeper and get more bits of brass" is the wrong reason for reading the book. A good discussion of stress and how to cope with it closes chapter 1.

There is a good discussion of the thermal problems of diving and the equipment needed to stay warm. The effects of various diving gases gets clear mention and how the cylinders should be marked is made clear. Quite firmly he recommends that it should not be possible to connect an unbreathable gas to a diving regulator, this requires different threads.

His discussion of equipment opens with a reminder that the deep diver, which is what most technical diving is about, is effectively a solo diver and must be equipped with redundant systems for safety. He recommends that suit and buoyancy gases should be from a dedicated supply, not from a breathing supply. The advice is rather spoilt by the diagram on the same page showing the BC inflation coming from a nitrox breathing cylinder.

The discussion of rebreathers is quite restrained, but does not include any reference to the dangers of CO_2 build up which has led to many deaths in closed circuit gear in various navies. Perhaps the new absorbers, which are huge, never fail, but I doubt it. However the effects of CO_2 build up are discussed in the chapter on Deep Diving.

The discussion of gases other than air and overhead environments are informative and accurate. It comes across that breathing "mixtures" is a more complicated business for a scuba diver who has to swap regulators than for a surface supplied diver who can have the "luxury" (necessity ?) of a full face mask.

The weak point of the book is in its treatment of first aid for physical trauma which is sketchy and in the case of stings and puncture wounds from venomous fish, well out of date. The author recommends “a tight band not a tourniquet” and loosening it every 15 minutes rather than the pressure bandage immobilisation which has been so successful in Australia and wherever it has been tried. However the section on recognition of decompression illness (referred to as decompression sickness) is good, with a recommendation, imported from DAN USA, for a short neurological exam. Carl Edmonds' in water oxygen recompression treatment get an enthusiastic entry. However, for reasons not mentioned in the text, on the same page as the diagram of underwater recompression is a box which reads “It is extremely dangerous - and unjustifiable - to refuse or reduce treatment of a casualty suffering from decompression sickness following either an extreme air exposure or an enriched air dive”. Whatever prompted its inclusion it suggests that not all is well with the diver doctor relationship in the UK.

This book should be read by every diver who is thinking about deeper, both vertically and horizontally, diving. It should also be read by everyone interested in how the frontiers of non-occupational diving are being advanced and the problems involved.

John Knight

U.S. NAVY DIVING MANUAL, VOLUME 1 1993
Review copy from Best Publishing Company,
P.O.Box 30100, Flagstaff, Arizona 86003-0100, U.S.A.
Price from Best Publishing Company $US 45.50. Postage and packing extra.

This Edition is a rewrite with major changes, some of which are not successful. An unfortunate omission is an index, but most entries can be found by wading through the table of contents. The information is presented in a manner suited for a diving trainee, but this is not ideal tor a diving doctor. For example, if one is interested in arterial gas embolism, physiology is found in chapter 3, medicine in section 8 of chapter 8 and recompression treatment in section 15 of chapter 8. Other aspects of diving medicine are found in these chapters and there are also appendices on dangerous marine animals, neurological examination and first aid.

The new USN decompression tables are not in the manual. The old tables have been modified to a 30 ft/min rate of ascent. This change is sometimes confusing, for example, for a dive to 120 ft for less than 15 minutes does not require decompression stops. It would, by my maths, require the ascent to take 4 mins (120/30 = 4). The total ascent time is given as 2 minutes. If the diver exceeds the 15 minutes bottom time he has to stop at 10 ft. The next schedule has an ascent time to the first stop as 3 min 40 see which I would have expected, (110 ft at 30 ft/min) followed by 2 mins at 10 ft and an ascent to the surface, but the total decompression time is given as 4 minutes, rather than the 6 minutes which I would have expected. For some unexplained reason, decompression stops are now taken with the mouth at the depth rather than the chest.

The flow charts have changed from the previous edition. A case of suspected arterial gas embolism with a pulse is now taken to 60 ft and given oxygen. If the response is satisfactory the 165 ft air tables are not used. The USN still require that the chamber be surfaced for any defibrillation. If a gas embolism case has no pulse and cardiac arrest is diagnosed one can institute advanced cardiac life support (ACLS) before recompression, or recompress to 60 ft while continuing the basic life support efforts.

Type 1 and Type 11 descriptions of decompression sickness remain, but it is modified by division into Emergent, Urgent and Timely. This is on the basis of the urgency of the treatment. In the interests of having a standard classification system it is a pity that the USN has not come to an agreement with the Royal Navy.

Other random comments: The lower limit for CNS oxygen toxicity has been reduced to 1.3 ATA, but it is legal to have an attendant on oxygen at 30 ft or less without locking a second attendant. The unguarded attendant must hold the mask to the face rather than securing it.

The rules regarding medical unfitness to dive following decompression sickness treatment are less conservative than used by many in Australasia. The USN suggest a week for Type I DCS that resolved completely and two weeks for mild Type II that resolved quickly.

Despite the problems mentioned this is still a useful manual and is probably the best one for an instructor. Because to the points raised and the absence of the new decompression tables, medically orientated readers may prefer to wait and buy the next edition. IF I needed a quality manual now I would find it difficult to choose between the USN and the NOAA manuals.

John Pennefather

COLD WATER CASUALTY
28 minute video. Year of production 1990
Services Sound and Vision Corporation, Chalfont Grove, Narcot Lane, Chalfont St Peter, Gerrards Cross, Buckinghamshire, England SL9 8TN. Tel (UK) 0494-871-773. Fax 049-872-982.
Price £40.00 Postage and packing £6.00. These must be paid in UK currency before despatch.

This International Award winning, Royal Navy training video starts with the chilling facts. In 15°C water the unprotected, not wearing a survival suit that keeps the water off, human can expect to survive for 2 to 3 hours. In 5°C water the time is 2 to three MINUTES. The video is not aimed only at the services but at anyone who might have to rescue someone from the water. Civilian organisations, including helicopter rescue, have taken parts in the video alongside the naval personnel.

Attention is drawn to the occurrence of uncontrollable hyperpnoea as a response to falling into cold water, which by preventing the victim from swimming can lead to almost instantaneous drowning. Jumping in to save the victim may drown the rescuer as well.

The effects of hypothermia and the need for careful handling and slow warming are emphasised. The mechanisms of post-rescue collapse are explained and the right way to winch a person from the sea, using two strops, one under the arms and one behind the knees, is shown. The correct way to warm a person in a bath is shown and the need for constant watching is emphasised.

The dangers of leaving rescue victims unattended are illustrated by two chilling episodes. The first was a woman having a warm-up shower while the MO was reporting her recovery to the Captain on the bridge. While he spoke she fainted as her skin warmed and then was propped up by the shower wall so prolonging her brain hypoxia. The second was the young sailor, turned in in his mess, who awoke the morning after his rescue with a productive cough with bloody sputum and considerable dyspnoea and cyanosis from secondary drowning.

Everyone who might have to rescue someone from the sea should watch this excellent introduction to the problems of keeping the person rescued from a cold sea alive and on the road to recovery, and most would learn a lot from it. I have yet to meet anyone who has seen it that does not consider it good or excellent.

John Knight

THE OBSTRUCTED AIRWAY

32 minute video. Year of production 1992

Services Sound and Vision Corporation, Chalfont Grove, Narcot Lane, Chalfont St Peter, Gerrards Cross, Buckinghamshire, England SL9 8TN. Tel (UK) 0494-871-773. Fax 049-872-982.

Price £40.00 Postage and packing £6.00. These must be paid in UK currency before despatch.

This is another International Award winner from the Royal Navy and it thoroughly deserved its win. I have never seen a better account of the various problems of the obstructed airway and how to deal with them. Dealing with an obstructed airway is absolutely vital first aid, the A of ABC. From its early 1970s film “Don’t let him die” the RN has produced excellent airway management instructional material. The Services long ago learnt that good first aid improves casualty survival.

The video opens with a view of the human airway through a bronchoscope. Then there is the statement that all patients had given their informed consent and that the hospital ethics committees had approved the procedures. The demonstrations are almost all done using anaesthetised patients. For reasons of clarity those doing the various manoeuvres did not wear gloves. This was a decision made by the producers. Perhaps from a 1995 viewpoint they were wrong, but in an emergency time spent looking for gloves could cost a life.

The target audience is a wide one from first aiders to medical technicians to doctors. There is something here for everyone to learn. The symptoms and signs of an obstructed airway are explained, with cutaway drawings showing the problems and then how the airway is restored intercut with film of the patient’s head and the rescuer’s hands. Each step is clearly shown and easily followed. The problems of an obstructed airway in someone who may have a spinal injury is dealt with early in the video.

Having restored the airway by positioning the choices open to the rescuer for keeping it open are discussed. Again drawings and actual patients are illustrated to help understand the workings of Guedel airways, laryngeal masks, which all medical branch sailors are expected to be able to insert properly, and endotracheal intubation. The problems with each method are clearly stated. The recommended routine for intubation included attaching a large syringe to the ETT and sucking. In theory an oesophageal intubation should not produce any air. It was encouraging to see that the old teaching of “when in doubt take it out” emphasised.

The problems of a person inhaling a bolus of food were convincingly sorted out by abdominal compression from behind.

The final part shows emergency crico-thyroid puncture. The steps were clearly portrayed but these cannot have been done on the living as there was very little bleeding, and only dark venous blood, and no movement on incision in spite of no local being used.

This video should be in the library of every hospital and every organisation which teaches first aid. Everyone who teaches airway management should see it.

John Knight

SPUMS ANNUAL SCIENTIFIC MEETING 1994

A PRE-DIVE CHECK; AN EVALUATION OF A SAFETY PROCEDURE IN RECREATIONAL DIVING: PART 1.

Chris Acott

Abstract

In this study divers were asked to do a pre-dive equipment check on some diving equipment (buoyancy jacket, regulator, air cylinder, contents and depth gauges) that had been assembled so that there were 9 faults to be detected. Only two out of the 55 divers who participated detected all faults. If these divers are representative of recreational divers then an adequate pre-dive equipment check is not being performed by divers.

Introduction

Diving is an equipment orientated sport so a pre-dive equipment check is an essential part of dive preparation and safety.[1-3] Failure to do an adequate pre-dive equipment check is an important contributing factor in the incidents reported to the Diving Incident Monitoring Study[4] and its preceding pilot study,[5] however, accident and fatality data fail to implicate a lack of a pre-dive equipment check as a contributing factor to recreational diving morbidity or mortality.[6,7]

A study was designed to test the thoroughness of the average diver's pre-dive equipment check.

Method

Divers who attended an annual dive equipment exhibition were asked, at random, to perform their "normal" pre-dive check on some diving equipment (buoyancy jacket (BCD), air cylinder, regulator with octopus, contents gauge and depth gauge with maximum depth indicator) which had been assembled incorrectly to contain nine equipment faults that had been noted in the incidents reported to the Diving Incident Monitoring Study (DIMS). The divers were asked to record their results. No information was given about the number of faults and there was no time limit for performing the check, but the time taken was noted by an observer (the author). The diver's qualifications were not asked for.

The nine faults are listed in Table 1. Four interfered with the air supply and regulator. These were that the air cylinder was empty , the outlet valve had not been opened, there was tape across the pillar valve outlet and the regulator mouthpiece was torn. Four faults affected the functioning of the BCD. These were that the power inflator was not connected, the inflator hose mouthpiece was torn and loose, the dump valve was loose and the air cylinder was loose in its harness. Finally the maximum depth indicator was not zeroed.

TABLE 1

THE NINE FAULTS

The air was not turned on
The tank was empty
Masking tape had been left on the pillar valve
The regulator mouthpiece was partially bitten through
The tank was loose in the harness
The buoyancy jacket's emergency dump valve was loose
The power inflator was not connected
The oral inflator was torn and loose
The maximum depth indicator was not zeroed

Results

Fifty five divers checked the equipment. Table 2 shows the number of divers and percentage detecting the various faults. The fault most commonly detected was disconnection of the power inflator which was detected by 47 (85%) of divers.

The time taken to complete the check varied between 2 and 10 minutes with the average being 5 minutes.

Only two divers identified all the faults, 4 divers detected 8 faults and, most alarmingly, 4 divers failed to detect any fault.

Forty two divers noted that the tank was switched off but only 23 of these noted any additional air supply problems. Seven divers noted all the faults with the air supply but only 4 of these noted the regulator's torn mouthpiece. Three divers noted the empty tank, that the air supply was switched off and the faulty BCD dump valve.

Eight divers identified all the buoyancy jacket's faults.

Twenty divers noted that the maximum depth indicator was not zeroed.

TABLE 2

FAULTS IDENTIFIED BY ¡55 DIVERS

Faults Detected by divers	Number	%
Air supply and regulator		
Empty tank	16	29
Air not turned on	42	76
Pillar valve tape still on	16	29
Torn regulator mouthpiece	17	31
Buoyancy jacket		
Power inflator not connected	47	85
Inflator hose mouthpiece	10	18
Emergency dump valve	12	22
Tank loose	33	60
Depth gauge		
Maximum depth indicator not zeroed	20	36

Discussion

Anecdotal data suggest that the average time taken to do a pre-dive check in this study was longer than the time taken to do an "on site" pre-dive check.

These results are disturbing for only 2 divers noted all the faults, only 3 noted the faults that could have potentially fatal consequences (the empty tank, the air supply switched off and the loose dump valve) and that only 14 noted the inadequacy of the air supply. Accident and incident data have shown that morbidity and mortality are associated with inaccurate depth gauges and rapid changes in buoyancy caused by buoyancy jacket problems[5-8] and the majority of divers in this study failed to notice the faults with either the buoyancy jacket or depth gauge.

Ninety six percent of the divers tested did not perform an adequate pre-dive check on the equipment, in particular, how to check the adequacy of an air supply and how to check to see if a buoyancy jacket and depth gauge will function correctly. If these divers could be considered as being representative of recreational divers, because they showed the motivation to attend a diving equipment exhibition that charged an entrance fee, then these data have the obvious safety implication that the majority of recreational divers do not adequately check their equipment before use. With the prevalence of a "failure to check" in diving incidents[4,5,8] an easy to remember, simple guide or a written pre-dive check list is needed. Once devised then its thoroughness will need to be tested.

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CARBON MONOXIDE: FROM TOXIC POISON TO BRAIN MESSENGER

Des Gorman

Introduction

Carbon monoxide (CO) is the most common lethal poison in every community that has been studied.[1] Although many of these poisonings are the result of a deliberate exposure to commit a suicide, toxic exposures to CO are also often the result of both domestic and industrial accidents.[2] In Western societies, the motor vehicle is the major source of CO.[2] Survival after poisoning with CO is frequently associated with neuropsychological deficits, and especially with problems in short-term memory and mood.[3-7] Despite this mortality and morbidity, the toxic mechanisms and the ideal treatment of CO poisoning remain controversial. The received version of CO toxicity is based on hypoxia,[5] and the majority of treatment algorithms are consequently designed to restore blood oxygen content.[5] However, the hypoxic theories of CO toxicity are seriously flawed and when treatment of poisoned patients has been essentially titrated against blood oxygen content (in fact, it was titrated against the carboxyhaemoglobin (COHb) concentration), many of these patients have developed sequelae from their CO exposure.[7,8] This review of the toxicity of CO is prompted by the need then to:

identify the flaws in the hypoxic theories of CO toxicity;

discourage the treatment of CO poisoned patients with regimens that are designed solely to relieve hypoxia;

examine the recent demonstration of a toxic mechanism which is a good explanation of the delayed effects of CO; and

examine the data that support an important role for endogenous CO in normal neurobiology.

Requirements of a toxic theory for carbon monoxide

A toxic theory for CO must be compatible with both the "natural" history of this poisoning in humans and the demonstrated pathological changes in survivors and lethal poisonings.

A loss of neural function, and particularly confusion, dominate the clinical presentations of CO poisonings.[2-7] Cardiovascular manifestations are much less common. Unless the patient dies, or the presentation is complicated by severe hypoxia arising from apnoea or aspiration of vomitus or loss of airway patency, or other poisons are simultaneously involved, removal of the victim from the CO source is usually followed by recovery and this can probably be accelerated by breathing 100% oxygen.[3-7] Some of these patient recoveries are incomplete and other patients continue to improve after their discharge from hospital (late recoveries).[3-7] Patients who do recover can subsequently relapse or deteriorate (late deteriorations).[3-7] Similar delayed encephalopathies are seen after other forms of brain injury.[9,10]

The neural pathology of CO poisoning has been variously demonstrated by necropsy and neuro-imaging[11-19] to be predominant necrosis of the globus pallidus, areas of the cerebral cortex, hippocampus, cerebellum and substantia nigra. It must be noted that the pathological changes described here have been demonstrated in severely poisoned patients and hence may not be "typical" of the pathology to be found in the majority of those intoxicated. It is also noteworthy that these changes are not identical to those found in hypoxic brain injuries. For example, hippocampal neurons are relatively resistant to hypoxia.[20] There is also a profound difference in the demonstrated resistance of cortical brain function to hypoxia and the extreme sensitivity of this function to CO in rabbits in our laboratory.[21]

Theories of carbon monoxide toxicity

HYPOXIA

The predominant theory of CO toxicity is that it causes hypoxia as a combined result of CO binding to the reduced haeme groups of haemoglobin (Hb) and myoglobin (Mb).[22-31] The Hb that is bound to CO as COHb is unable to form oxyhaemoglobin (OHb) and that OHb which is formed dissociates at relatively lower oxygen tensions in the presence of CO (ie. there is a left shift in the OHb dissociation curve).[32] The poisoning of Hb by CO is argued to be enhanced by a significantly (between 200 and 230 times for human Hb) greater affinity of Hb for CO in comparison with oxygen.[33,34] Although the equilibration of CO with Hb in red blood cells is slower than the oxygen binding to Hb, the formation of COHb is nevertheless complete in a fraction of a second (and hence a pulmonary circulation-time).[35]

The binding of CO to Mb will slow diffusion of oxygen into tissues and is proposed to cause myocardial depression and a consequent hypotensive hypoperfusion of critical organs such as the brain.[12]

While it is not contested that CO binds to Hb and Mb, and that it is possible to measure decreases in tissue and venous blood oxygen tensions in experimental animals[36,37] and humans[38] in the presence of COHb, there are a number of observations that challenge hypoxia as the unique or predominant toxic mechanism of CO.

First, the left shift in OHb dissociation[32] is only significant at a capillary level of oxygen tension if the COHb exceeds 40%, inhibition of brain function is seen at lower concentrations than this in rabbits[21] and in sheep (P. Langstone - personal communication 1994). In these species, brain function is shown to be affected by levels of CO that not only do not cause a capillary-level shift in OHb dissociation, but also that do not cause any change in oxygen delivery, as brain blood flow increases sufficiently to compensate for the decrease in blood oxygen content[21] (P. Langstone - personnal communication 1994).

Second, CO is lethal to rats in hyperbaric oxygen (HBO) conditions in which enough oxygen will be in solution in plasma to meet tissue needs, demonstrating a clear tissue toxicity unrelated to Hb.[39] This conclusion is said to be challenged by the increased survival of animals exposed to CO and given a perfluorocarbon emulsion infusion,[40] but such a challenge is unreasonable.

Third, through a series of exchange-transfusion experiments, all be they of only moderate standard (eg. inadequate controls), it has also been demonstrated that replacement of normal blood cells with those that have been poisoned with CO does not produce any overt toxicity.[41-44]

Fourth, data from other series of animal-model studies are inconsistent with a primary hypoxic mechanism. In those animals in which brain blood flow has been measured during an exposure to CO, flow actually increases[21,38,45-49] such that there is a compensation for the reduced blood oxygen content and a preservation of oxygen delivery.[21] It must be noted that this compensatory maintenance of oxygen delivery, and oxygen availability to tissues, does not prevent a CO-induced disruption of brain function[21] and as CO levels continue to increase, will eventually be overcome.[46] In rats, HBO can be shown to inhibit a CO-precipitated peroxidation of lipids by a mechanism that does not involve an accelerated dissociation of COHb.[50] Also, in rhesus monkeys, the duration and intensity of a CO insult was not critically related to the severity of the consequent abnormality in the cerebral white matter, as would be expected in a "simple" hypoxic insult.[25,26]

Fifth and final, the outcome of patients poisoned with CO does not correlate well with the COHb level measured on arrival at the hospital, indeed, such levels can not even be used to distinguish survivors from non-survivors,[2-7] many patients will develop severe sequelae of CO poisoning despite having no clinical or laboratory evidence of systemic hypoxia,[5] titration of treatment with oxygen against COHb concentration is often unsuccessful in preventing sequelae,[7,8] body stores of CO remain elevated after COHb levels have returned to "normal",[51] and as reported above, the pathological changes seen in severely CO poisoned patients are not identical to those of hypoxic brain injury .[11-19]

TISSUE TOXICITY

The study in rats cited above,[39] demonstrated more than 60 years ago that there is a significant tissue toxicity of CO that is not related to Hb. Since that time a series of tissue toxicity theories of CO have arisen, most have been based on inhibition of the haeme proteins other than Hb and Mb, and in particular, cytochrome C oxidase (CyC-Oase).[33] However, most of these theories rely upon a pre-existing hypoxia to explain both tissue uptake and binding of CO to intracellular proteins. Although many of the intracellular compounds that contain iron or copper will bind CO,[24] under normal circumstances only about 15% of total body CO is extravascular.[52] A significant intracellular hypoxia is "needed" to induce an extravascular redistribution of CO,[52,53] and then, most of the redistributed CO will bind to cardiac[54] and skeletal[55] Mb.

Cytochrome C

Carbon monoxide will bind to the a3 component of reduced CyC-Oase to poison respiration,[56-60] but the affinity for the cytochrome of CO is low in comparison to that of oxygen.[33] For example, direct evidence for CO binding to CyC-Oase in the brain has been obtained in experimental animals, but only in the concurrent presence of COHb levels in excess of 50% and hypotension.[61]

Other haemoproteins

Carbon monoxide will also bind to other reduced haemoproteins such as cytochromes of the P450-type, tryptophan dioxygenase and guanylyl cyclase.[33,62,63] While the significance of CO binding to the former 2 enzymes is uncertain, the over-stimulation of the formation of cyclic-GMP in neurons by exogenous CO[62] may be an essential feature of CO poisoning. This hypothesis, that the acute toxicity of CO is due to an excess of normal endogenous CO functions (which are described later in this paper), is totally conjectural, but a similar argument has achieved credibility in the context of nitric oxide (NO) and ischaemic brain injuries.[64]

Lipid peroxidation

A rat model of CO poisoning[65] has been used to establish a very plausible explanation for the frequent delayed effects of CO (relapses and deteriorations),[2-7] but not for acute toxicity. The first evidence of lipid peroxidation is seen about 90 minutes after rats are exposed to CO (this being due to the displacement of NO from platelets by CO). Rats are probably a reasonable model for human CO exposures in this context.[13,66]

This lipid peroxidation can be inhibited by HBO, but not by 100% oxygen at atmospheric pressure.[50,65,67,68] This is again consistent with clinical experience.[2-7] Although HBO can be shown to antagonise the conversion of nascent enzyme xanthine dehydrogenase to free-radical producing xanthine oxidase,[69,70] the important action of HBO in this context is almost certainly to inhibit the CO-induced accumulation of neutrophils and the adherence of these cells to microvessels.[71] The neutrophils are stimulated by CO to bind to endothelial cells, block blood flow and infiltrate the microvasculature, these cells have been shown to be responsible for the post-CO oxidative brain injury.[71,72] The therapeutic role of HBO proposed here is similarly argued for general ischaemic-reperfusion injuries[73] and in decompression illness.[74]

The ideal dose of oxygen to inhibit post-CO peroxidative injury is not established. In different rat preparations, 101 kPa oxygen had no effect on CO-induced lipid peroxidation, 202 kPa oxygen had some effect and 303 kPa oxygen significantly reduced this peroxidation;[65] whereas, 151 kPa oxygen reduced hydroxyl radical formation after a CO exposure and 252 kPa oxygen actually increased the formation of these radicals.[75] In the latter study, the adverse effect of 252 kPa oxygen was reversed by the concurrent administration of a monoamine oxidase inhibitor.[75] This finding has obvious clinical implications.

Surface adsorption

Because CO is a small molecule and has a high dipole moment as a result of the uneven sharing of electrons between the carbon and the oxygen atoms, it will readily and tenaciously be adsorbed to solid surfaces (B.A.Hills - personal communication 1987). In many circumstances, CO may then compete successfully for adsorption sites with other reagents. Thus it is possible that reduced rates of reaction could underline the clinical toxicity of CO.

Immune suppression

An observation of uncertain significance in the context of the toxicity of exogenous CO is that the gas alters the immune response, CO induces stress protein-72 production and reduces IL-IB formation in human alveolar macrophages.[76]

OVERVIEW

It is highly unlikely then, with the possible exception of guanylyl cyclase stimulation about which little is known, that none of the theories of CO toxicity outlined here can explain the range of toxic manifestations of this gas in isolation. Indeed, it is likely that different mechanisms underlie the acute toxicity (a primary acute brain syndrome) and the delayed effects (a progressive encephalopathy).

Despite these comments, the received wisdom is that CO is an hypoxic toxin and that the treatment of CO poisoning should be directed at relief of this hypoxia. It is likely that such an approach, when taken to the extreme of titrating treatment against COHb levels in blood, has resulted in some patients suffering otherwise avoidable sequelae.[7,8] The variable response of CO-induced lipid peroxidation to different levels of HBO[65,75] shows that the future of clinical CO research must instead be based on an approach that compares the response of CO poisoned systems and patients to a wide range of different oxygen doses and adjuvant therapy.

The biology of carbon monoxide

Until the normal biological roles of NO were suggested and then confirmed, the endogenous CO produced was considered to be a toxic waste-product of haeme catabolism. It is now clear that this attitude was naive and that endogenous CO is important biologically.

THE BIOLOGY OF NITRIC OXIDE

Nitric oxide is a labile gas that is produced by the catabolism of L-arginine by nitric oxide synthetase (N0S).[77] There are at least 3 forms of NOS, 2 constitutive forms which are variously expressed by endothelium, neurons and astrocytes and an inducible form found in neutrophils and monocytes.

The initial role identified for NO (at the time regarded as a toxic gas) was as part of the mechanism by which macrophages kill tumour cells and bacteria.[78] Since then a wide range of roles have been identified for NO and these include:

action as an endothelial-derived relaxing factor (EDRF)[79] to couple brain blood flow and metabolism[80,81] and also in other vascular actions such as platelet inhibition, cell adhesion, penile erection, the control of the foetal and neonatal pulmonary circulation and the regulation of the expression of vasoconstrictors and growth factors by vascular endothelium;[82-84]

modulation of neuronal behaviour by regulation of cyclic GMP[85,86] and regulation of neural released hormones such as vasopressin and corticotrophin-releasing hormone;[85]

and mediation of ischaemic-reperfusion brain injuries.[64]

THE BIOLOGY OF CARBON MONOXIDE

The demonstration that gaseous NO was a neuronal messenger led to the suggestion that it might be the first of a family of such messengers and not unique.[86] The argument that CO was a member of this family followed the molecular cloning of NOS.[86] The amino acid sequence of NOS is similar to only one other known mammalian enzyme, cytochrome P450 reductase, which is an electron donor to the liver enzymes that metabolise drugs and to haeme oxygenase, the enzyme that metabolises haeme groups to biliverdin and CO.[88,89]

The electron donating function of cytochrome P450 reductase is mediated by 3 cofactors, NADPH, fiavin adenine dinucleotide and flavin mononucleotide, which are also co-factors to NOS and the recognition sites for these co-factors are in the same places on the 2 enzymes.[86]

There are 2 forms of haeme oxygenase; an inducible form (type 1) found in the liver and spleen and a non-inducible form (type 2) found throughout the body and in significant concentrations in specific areas of the brain.[62,90,91]

The more definitive evidence for CO to be an important neuronal messenger has subsequently accumulated and is summarised below:

mRNA for type 2 haeme oxygenase is situated in discrete populations of neurons in rat brain, olfactory bulb, hippocampus, cerebellum, pontine nucleus, habenula, piriform cortex, tenia tecta, olfactory tubercle and islands of Callejae, and in a distribution common to that of cytochrome P450 reductase, delta aminolevulinate synthase (ALAS), the rate-limiting enzyme in porphyrin biosynthesis, and guanylyl cyclase;[62,86]

most of these brain areas have low concentrations of NOS;

the brain is not a site for red blood cell catabolism[92] and the collocation of all the enzymes necessary to produce both CO and cyclic GMP in these areas of the brain is highly suggestive of a primary messenger role for CO.

there are major discrepancies in the brain distributions ofguanylyl cyclase and NOS, the correlation in the rat brain is much better between concentrations of type 2 haeme oxygenase and guanylyl cyclase;[62]

it is also noteworthy that in those areas of the brain where there is considerable guanylyl cyclase but little type 2 haeme oxygenase (eg. corpus striatum), significant concentrations of NOS can be identified;[93]

inhibitors of type 2 haeme oxygenase, but not inhibitors of NOS, deplete endogenous cyclic GMP in (rat olfactory) neurons;[62]

carbon monoxide binds to the haeme group of guanylyl cyclase in an analogous fashion to NO, increases the formation of cyclic GMP and consequently dilates blood vessels and gut smooth muscle and inhibits platelet aggregation;[89,94-100]

and there is at least a suggestion that type 2 haeme oxygenase blockade inhibits long-term potentiation (LTP) in the hippocampus.[92]

Overall then, all these findings indicate that CO is an important neural messenger associated with physiologic maintenance of endogenous cyclic GMP concentrations.

The (now essentially accepted) biological role of CO outlined above may determine or contribute to the acute toxicity of exogenous CO gas in a manner analogous to that proposed for the "contribution" of NO to ischaemic brain damage.[64] Exogenous CO will be delivered to the brain in solution in plasma and bound to Hb and will diffuse into neurons of all types to bind to available guanylyl cyclase, this in turn will increase the production of cyclic GMP, perhaps to excess and cause a consequent excess of some neuronal activity to the detriment of the cell ("neuronal over-heating"). This is likely to be worse in those areas of the brain where NO is the primary regulator of cyclic GMP as CO is a stable gas in comparison to NO and hence will exist for longer both within the neurons and specifically in combination with guanylyl cyclase.

Summary

The chemically similar gases NO and CO are produced endogenously and are biologically important. Both NO and CO are also toxic when inhaled or absorbed from exogenous sources and this toxicity may arise, in part, from an over-stimulation of those functions which are "normally" regulated by the gases.

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INVESTIGATING DIVING FATALITIES
A CASE REPORT

Peter Lewis

Summary

A case report is presented with discussion of the autopsy technique and the evidence needed at the coronial inquest.

Introduction

Investigation of a skin-diving accident requires assessment of:

1 medical history;
2 diving experience;
3 dive profile;
4 environmental conditions;
5 diving equipment;
6 the autopsy.

Finally a correlation of all facts needs to be made.

Case report

The victim was a 28 year old male who died while using hookah, or, more properly, surface supplied air from a compressor. The autopsy showed signs of drowning but otherwise did not indicate the underlying cause of death.

MEDICAL HISTORY

He was an overweight 28 year old electrician, who had been an Australian Rules football (Victorian Football League) player. He had had a knee reconstruction. His father died of heart attack when in his 50s.

DIVING EXPERIENCE

Unknown but at least of 4 years duration and he could free-dive to 12 m.

DIVE PROFILE

His buddies were two experienced snorkellers and one novice. He used hookah to dive to 9 m for 25 minutes. After a surface interval of 30 minutes a second dive was made to 9 m for 10 minutes and then, after a further surface interval of 2 minutes, a third dive was made to 9 m for 5 minutes. At this time it was discovered that he was not breathing and he was pulled to the surface by the air-hose and brought, with enormous difficulty, into the boat. The face mask was 1/4 full of froth and blood. Resuscitation was attempted but to no avail.

ENVIRONMENTAL CONDITIONS

He was diving off an island, 2 km offshore, in a marine reserve with no current, 20 m visibility and a 5-10 knot breeze.

DIVING EQUIPMENT

His face mask was perished, the booties had broken zips and the compressor was in poor condition. The regulator hose was, inappropriately, tied directly to his weight belt. The hookah unit was sent to the police diving unit in Sydney for assessment and this revealed four of the five engine mounts were broken. This allowed the compressor to pivot, which in turn caused the air intake hose to disconnect. This hose had no clamps, was a poor fit and had multiple cracks. Numerous other compressor defects were noted. Compressed air was taken for analysis and this revealed a carbon monoxide concentration of 144 p.p.m. while the hose was connected and 633 p.p.m. when the hose was disconnected. Australian Diving standards require a maximum of 10 p.p.m.

AUTOPSY

Blood taken revealed a carbon monoxide saturation of 50%. It is of interest was that the body, tissues and blood did not show the classic cherry-red colour.

CORRELATION

The history, police reports, autopsy, toxicology and equipment testing allowed the conclusion of “death due to drowning due to carbon monoxide poisoning due to diving using defective equipment”.

Comments on Carbon Monoxide Levels.

Non-smokers have carbon monoxide levels of <1% while smokers average 5% (range 1 to 9%, although super-inhalers can have up to 16%:). Blood levels less than 10% usually produce no symptoms while higher levels produce headache, lethargy and nausea. Levels over 50% produce increasing confusion, then syncope and coma. Exhaust fumes from older cars contain 5 to 6% carbon monoxide which if led to the sealed interior of a car (a method of suicide) have caused death in approximately 10 minutes.[1] The toxic limits of carbon monoxide by varying ambient and oxygen partial pressure have not been established.[2] A comprehensive review of carbon monoxide poisoning has been published in the SPUMS Journal.[3]

Post mortem examination

A technique has been published by the Royal College of Pathologists of Australasia[4] and is described in the book “Diving and Subaquatic Medicine”.[5] In summary, this involves a full assessment of the history and circumstances of the accident, a detailed autopsy, including histological examination, and special tests.

Before the autopsy the body should have X-rays of neck, chest and abdomen to detect intravascular air. CT scans are excellent if one can get them. The external examination should include assessment of colour and any subcutaneous emphysema around the root of the neck. Opening the cranium underwater is recommended, however, this is impractical for the majority of prosectors. It is important to dissect carefully so that assessment of the distribution and significance of any air within the cerebral vessels can be made. The chest cavity can be opened underwater by creating a shallow pool by pouring water within the reflected flaps of thoracic skin. Aspirating the ventricles of the heart by using a syringe partly filled with water will reveal any intracardiac air. The presence and size of any patent foramen ovale should be recorded. Blood should be taken for estimation of alcohol, carbon monoxide and other drugs. Vitreous humour biochemistry may sometimes be of value.

Correlation of findings for the Coroner

The post-mortem findings are interpreted with the knowledge of all the circumstances of the accident so that the event or events leading to the fatality may be completely defined. This correlation, however, needs to be made by a knowledgeable person.

I urge SPUMS members to volunteer their services to the pathologist or government medical officer at the time of an autopsy of a diver and if necessary to write a definitive correlation for the coroner. In this way relevant findings should be handed down and appropriate lessons learned.

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OXYGEN AS A DRUG: A DOSE RESPONSE CURVE FOR RADIATION NECROSIS.

WJ Ehler, RE Marx and MJ Peleo

This paper was first presented at the Undersea and Hyperbaric Medical Society's 1993 Annual Scientific Meeting. It was accepted for the SPUMS Annual Scientific Meeting 1994 because the audience was different and the paper of importance. It is reprinted from Undersea and Hyperbaric Medicine 1993; 20 (Supp): 44-45 by kind permission from the Editor.

Background

Hyperbaric oxygen is a well known adjunct in the treatment of human clinical radiation necrosis. Its mechanism of action has been determined to be a stimulation of macrophage derived angiogenesis factor and macrophage derived growth factor by establishing physical oxygen gradients in radiated tissue. Angiogenesis is directly proportional to the oxygen pressure in the hyperbaric environment.

Methods

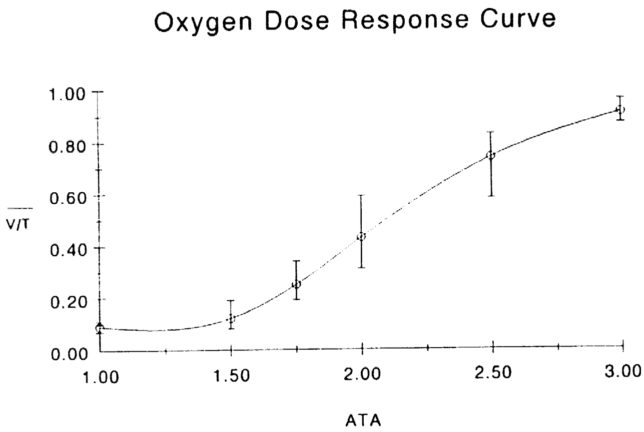
42 New Zealand white rabbits (*Oryctologus cuniculus*) received 320 cGy fractions of cobalt (^{60}Co) radiation twice weekly for a total dose of 5,440 cGy. Resulting tissue damage which develops over six months does not produce overt necrosis. The 42 animals were divided into 6 groups of 7 animals each. Each group of animals was then exposed to oxygen at 1, 1.5, 1.75, 2.0, 2.5, and 3.0 ATA. The animals were then killed painlessly with infusion of 30% Barium Sulfate and 5 ml of Hypaque. The radiated tissue was harvested and prepared for tissue microradiographic angiography. The radiographs were coded and analysed by a blinded investigator (MP) using a random point analysis of vessels per tissue area (V/T). A mean score V/T versus dose of oxygen in atmospheres was derived (Table 1 and Figure on page 87.

TABLE 1

ATA	1.00	1.50	1.75	2.00	2.50	3.00
Vessels (V/T)	0.09	0.12	0.25	0.43	0.74	0.91

Conclusions

The results indicate that oxygen does indeed behave as a drug. The optimum dose in this model is 3.0 ATA



which borders on acute oxygen toxicity. The curve of V/T versus ATA shows a minimal and only gradual increase to 2.0 ATA. At 2.5 ATA, a sharp increase in angiogenesis is noted ($p<0.001$ ANOVA). This study strongly implies a greatly reduced response at treatment depth of 2.0 ATA as compared to 2.5 ATA and to 3.0 ATA.

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ARTICLES OF INTEREST REPRINTED FROM OTHER JOURNALS

WHY US DIVERS DIED IN 1991

Ben Davidson

The National Underwater Accident Data Centre (NUADC) at the University of Rhode Island has been recording diving fatalities involving US citizens for 20 years. To further your awareness of the causes of death so that you may dive more safely, *Undercurrent* has been reporting their analysis for 15 years. The 1991 report on scuba fatalities is the second joint effort between DAN and NUADC.

In 1991, 67 recreational scuba fatalities were reported. While 67 is the second lowest number of scuba deaths recorded since 1970, at least 90 scuba related deaths have been reported for 1992. Of the 67 deaths in 1991, the youngest was 16 years of age and the oldest was 72. Twenty-one percent of all fatalities were 50 years of age or older. The female deaths were 25 percent of the total.

In determining the overall fatality rate, it is difficult to obtain the exact number of active divers. The number of newly certified divers is not available and not all divers remain active after their first year of diving, while some drop out and then re-enter. Nonetheless, NUADC estimates the active diver population at 2.5 to 3.2 million divers at the end of 1991, leading to a fatality rate of 2.09 to 2.68 per 100,000 participants.

(Undercurrent Editor's note:
The National Sporting Goods Association surveys 20,000 households annually to determine participation in recreational sports; they estimate 2,000,000 divers.)

Location of Diving Fatalities

Florida recorded 14 scuba fatalities in 1991, down from 22 in 1990. There were 10 scuba fatalities in California in 1991, while 14 were noted in 1990. Pennsylvania had four deaths in 1991, two occurring in the same quarry, several months apart. New Jersey had four wreck-diving deaths, Hawaii three fatalities, while two were recorded in Texas. One of these victims died of hypothermia after 20 hours in the water without a wet-suit, while his wet-suited partner survived. They had been diving offshore, but drifted away from their boat in the current. They reached a buoy after several hours in the water and clung to it overnight. The decedent died shortly before rescue.

Five Americans died in Cozumel, Mexico. The Bahamas accounted for three fatalities, and one death each was reported in Okinawa, Palau, Dominica, Bonaire and St. Maarten.

Dive Activity and Certification Status

Of the 67 scuba fatalities, 59 divers were certified to dive (five of whom were taking advanced level classes), while four were undertaking their initial training. Four divers were without proper certification or supervision.

The percentage of charter boat fatalities was 30.2% in 1991 and of shore-based fatalities was 46%.

Nine persons conducting technical level dives were killed. As stated in Technical Diver, "technical diving is a discipline that utilises special equipment and methods to improve underwater safety and performance, enabling divers to extend their range beyond the established recreational envelope." These include cave dives, wreck penetrations, ice dives, and deep, extensive decompression dives.

Technical divers have invested significant amounts of time and money to safely accomplish dives. Seven of these nine fatalities did not have the proper training or experience for technical level diving.

Cave deaths

Three double fatalities in caves accounted for six of the seven cave deaths.

For example, a 30 year old female and a 32 year old male entered a cave system despite park regulations and warnings from their instructor. The male had several specialty certifications while the female was making her first dive since certification. After conditions became silty, only the third member of the team could find the way out. They did not use guide lines. When recovered, both victims were out of air.

A husband and wife buddy team died while attempting a cave dive in Missouri. The husband was reported to be an experienced diver, having "logged over 600 dives", while his wife was new to diving. Neither diver was trained in cave diving. They entered the system with no guide lines to the surface. The husband carried the main light and the wife carried the backup light. Reportedly visibility is generally about 9 to 12 m (30 to 40 ft), but recent rains and flash floods had dropped the visibility to less than 1.5 m (five ft). Although this cave system is not complicated, it took the recovery team over one day to find the bodies which were located more than 90 m (300 ft) into the system and about 3 m (10 ft) off the permanent line. The husband's inflator hose was disconnected. When tested, it caused the buoyancy compensator to continually inflate.

[Undercurrent Editor's Note: We published a story in the February 1993 issue of Undercurrent entitled The Extra Weights We Carry- The psychology of dependency." These two cases are strikingly similar to the situation described in our story, where an experienced male led an inexperienced and dependent female. Our subject was lucky to survive. These four people didn't.] See page 98-100 of this issue.

Finally, the experienced cave diver who died was trapped in a cave following a geologic disturbance that blocked the cave exit.

Environment

While accidents and fatalities are usually the result of multiple factors, in most instances, there is generally one event or condition that precipitates a sequence of events. In three of the 1991 cases, the environment was the probable starting event. All occurred at the surface, after successful completion of an uneventful dive.

Panic was the probable starting cause in one training fatality, and narcosis was the probable starting cause in an advanced training fatality.

In the narcosis case, the victim was a 22-year-old female making a deep dive for her advanced open water certification at 30 m (100 ft). She was missing at the 4.5 m (15 ft) stop and was recovered by the two dive instructors. She had 110 bar (1,600 psi) remaining and her 10 kg (22 lb) weight belt was in place. She was recompressed, but died from drowning.

Entrapment was the initial cause in one case. The victim was an experienced cave diver who was trapped in a cave following geologic disturbance which blocked the cave exit. One member of the team found the exit and survived.

Heavy Seas

In some cases, heavy seas contributed to the drowning. A male who was diving with his buddy in the tropics experienced difficulty while surface swimming to the boat. The buddy managed to reach the boat, but the victim did not and drowned. The victim surfaced, called for assistance, then submerged. When recovered, the tank contained sea water and the victim was still wearing his weight belt. Fellow divers reported the sea state was "rough as hell".

A 3l year old female receiving instruction in open water certification and surf entry had made one previous similar dive and had experienced an episode of hyperventilation in the pool. She and the instructor swam under the surf, surfaced, and switched from regulators to snorkels. A large wave caught the victim and she aspirated sea water. She was rescued with difficulty by the instructor who initiated CPR, but she still drowned.

Equipment Unfamiliarity

Equipment unfamiliarity may have precipitated the drowning death of a 30-year-old-female who had been certified about five years. She was diving from a private vessel in about 13.5 m (45 ft). She and her buddy began their ascent together. She had 41 bar (600 psi) in her tank. During the ascent, she signalled to her buddy that she needed to share air, which they did for a brief time. Her cylinder was equipped with a J-valve which the diver must operate to obtain the last 20 bar (300 psi) of air. The buddy noted that the J-valve was up and attempted to pull it down.

However, she started struggling and pushed him away, then made a breath-hold ascent. She reached the surface, then sank.

Drowning death often follows the occurrence of factors which prevent the diver from reaching or remaining at the surface. Buoyancy control not only makes diving pleasurable, but also is a self-rescue skill which should prevent drowning.

The inexperienced diver has probably not learned the technique well enough so that the responses are automatic. In a stressful situation, such as out-of-air and negative buoyancy, the diver responds inappropriately. As the BC inflation and deflation controls are operated by the left hand in most designs, the stressed diver has only a 50/50 chance that the proper control will be activated when attempting to control buoyancy in an emergency. Even experienced divers frequently make errors in pressing the proper button during routine dives.

An inexperienced diver who panics when attempting unsuccessfully to inflate a buoyancy compensator by depressing the deflate button will not make a decision to use the other button. Instead, in all likelihood, the diver will merely press the deflate button even harder. Several of the drowning deaths appeared to fit the pattern of an inability to control buoyancy even though the equipment was found to be working properly and there was sufficient air in the tank.

While doing a navigation exercise during the fourth open water check out dive, a 28 year old female unintentionally descended below the thermocline. Her buddy helped her ascend, but she started thrashing and struggling. Reportedly, she then used the deflator instead of the inflator to establish buoyancy. The buddy was unable to lend further assistance, so he surfaced and called for help. The body was located after a one hour search. The autopsy indicated the cause of death was drowning, caused by an air embolism.

Equipment Problems

Equipment difficulty may have played a role in the case of a 26 year old male who made a 39 m (130 ft) dive for a 25 minutes using “independents” (twin tanks without a manifold). He was reported to have done only a few dives with this equipment. Approximately 20 minutes after the dive began, he attempted to use his buddy’s regulator, but could not. He became unconscious at depth and was brought to the surface by fellow divers. On investigation, the equipment was in working order; however, one tank was empty and the other contained 234 bar (3,400 psi). The decedent was probably not breathing during rescue to the surface and, in effect, was ascending while breath holding.

A 46 year old male with 22 dives since certification was diving with companions on a wreck when he was discovered on the bottom with his free-flowing regulator out of his mouth. Companions attempted to inflate his BC, but the tank was apparently empty due to the free-flowing regulator. His pony bottle was full. The victim had complained about an “upset stomach” and a “tight weight belt” prior to the dive.

Failure to Drop Lead

In reviewing diver fatalities, it is amazing to find the number of divers in distress who fail to remove their weight belts. As one might expect, uncertified divers may fail to drop their weights, but even trained divers die without discarding their lead. Here are some of the cases:

A 43 year old male was making his third dive of the day and had just started the descent with his buddy after indicating “OK”. The buddy noticed his partner not descending and returned to the surface, to hear him say that he had an “emergency”. He then became unconscious. The buddy was unable to support the victim at the surface and the body sank. Rescuers found the body after a one and a half hour search. The victim wore all his weights (12 kg or 26 lb) strapped to the tank.

Another victim was a 30 year old male who had been lobster diving in an inlet and had made three long shallow dives to 6-9 m (20-30 ft) during the day. An observer witnessed him surface, call for help, then sink. The recovery team located the body 19 hours after the incident. There was no air in the tank or buoyancy compensator. He was wearing a 5.5 kg (12 lb) weight belt while clad in a bathing suit.

A 16 year old male with limited diving experience was making a 27 m (90 ft) wreck dive for an advanced level certification. After agreeing to ascend, the buddy team could not find the down line and initiated a free ascent. About 3 m (10 ft) off the bottom, the victim came to this buddy with the regulator out of his mouth. The buddy gave the victim his octopus and signalled to ascend. The victim did not respond, so the buddy ascended on his own and called for assistance. The body was located in about 5 minutes. The victim’s tank had 34 bar (500 psi) remaining and his weight belt was still on.

A 26 year old male uncertified diver had been diving with a certified buddy in a high altitude lake. He had had trouble equalising his ears on several previous dives. After descending and ascending several times, both divers were able to descend to approximately 4.5 m (15 ft). The victim signalled “OK” to his buddy who then turned away and swam a short distance. The certified buddy turned around and noticed his partner on the lake floor with his regulator out of the mouth and mask removed from the face. The victim was still wearing his 14.5 kg (32 lb) weight belt. The buddy brought the victim to the surface and called for help. The tank pressure was 138 bar (2,000 psi) when measured after the accident.

Two buddies did a shore entry to about 4.5 m (15 ft), while their friend sat on the beach and watched. The inexperienced member of the dive team left the water and lent his gear to his uncertified friend, unknown to the other buddy. The uncertified diver was observed to be in distress on the surface a short time later. The buddy who had lent the gear swam to the panicked victim and attempted to render assistance; however, the victim ditched all gear except his weight belt and sank to the ocean floor. The search team located the body in one hour. The tank was out of air. The cause of death was drowning.

A male untrained diver was using borrowed gear and collecting lobsters in the company of two certified lobster divers. He was diving alone and was observed to surface, call for help and then submerge. Witnesses went to his assistance immediately and found him out of his scuba gear on the bottom, but still wearing his 3 kg (7 lb) weight belt and one fin.

Stress and death

Some presumably healthy individuals die suddenly and unexpectedly. The victim is usually not rescued in time to allow resuscitation at a medical facility. The cause is nearly always cardiovascular disease.

The cardiovascular response to diving stems from different kinds of stress. Physical stress from exercise and cold results in increased oxygen consumption and increased work load for the cardiovascular system.

Emotional stress may result in an acute anxiety reaction causing a very rapid heart rate, elevated blood pressure and hyperventilation. These stresses may result in dysrhythmia, angina and sudden death in the presence of cardiovascular disease.

Anxiety can produce a rapid forceful heart rate of which the individual becomes acutely aware. This awareness can result in rapid breathing which, in turn, creates a reverberating circuit of increased, anxiety-associated heart rate and respiration rate. The panic or acute anxiety may cause high blood pressure and pulse rate of 170-180 per minute.

Normal breathing rate is around 15 breaths per minute. A person in panic, breathing rapidly, may achieve a rate of 35 breaths per minute. Dr Glen Egstrom at UCLA found that a diver at 18 m (60 ft), with breathing at 35 breaths per minute, will over-breathe the average regulator. The regulator simply cannot handle this exaggerated level of breathing requirement and will not provide needed air.

These stresses demand increased output from the heart and an increased blood flow. If disease is obstructing, blood flow becomes inadequate for the working heart. The result may be chest pain, lethal rhythm disturbances or heart failure.

Cardiovascular disease was a factor in half the deaths of divers older than 40. There were nine deaths immediately caused by myocardial infarction and an additional five deaths from drowning after myocardial infarction (heart attack). Four more victims had a cardiovascular disorder such as hypertension and coronary artery disease.

In the age 40 and under group, there were two deaths from drowning with cardiovascular disease as a contributing factor. Thus, at least 20 victims had cardiovascular disease severe enough to have disqualified them as divers.

A heart attack that happens to a tennis player or jogger does not place the individual in further jeopardy from the environment. However, a diver who develops a heart attack during a dive may drown. Divers with risk factors for coronary artery disease, age, smoking, hypertension and other life style characteristics, should have a careful examination to search for the disease.

A 51 year old experienced scuba diver and a member of an elite US military organization was hypertensive and a smoker. He had experienced difficulty on previous dives because of shortness of breath. He and a companion were diving in 1.6-3 m (5-10 ft) of water, where he died of cardiac arrest. The autopsy disclosed coronary atherosclerosis.

A 72 year old male diver had a history of emphysema and tobacco abuse. On entering the water, he immediately developed distress and shot to the surface. He was rescued and placed in the boat followed by CPR but died from a heart attack.

An obese 58 year old female (clearly not physically qualified for scuba diving) got into difficulties while diving in the tropics and died of a heart attack. A male with morbid obesity, hypertensive cardiovascular disease, and diabetes experienced cardiac arrest at the end of a dive.

A female who had made 150 dives had no known medical problems and had undergone a physical shortly before the dive trip. She developed difficulty on the first dive while at about 12 m (40 ft). She surfaced conscious and speaking, but developed cardiac arrest during rescue. Autopsy disclosed coronary artery disease.

A male who had know coronary artery disease with two previous heart attacks and a three vessel coronary artery bypass graft procedure was making his first dive since surgery one year before. He surfaced, called for help and then developed cardiac arrest at the end of a relatively uneventful dive. The cause of death was determined to be acute myocardial infarction.

Fainting

A syncope is a sudden loss of consciousness, i.e. fainting. The most common cause is decreased cardiac output, often caused by arrhythmias and either slow or rapid heart rate (below 35 or 150-180). Other causes may be decreased return of blood to the heart through the veins, low blood volume, and obstruction to cardiac output. Fainting in apparently healthy people is common.

The simple faint is a form of syncope due to peripheral dilation of blood vessels as a result of many different stimuli. The person who faints due to apprehension about a needle stick or minor injury is familiar to all. Anxiety, which may range from mild to the panic attack, may produce syncope by hyperventilation, which causes low CO_2 content in blood, producing cerebral vasoconstriction and causing unconsciousness.

Exercise syncope may occur in the person with obstruction to cardiac output so that normal activity is tolerated, but there is insufficient response to the demand for cardiac output from the exercise. A sudden drop in blood pressure on assuming upright position occurs in individuals taking certain blood pressure medications as well as in a few apparently normal individuals taking no medication whatever. Seizures, hypoglycaemia (low blood sugar), anaphylactic reactions, nitrogen narcosis, oxygen toxicity, excessive carbon dioxide, contaminated breathing gas, and insufficient oxygen in the breathing gas may also cause fainting.

Several drownings occurred after the diver appeared to lose consciousness. The drowning itself was the probable cause of death in most cases. The diver with an interrupted air supply may lose consciousness during reflex breath-holding prior to inhaling water.

A 52 year old male was diving on and offshore wreck at 24 m (80 ft) with one buddy. The buddy pair surface down current from the boat and were unable to reach it. The surviving buddy was picked up by another boat, which then came across the diver who had dropped his tanks and weight belt and was floating on his back with his buoyancy compensator inflated. His heart had stopped. The combination of cold water, hypothermia and mild coronary artery disease with maximum physical effort in swimming against current seem to have been the cause.

A 40 year old experienced diver was trying out new scuba gear in a shallow restaurant pond, when he died. An employee of the restaurant observed the victim swimming underwater, stand up, remove and replace his mask and then resubmerge. Later the victim was found floating face up with his head underwater. The presence of coronary artery disease, along with the exertion of using scuba gear, suggests a cardiac event as the cause of death.

A male discontinued a dive and returned to surface where he denied difficulty, but was coughing. He stated that he would rest on the surface. A short time later he was floating face down in the water and, on rescue, was in cardiac arrest. Autopsy revealed acute myocardial infarction and coronary artery disease.

Contributing factors

While a high percentage of deaths can be attributed to drowning, it is important to understand the contributing cause (Table 1).

TABLE 1

Contributing factors	**Number of divers**
Insufficient air	19
Buoyancy problem	15
Entrapment	11
Cardiovascular	8
Alcohol/drugs	5
Panic state	5
Nitrogen narcosis	4
Air embolism	3
Hypothermia	1
Obesity	1
Rapid ascent	1
Total	**73**

The majority of the drowning cases were associated with running out of air. Many inexperienced divers simply ran out of air unexpectedly, and were unable to perform self-rescue.

About half the drowning deaths occurred during ascent or on the surface after the dive. In several cases, divers died while getting into trouble swimming on the surface back to the boat. In two cases, buddies got separated on the swim and the one who dropped behind got into trouble and drowned.

A female (diving from a charter boat) surfaced with her companion 140 m (150 yards) from the boat. On the swim back, she became separated from her buddy, who was in the lead and did not realise she was in difficulty. When found on the bottom, her tank was empty and she was still wearing her 16 pound weight belt.

A 38 year old male had not made a dive since certification one year before. He surfaced with his buddy after reaching 35 bar (500 psi), but failed to keep up with his buddy on the swim to the boat. Recovered from the bottom by the dive guide, he was resuscitated, but died about 48 hours later. His cylinder was empty, his buoyancy compensator not inflated.

Booze and drugs

Alcohol and drugs contributed to at least two deaths, while several other victims were found to have either or both in their system. When one of a three member buddy team developed difficulty, the other two escorted him to the surface. Shortly after the diver in trouble was rescued, another buddy was found floating face down in water with his regulator out. An autopsy found a substantial amount of cocaine in his system.

When an individual is excited, as the dead diver was when he was taking care of his buddy, his body naturally produces catecholamine, a neurotransmitter. The synergistic effect between catecholamine and the cocaine apparently affected his heart.

A male who was attempting to recover a sunken lobster boat was drinking beer before the dive and had a history of drug and alcohol abuse. He was wearing a 18 kg (40 lb) weight belt with a wet suit. Unknown difficulty developed at the surface and he sank. There was no standby diver and the body was recovered about two hours later.

A female on a three week diving trip to a tropical area had made many dives and was taking medications for depression. Reports also slate that she “drank heavily” during her stay. She made a dive with a guide to 36 m (120 ft) and then, apparently narked, she left the guide and went to 75 m (250 ft) where she began to take off her scuba gear. The guide forced her to the surface, where she died after 15 minutes.

Entanglement can also cause drowning. A 28 year old male was salvaging lost anchors near a dam site when his buddy experienced difficulty and surfaced. The recovery team located the victim suspended in 4.5 m (15 ft) of water by a rope caught on his leg. There were cut marks on the rope and his buoyancy compensator buckle had been unlatched.

Drowned with Air Remaining

Some drowning victims had air in their cylinders.

A 31 year old female was diving in a quarry with 7°C (46°F) water, limited visibility, and an unfamiliar dive buddy. They made an unplanned ascent due to cold and lost contact with each other. The victim did not surface and was found on the bottom some time later. One fin was missing and her buoyancy compensator was not inflated. When tested, the tank had 138 bar (2,000 psi) of air remaining.

A 41 year old male was participating in an advanced class of six students. At 36 m (120 ft) the instructor stopped the dive because of decreasing visibility and the party surfaced. The victim was missing and his body was located on the bottom 90 minutes later. His cylinder contained 34 bar (500 psi) and he was still wearing his 15 kg (33 lb) weight belt. This is the case of another drowning victim, who was overweighted and failed to drop his belt.

An 18 year old male was diving with a companion in a sink hole. On their second dive, the victim indicated a desire to ascend and the buddy team started for the surface. The victim did not appear at the surface. The buddy searched for a short time and then called for assistance. The dive recovery team found him on the bottom with the regulator out of his mouth. The inflator hose for the buoyancy compensator did not match the connector on the buoyancy compensator and, therefore, could not be connected. The cylinder contained 14 bar (200 psi) when turned off.

Diving Alone

In 1991, six deaths were solo diving fatalities. In one case, a 43 year old male was diving alone from a rocky shore in an area of strong current and rough surf using rental gear. A witness observed the victim in distress. Lifeguards were about half a mile away and, by the time they could be summoned and reached the scene, the victim was floating face down in the water. He had abandoned his gear and weight belt.

A 49 year old male surfacing after spearing a fish indicated to his friend on the boat that he needed assistance, then submerged. The friend dived in without any gear and unsuccessfully attempted to pull the diver up. A diver from another boat attempted to reach the victim, but was low on air. He saw the victim stop kicking and air bubbles discontinue from the regulator. At a thermocline at 24 m (80 ft), visibility dropped from 24 m (80 ft) to 1.5 m (5 ft). The victim had allegedly been drinking rum prior to the dive.

A 32 year old male, a graduate of a commercial diving school and an active instructor, disappeared while solo diving. He planned a dive to 90 m (300 ft), using multiple tank harnesses. His body was never located.

Hit by a Boat

A 17 year old uncertified male was diving in about 9 m (30 ft) with three friends, none of whom towed a dive flag. When he surfaced he was hit by a boat and lacerated by the propeller. It may be that the victim surfaced because he could not control his buoyancy. The 160 cm (5’4"), 68 kg (10.5 stone or 150 lb) youth dived in his swim suit and was using an aluminium tank, which provided three to four pounds of positive buoyancy at the time of the accident.

Analysis of DAN’s DCS accidents

The Divers Alert Network, DAN, received reports on 708 accidents involving American divers in 1991. The cases of 437 sport divers who were diagnosed as being bent had adequate data for analysis. 288 cases occurred in the U.S. Some interesting foreign data:

Mexico	35
Bahamas	29
Caymans	20
Honduras	11
Belize	7
Turks and Caicos	7
Bonaire	4

Here are a few pertinent aspects of those cases, which we hope will provide you with tips to help you dive more safely.

Injured Diver Characteristics

The 1991 age distribution is similar to previous years. One difference is six injuries of 10-14 year old divers, which were equal to the total for the previous four years combined. While Open Water Certification limits young divers to 18 m (60 ft), two were deeper. Three of these cases were DCS I, involving pain-only symptoms, the other three were DCS II, of which one case was possibly embolism. There were no residual symptoms in any of the divers.

Approximately 27% of the injured divers were female, about the same percentage as the general diving population. Forty-five percent of the female injuries occurred in the first two years of diving, compared to 21%t of the total male injuries.

Contrary to myth, DAN data suggest that women seem neither more nor less likely than men to experience decompression illness.

Diver Health and Fitness

Divers with current medical problems may be more susceptible to DCS than healthy divers. Twenty-six percent of all injured divers had a current medical problem. Fifty four percent had at least one previous illness. Chest-lung problem, GI and abdominal problems, spine and back problems, and muscular and skeletal problems were the most common previous illnesses. Thirteen percent had suffered a previous decompression illness.

What I find curious, is that 90% of the injured divers proclaimed themselves “fit.” Having observed thousands of divers over the years, I do not find my fellow aquanauts to be unusually fit people. We are probably no better or worse than the general population. For example, it is not uncommon to have a number of people on a dive boat 14 kg (30 lb) or more overweight.

Do only the fit divers get bent? Sounds like the injured divers want to blame someone else other than themselves.

Seventy-two percent stated they exercised weekly, averaging 3.5 days a week per diver. Seems like the 28 % who don’t exercise are lucky to stay fit.

Strenuous Exercise Before, During or After a Dive

Exercise to the point of muscle fatigue may contribute to decompression illness, and should be avoided from one to six hours before and after diving. Twenty-nine percent of the injured divers admitted to performing some form of strenuous activity prior to or after their dive.

Sixty-one percent of the divers who got bent recalled that their dive itself included strenuous activity. Divers who struggle in a current or make a long and tough swim would be well advised to take extra time on a decompression stop.

Alcohol Use, Nausea, Fatigue

While the exact role alcohol consumption plays in decompression illness is unknown, it apparently contributes to decompression illness because it tends to cause dehydration. Without appropriate rehydration, repetitive post-dive drinking for several days may lessen the body’s ability to offgas nitrogen accumulated during scuba diving. Performance may be impaired for many hours after being intoxicated. Thirty-seven percent of the divers who got bent drank alcohol in the 12 hour period prior to their dive.

I have personally found that rules prohibiting the moderate intake of alcohol, a beer or a glass of wine, prior to diving more often than not represents a new form of moralism, rather than any effort to prevent bends. The DCS culprit seems to be dehydration, which is caused by any number of substances and is cured by drinking water or juices. The “one beer and you’re finished diving for the day” rule has nothing to do with preventing bends. It is a rule imposed by charter managers and boat captains who get off on exercising moral authority. Let he who drinks a beer be required to drink two glasses of water. With that the problem is solved.

Getting smashed is another matter. For the past several years, nausea and diarrhoea have been the most common acute conditions affecting the diver on the dive day. Vomiting and diarrhoea may well contribute to diver dehydration: if the diver is hung over, he is already dehydrated. Furthermore, fatigue and lack of sleep can impede optimal physical performance and lead to inappropriate decision making. One-third of the 1991 injury population began the dive-injury day fatigued or with less than an adequate amount of sleep. That, too, can be another symptom of excessive partying.

Smoking

The percentage of current smokers in scuba diving continues to fall below the national average: 52% of the U.S. population are either current or past smokers: the injured diver population has ranged between 31% and 43%t current or past smokers. Twenty-eight percent of the national population currently smoke, while only 15% of the DAN injury population were current smokers.

The percentage of arterial gas embolism is higher among current smokers than the entire population, but the percentage of contributory factors was also higher. As a result, no conclusion can be made that smokers are at a higher risk for embolism than non-smokers, based on current data.

Characteristics of dives that resulted in DCS or AGE

Arterial gas embolism (AGE) can occur in any diver who ascends too rapidly from any depth. The typical AGE incident occurs within dive table limits and or during the first dive of the first day.

There has been a resurgence of inexperienced divers suffering from AGE, 52% in 1991 compared to 34% in 1990. Only 60% claim to have made a rapid ascent, the predominant cause of AGE. Time and depth exposures are not major contributing factors: only 46% of divers went deeper than 24 m (80 ft), and 60% were within the no-decompression limit of the tables. Decompression sickness (DCS) results from the duration of exposure at a depth of 9 m (30 ft) or greater. It was associated with dives 24 m (80 ft) or greater, repetitive diving within the tables and with multi-level profiles. A rapid ascent occurred in 59% of AGE cases but only 22% of DCS cases.

DCS I includes all cases of pain-only bends occurring in the extremities and also includes skin bends. DCS II is more serious, and includes all cases with neurological or cardiopulmonary symptoms except those diagnosed as air embolism. The percentage of DCS II appears to be rising annually.

The most common initial DCS symptom was pain, but up to six symptoms were reported by individuals. Numbness and pain appeared in more than 50%, corroborating the neurological nature of most decompression illness. Two symptoms reflect the serious nature of progressive neurological DCS: 13.5% had difficulty walking at some time after their dive, and six percent suffered paralysis.

Nearly 19% of those injured continued diving after the first symptoms of decompression illness. This is presumably due either to a lack of knowledge or an unwillingness to admit the possibility of decompression illness. About 2.5% had suffered a previous episode of decompression illness. The second bends hit tends to be more severe than the first.

Decompression illness in computer and table divers

Compared to table users, computer users can stay down longer, and make earlier repetitive and deeper dives. When making multi-level dives, computer users can go deeper during their repetitive dives.

The use of computers supposedly enables divers make repetitive dives more safely. However, while using computers, more than 80% of the divers suffering decompression illness in 1991 made multi-level, repetitive dives deeper than 24 m (80 ft). Other factors such as multi-day diving and fatigue appear less important.

The number of divers who suffered pain-only bends (DCS I) was approximately equal in both computer and table users as was neurological or more serious bends (DCS II). DCS II was much more common than DCS I in both computer and table divers. Slightly less than half the divers with decompression illness used computers in 1991.

Approximately 25% of computer divers thought that they were within the tables. However, only 15% reckoned they were diving outside the standard decompression table limits. Staged decompression has decreased in computer users, presumably as the computer indicates there is no need for decompression at the end of the dive schedule.

Arterial gas embolism was two to three times greater in frequency in table users than computer users. It may be that computer users are more experienced divers, who have been diving both more often and longer than table users.

This may indicate that table users were more likely to miscalculate time and run out of air.

Equipment Problems

Fifteen percent of the 1991 cases involved equipment problems, which not only includes failure or malfunction. but also includes unfamiliarity with the equipment. Problems mainly occurred with the regulator, dive computer or buoyancy control. Other problems included gauge or timer problems, an improper wet suit fit, a mask leak, a tank not turned on, and three cases where someone else's actions or equipment reportedly led to an injury.

First Contact for Assistance

Approximately half the injured divers called for assistance within 12 hours of the onset of their first symptom. Some divers delay seeking medical evaluation because they may not feel their symptoms are serious enough. Others may not recognise their symptoms as being related to decompression illness. Pain can easily be mistaken for the aches and pains associated with exertion. A remote dive site may limit access to medical evaluation. Delays in treatment may decrease the possibility of immediate and complete resolution of symptoms. Thirty six percent of all injured divers received no first aid.

Post Hyperbaric Treatment Residuals

After completion of hyperbaric therapy, 48% of the treated divers still had residual symptoms. Twenty four percent had a neurological residual and 24% had residual pain. At the three month follow up, 17% of injured divers still had some symptom of injury.

Decompression illness often leads to permanent injury. Hyperbaric therapy provided complete resolution of symptoms in a little over half of all cases. This percentage might be improved if more divers sought earlier treatment.

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MORE DIVES, MORE TROUBLE

Tim Parish

The 1994 diving season saw British divers basking in a relatively long hot summer, which undoubtedly contributed to the increase in the number of annual man-dives carried out to 2.5 million, compared with 1.75 million in 1993. This in turn has helped lead to an increase in reported incidents in 1994 over previous years, 149 in 1992 and 263 in 1993, with a total of 385 incidents logged into the BS-AC database for the 1994 statistical year (October 1993 to September 1994). Twelve divers died.

The elevated figures for 1994 should not, however, be interpreted simply as an indication that more incidents took place. As in 1993, a significant factor was a further increase in both the sources and the accuracy of the data to which the BS-AC has access. To give an idea of the current breadth of our database, last year we received 164 Incident Report Forms from BS-AC members, 192 incident reports from the Coastguard Agency, and 106 from the British Hyperbaric Association (BHA), whose data is supplied to us by The Institute of Naval Medicine. This was added to by 33 newspaper reports, 54 reports from the RNLI, and 40 directly from the Diving Diseases Research Centre. While we can never guarantee to collect information on 100 per cent of serious incidents, we are now probably as close to that goal as we can practically be.

The monthly pattern of incident occurrence changed in 1994. The usual peak seen around the Easter public holidays was significantly reduced, particularly for decompression incidents. This was undoubtedly due to the storms that raged around the country over the Easter holidays. However, it apparently did not stop one set of hairy chests going out to sea. They had to be rescued when their engine failed in a Force 10 gale!

TABLE 1

INCIDENTS BY MONTH

October 1993	14
November 1993	9
December 1993	8
January 1994	9
February 1994	15
March 1994	14
April 1994	39
May 1994	48
June 1994	62
July 1994	70
August 1994	43
September 1994	31

The 1994 figures show 12 fatalities (in 11 incidents), 6 of which involved BS-AC members. Most of these incidents were avoidable and occurred due to divers not following the BS-AC's recommendations regarding safe diving practices, not carrying out adequate dive planning, or diving solo. Particularly disturbing is an incident (reported in Diver Magazine in November) in which a Novice Diver drowned in a cave at Hodge Close, after running out of air. The pair of divers had planned to "poke their heads" in the entrance to the cave, but changed their plan during the dive, making a deeper penetration of the cave system. A dive with no clear surface available is a risky undertaking at the best of times, and is certainly not the type of dive on which to take an inexperienced diver.

The Novice Diver concerned was, as it happened, fairly experienced: but it still has to be said that the dive plan involved taking a Novice deeper than the recommended depth limit and did not include penetrating the cave to the depth that occurred.

A further fatality happened when two experienced divers were diving on the wreck of a submarine off the north-east coast of England. On reaching the wreck, one of the divers decided to abort the dive; the other decided to continue the dive on his own. The diver who aborted the dive reached the surface safely. The second diver was later found trapped in line quite close to the shot. Alone and unable to free himself, he had drowned after running out of air. The moral is strikingly clear and does not need to be repeated here.

There were 149 reported incidents of decompression illness (DCI) in 1994. Depth continues to be a major factor in cases of decompression illness, yet the trend towards deeper diving continues unabated. Decompression incidents which occur *within* the BS-AC's recommended depth limits continue to hover around the 40 per cent mark, despite better tables and the number of people using dive computers.

TABLE 2

FACTORS INVOLVED IN DECOMPRESSION INCIDENTS

Factors	%
Within limits	38
Rapid ascents	26
Deep diving	24
Repeat dives	5
Missed decompression stops	5
Misuse of tables	3

(Figures taken from the pie chart in Diver)

TABLE 3

INCIDENTS OCURRING DEEPER THAN RECOMMENDED DEPTHS

Diver status	Within limits	Outside limits
Novice divers (limit 20 m)	36%	64%
Sports divers (limit 35 m)	63%	37%

The seasonal pattern of decompression incidents, which has its peak in the months of July and August, may point to multiple dives (during the annual diving holiday) being a more significant factor than is indicated by the divers themselves in the incident reports. We do not receive much detail regarding many of these incidents, particularly during the summer, so it is difficult to be more definite. I will be endeavouring to run a deeper analysis of the factors involved in DCI incidents over the next 12 months.

One of the good things that the DCI reports have highlighted has been the effects of oxygen administration training, pioneered in sport diving by the BS-AC. With many BS-AC divers now trained to administer oxygen as a first aid measure, it is not surprising that a significant number of divers suffering symptoms of DCI have been given 100% oxygen as soon as symptoms have been noted. Of these, a large number have been totally free of symptoms by the time they have reached a recompression chamber. The importance of carrying oxygen, and being trained to use it, cannot be over-emphasised.

The 1994 diving year has also seen a number of divers suffering decompression illness despite breathing nitrox and/or using oxygen as a decompression gas. T he year has also seen a female trimix diver suffering serious neurological DCI, the symptoms of which were not completely resolved. Despite the incomplete resolution of symptoms, the diver in question apparently continued to carry out deep dives, diving to 93m just weeks after the initial incident.

Diving too deep also appears to be a factor in incidents involving Novice and Sports Divers; a considerable proportion of which occur at depths far beyond those recommended for the relevant grades. More than 60 per cent of incidents involving Novice Divers in 1994 occurred at depths greater than the recommended 20m limit, including one at 56m. Over 30 per cent of incidents involving Sports Divers occurred deeper than the recommended 35m limit. These figures are too significant to ignore. Diving officers and instructors please take note!

There were 112 surface and boating incidents involving divers in 1994. Of these, 51 were searches for missing divers, a dramatic and unwelcome increase over the 37 reported in 1993. Each of these incidents usually results in RNLI and SAR helicopter launches to carry out thorough searches. It is therefore annoying to discover that more than a few of these call-outs were false alarms following separation underwater, resulting in one diver surfacing and the other continuing his or her dive alone, totally against any training, advice or plain common sense. The BS-AC, with assistance from the Coastguard Agency, will be addressing the issue of lost divers in 1995, with the aim of reducing the number of occurrences considerably. Any advice and information resulting from this initiative will be published as quickly as possible.

TABLE 4

CAUSES OF SURFACE INCIDENTS IN 1993 AND 1994

Cause	1993	1994
Lost divers	37	51
Engine failure	19	45
Capsize/sinking	4	3
Other	13	18

Another boating statistic of note is the number of engine failures which have occurred to divers' outboard engines, 45 occurrences requiring Coastguard assistance in 1994. Divers must make more effort to ensure that their dive boats are at least as well maintained as their diving equipment. Engines should always be serviced according to the manufacturer's recommendations and, after the engine is serviced, it should be tested before it is used for a long sea passage. An article on this very subject was published in the last issue of Diver Magazine. Make sure that you follow its advice to maintain your engine's reliability.

One incident which particularly stood out in 1994 involved the three divers who were flung from their 5 m RIB while returning from a dive in Lyme Bay. Their "misadventure" was reported in the press over several days, with local papers printing fanciful stories about the event for weeks afterwards. The fact that the divers in question had not followed standard procedure and notified the Coastguard of their passage details and dive site meant that they were not missed until their wives raised the alarm. This was not done until late evening, by which time the divers had already been in the water for some 8 hours. It was also too dark at that time to mount a realistic search. Do remember to notify somebody of your intentions, preferably the Coastguard. Then, if the unthinkable happens to you, the emergency services have a decent chance of helping you to safety.

Most of the incidents published in the 1994 BS-AC Incident Report have a moral. Please make sure that you get a copy of the full report, which is available free of charge from BS-AC Headquarters. Read the incident narratives and then think carefully. Could that incident happen in your club next season? How are *you* going to make sure that it does not?

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The offices of the British Sub-Aqua Club are at Telford's Quay, Ellesmere Port, South Wirral, Cheshire L65 4FY, United Kingdom.

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THE BS-AC REPORTING SCHEME AND ITS SOURCES

The British Sub-Aqua Club's Incident Reporting Scheme has been in operation for more than twenty years. Details of incidents are received directly from those involved, from recompression chamber operators, the Coastguard, and via a commercial press cuttings service to which the Club subscribes. Each Incident Report is analysed, coded and held on a computer database to allow for subsequent statistical analysis and the production of the annual Diving Incidents Report.

Each year this report is published and presented at the Diving Officers' Conference in November/December. Copies are supplied to all Conference delegates and to all

TABLE 1

SOURCES SUPPLYING INFORMATION

Coastguard	192
BS-AC reports	164
British Hyperbaric Assocation and Institute of Naval Medicine	106
Royal National Lifeboat Institution	54
Diving Diseases Research Centre	40
Newspaper	33
Total reports	**589**
Total incidents	**385**

BSAC branches. Additional copies may be obtained free of charge from HQ.

The scheme covers all sports diving incidents in the UK and those involving BSAC members overseas. An incident is considered to be any event involving divers or diving equipment, in or out of the water, where the diver is killed, injured or subjected to a greater-than-normal level of risk.

All information received is treated confidentially and the names of those involved are never made public, except where an act of rescue or lifesaving merits recognition.

Immediate notification of an incident, submitting brief details, should be made on a Preliminary Incident Report Card. Physical injuries, or damage to property, should be reported to HQ at the earliest opportunity. Further details of the incident should then be supplied on an Incident Report Form, a copy of which is sent to all those who submit Preliminary Incident Report Cards.

Forms and cards are available from BSAC HQ, and should be returned there on completion.

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THE EXTRA WEIGHTS WE CARRY

The psychology of dependency

Freelance writer Annette Cheatham recently submitted a piece illustrating the serious problems of a buddy-dependent diver. It begged, however, for outside commentary, so we asked her whether she would discuss the situation with a long time diving buddy, who happens to be a psychologist, and permit him to comment on the relationships she described. She agreed, so here is her story, followed by a commentary by Dr Michael H. Smith.

As a newly certified diver with eight dives under my belt (the deepest to 51 ft or 15 m), I felt confident and adventurous. Ready for a *real* dive, I was game for anything. Gathering my husband, kids, gear, and lunch, I set out for Blue Grotto in Williston, Florida.

Upon our arrival, we checked into the office and paid for the privilege of diving. Their introductory speech described our site as 110 ft (33 m) of 72°F (22°C), crystal clear water with 110 ft (33 m) visibility. The lecture proved to be a mixture of information and scare tactics, describing the four levels of descent and the skill necessary to go to each depth.

We all nodded in agreement and signed the liability waiver. As we geared up, I was unimpressed by the small, pond like opening complete with ducks. Where was the danger our host had warned us about? This pool looked about as dangerous as my bath tub.

After planning our dive and setting my Sherwood Source computer, three of us hit the water. Descending to the first level, a wooden platform at 15 ft (4.5 m), we gathered our bearings to continue to the second level at 60 ft (18 m). At that depth, my comfort level was under more pressure than my ears and I was ready to ascend. Being the brave men that they are, my husband and son pointed down and gave me the old "come on" wave. I decided to hang at 60 ft (18 m) and watch some students do their check out dives while the guys continued down to investigate. Ten minutes later, they returned and we headed to the surface.

During our 90 minute surface interval, I was subjected to the jokes of the guys calling me a wimp and sissy. Not being timid, I agreed to venture the full depth with them on our second dive and ignored the little voice in my head saying "Check your dive plan".

Hitting the water for our second dive, we descended slowly to the third level at 80 ft (24 m). I paused on a limestone-shaped peace sign, and felt the icy fingers of fear crawl down my neck. I had to consciously think: calm, quiet, breathe slowly. The guys pointed down into a narrow crevice that disappeared into the darkness of the fourth level, the cavern. Having second thoughts, I paused to regulate my breathing and clear my mind. As I looked into my son's eyes, I let pride rule, grabbed the guideline, and followed him down.

The descent was slow. With every foot, the darkness became a blacker shade of black. When we reached the bottom, my console grazed my hand, nudging me to check it. A small red beacon of warning blinked from my computer. We were at a whopping 110 ft (33 m). As if dropping the console would erase the readings, I let it go like a hot iron. Looking around, I found myself in a narrow horseshoe shaped passage that was totally enclosed by limestone. The only light was artificial. I thanked God for the almighty dive light and promised to buy stock in Eveready if I ever saw the light of day.

My heart beat became a staccato beat of fear, my mind played games, and my breathing raced to keep pace with my body and mind. I was no longer in open water, an emergency ascent was impossible. Anxiety now turned to mild panic. My rapid, shallow breathing gave new meaning to the term “hoser”. When I thought it couldn’t get any worse, my son took the light out of my hand to explore an opening that branched out about five feet from the guideline. My light gone, my son out of sight and no clear path to the top. Panic became sheer terror. Forgetting that my husband was behind me, I began to flail my free hand, not letting go of the guideline, and smacked my husband’s regulator out of his mouth.

My husband cleared his head, replaced his regulator and grabbed me with both hands. My son came back to the line and I focused on the guys and my breathing. We were finally ready to begin the ascent, eager to see the light. We found our way into open water and made three minute safety stops at both 30 ft (9 m) and 15 ft (4.5 m).

Climbing out of the water, I unhooked the clips on my BC. But, I felt a sudden rush of dizziness, like I had been smacked in the head with a bat. I dropped down on my knees and dropped my gear. I was disoriented and weak. Blood started to trickle from my nose as I lay on the deck like a dead fish.

After five minutes, I made my way to the table where our gear was, wondering why the guys hadn’t helped me. They too, had experienced the dizziness and bloody noses. I checked my computer. The flashing red light told me that the second dive had been to 110 ft (33 m) for 22 minutes. Not only had I broken a single dive limit, I had made a 60 ft (18 m) 35 minute dive before that.

For the next three days, the three of us suffered frequent nose bleeds, horrible headaches, dizziness and stiff joints. We denied that we had a problem, and did not seek medical help. Finally, I called a dive buddy who is a registered nurse and cried on her shoulder. After talking to a doctor friend of hers who specialises in dive medicine and accidents, my buddy informed me that we had been mildly “bent” and that everything would be all right in a few days. She said to consider ourselves lucky that our stupidity hadn’t killed us.

The Blue Grotto experience cost me three days off work due to illness, as well as the loss of confidence in my diving abilities. I did not follow my dive plan. I had failed to check my gauges. I had not taken responsibility for myself, and had panicked.

Diving after my bout with the bends was a frightening ordeal of constantly monitoring my computer in shallow depths. Not very enjoyable but necessary to restore my nerve. After numerous “safe” dives with family and friends, I am once again enjoying the wonders that the sport has to offer. Following dive plans, checking gauges and saying no to anything that makes me uncomfortable has allowed me to continue to dive and live.

Commentary by Dr Michael H. Smith.

Diver error is the most common cause of diver deaths. Diver does something stupid, diver dies (in this case almost dies). Yet because Ms Cheatham survived we can ascertain what really happened. As we peel away the story’s layers, we can become more aware of the unseen psychological weights she carried, perhaps many of us carry. Weights that can kill.

Layer 1 The Basic Skills

For experienced divers, and even those not so experienced, there are some glaring errors: a novice diver doing a cave dive: no cave diving training: second dive deeper than the first: vague dive plan: lack of buddy agreement.

Any of these mistakes by itself can kill. The author told me that her training was excellent and she trusted her instructor. Except for cave diving, Ms Cheatham believes that her errors had been covered in her certification training. So, let us proceed to other layers for the real causes.

Layer 2 The Weight of the Couple

Pairing up with someone else is fraught with inherent difficulties. As in any attempt at teamwork, good buddy diving requires training, practice, and a compatible meshing of personal styles, factors not often discussed in training.

Since we now accept that buddy breathing is passe and that self survival is critical, a case can be made for relying very little on your buddy.

Diving with a spouse compounds the complexities. The buddies bring their marital relationship and its full ramifications to the dive. In this case, we have a self admitted, husband-dependent woman who, she told me, was told to “learn to dive or be left alone”. Her husband was the experienced diver and he would lead the team.

This volatile mix of demands with authority is a recipe for disaster. Serious inexperience coupled with fear of assertion (or fear of abandonment) seems to have prevented Ms Cheatham from exercising independent good judgment.

Layer 3 The Weight of Family

This story is further compounded by a mother diving with her child. Concern for a child's safety is a deepseated parental instinct. Research has shown, however, that most parents will only risk their lives to save children if there is a real chance of success. This case falls within this framework: there was enough of a threat yet not a suicidal mission.

Another issue is the parent's age and the relationship between all family members. The child was 15 and the parent 31. Ms Cheatham told me that she felt competitive with her son, and that "if he could do it, I could too." Research shows that parents who have children in their 20's or younger have much greater difficulty separating their own identity from their child's.

This competitiveness was exacerbated by the teasing from the son and stepfather pairing together and calling the author "a wimp." The teenage son bonded with the stepfather and stripped the mother of authority and self confidence over herself and her child. Independent good judgment was again impaired.

Layer 4 The Weight of Personal History

Ms Cheatham told me that: "My father threw me in a pool when I was six and told me to swim. I almost drowned and was rescued by a lifeguard. That was one of the nicer things he ever did for me. My father was arrested." Such a parental relationship can foster deep seated insecurity and dependency, preventing a true independent self from emerging. In addition, the drowning trauma, untreated, raises the possibility of Post Traumatic Stress Disorder symptoms that may explain the fear and panic on the dive.

Conclusion

Each of us brings our own psychological weights to every dive. What we can learn from this case is that diving is much more than a technical equipment-based sport. It is equally social and psycho-historical. Every diver needs to understand what brings him or her to the water and how to manage the unseen weights that we all carry.

Annette Cheatham is a professional writer who moved recently from Florida to Colorado Springs, Colorado, U.S.A.

Dr. Michael H. Smith is a business consultant and organisational psychologist in Oakland, California, U.S.A.. He has written previously for UNDERCURRENT.

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HUMAN GUINEA PIGS:
What our readers tell us about their computers

In 1988 and again in 1992, we offered a questionnaire to our readers, asking about their experience with computers. Based on the results of our latest survey, computers have indeed come of age.

In 1988, a number of computer users behaved as if the computers were Godlike in their ability to forecast safe dive profiles. They believed that if their computer said they were diving safely, they were. Unfortunately, many who went to the limits paid with a bends hit. Several of those divers shared their experiences in these pages.

Getting Bent

A San Diego diver got bent using a Suunto that "was in its error mode, so it wasn't functioning as a computer." He reported that he "usually took it to its limits" and had another incident, using a Beauchat and a Skinny Dipper, which "shut off during the first of two dives." He followed a 20 minute dive to 76 m (253 ft) (+40 minutes decompression) with a non-decompression dive (48 m (160 ft) for 8 minutes then 24 m (80 ft) for 20 minutes) three hours later. "One hour after surfacing, I had decompression sickness, blockage of artery supplying nerves to the inner ear."

A Delaware diver reported skin bends "after doing a second decompression bounce dive following the first decompression dive, back to back, with no surface interval." And a Colorado diver who got bent admitted: "My fault. I wanted to take the computer to its limit."

A Honolulu woman said that "it appears that my physiology is such that by running my diving close to the extreme margin of Edge safe diving, I subject myself to more of a chance of becoming bent than by using the Navy tables. Bent once in Palau using the Edge, I discovered when I stopped using it my almost permanent back pain while repetitive diving went away."

One reader said that "in the Maldives in 1985, my Edge suddenly went black after two dives to the 12-18 m (40-60 ft) level. The divemaster prescribed a 36 m (120 ft) afternoon dive which I didn't want to miss so I went without the Edge. No problem. But, I then went on a "shallow" evening dive and one hour later I developed a constricted visual field in my left eye. It lasted one hour, I think I had transient decompression sickness, which was mostly my fault as I overdid it that day."

A woman from Pennsylvania reported that her Edge said she had "hours" when she surfaced. "I got two hits in the spine and experienced temporary paralysis."

While we can indeed fault divers who push their computer, these are also examples of what happens in an unregulated industry. Even today, decompression theory is still theory, without sufficient empirical data from human subjects to make it axiomatic.

So computers were introduced without human tests, and with little understanding about the decompression sickness possibilities of multi-level diving, multi-day diving, or missed safety stops. Independent scientific studies had not been conducted and independent bodies had not contemplated the effect of computer diving. So, divers got bent.

While the best of free market competition can today be found in the number of good computers that are on the market, in the 1980's the free market offered no regulation of these devices so critical to the health and safety of divers. Everyone who dived on a computer, in fact everyone who still dives on a computer, was a human guinea pig.

Thankfully, today we know more about diving computer profiles and the human body. The result is that we dive safer. Today, it seems that fewer divers test the limits of their computers. While we can only surmise that more and more divers are using computer, the number of bends cases reported to DAN between 1990 and 1991 decreased slightly. Among our readers (who we presume are wiser and better educated than ordinary divers), only one got bent.

Joseph Trujillo of Alta Loma, California, was diving at Catalina Island on the wreck of MV Valiant. "On the first dive, I went to 30 m (98 ft) for about 15 minutes videotaping the wreck. I then worked up to 21 m (70 ft) where I stayed for about 21 minutes. I made a one minute stop at 9 m (30 ft), a three minute stop at 6 m (20 ft), a five minute stop at 3 m (10 ft) and then came to the surface. I had a one hour and fifty-five minute surface interval. Then, I made a square dive to 28 m (94 ft) for 37 minutes. At no time did the computer indicate any decompression problem or ceiling. When I got to the surface I knew something was wrong and I was put on oxygen. All the symptoms went away. I elected not to go to the chamber which was near the harbour. The next morning, I knew I was in trouble and went to the hospital. I didn't send the computer to the company to be checked out because I didn't think it was in business any longer."

Orca's Paul Heinmiller told us that "the first dive fits into Orca's profile. He was not into decompression. However, the computer should not have allowed the second dive without indicating that decompression was needed and providing a ceiling. We have not seen the computer so we can't say what went wrong."

While the industry is now marketing more conservative computers, there is really only one significant change from the early models, the addition of electronic air pressure gauges to some computers, permitting them to be attached to the high pressure hose. The use of these computers is not widespread. Many divers do not like storing all critical information in one device. Should it fail, then one has no information, no depth indicator, no dive duration, no air indicator. Deciding what path to take to the surface is then a little more complicated. Thankfully, the current models, the Phoenix, Computek and Oceanic, seem to behave properly (although the Delphi had its problems).

Delphi/Phoenix

The Orca Delphi, an integrated dive computer and pressure gauge that attached to the high pressure hose, was introduced in 1989. But a bug in the software soon led to a recall. The Delphi lost its market, Orca got into financial difficulty, and production was stopped after 15,000 units were made.

In January, 1991, Orca Industries became a subsidiary of EIT Inc. EIT assumed no legal or financial responsibility for the old Delphi, but offered owners the opportunity to obtain their new and similar Phoenix for $250. Introduced in June 1992, the Phoenix is based upon the software program developed for the Delphi, but with major changes to accommodate newer technology. The Nitrox Phoenix will be introduced shortly.

Owners responding to our survey reported that the Phoenix provides more dive time compared to other computers, has an easy to read display with depth recording deeper than 39 m (130 ft), and offers the ability to decompress with it.

Elizabeth Collins of Winchester, Maryland, wrote, "I like the tissue group scrolling. Often I extend my hang time to bring a tissue group away from 100% saturation. I also like knowing how much time I have at a given depth based on my air consumption. I also like the 90 m (300 ft) depth limit."

Greg Battaglia of Reno, Nevada, told of a curious problem: "The Phoenix seemed to be working OK, and the battery usage was much improved over the Delphi, until I made a trip to Cayman Brac. Midway through a week of diving, I could not get the Phoenix to initialise. I checked battery voltage and connections, and all was well. Since returning home, I have made several dives with it, and it seems to be working OK."

Computek

Introduced in 1990 by Tekna (now Ocean Edge), Computek is an air integrated computer using the Swiss model with a Hann-Tekna algorithm, one of the more conservative.

Users like the decompression computer features, the visual depiction of remaining air, the back lighting for night diving and its overall ease of reading.

Generally, the users seemed satisfied with their Computek.

As Dave Meents of North Ogden, Utah, told us, "It is so easy to read. Battery is user replaceable and an easy battery to find. Everyone who has seen my computer loves the display."

Jim Marshall (Chicago) wrote, "It shuts down if you miss one second of a decompression on a dive. It is very conservative." He also found that the high pressure hose leaked at the first stage connection and the face plate developed bubbles in it. He returned it to the factory and the service was "excellent, repaired perfectly, and was free. It only took a few weeks."

Oceanic

Oceanic's DataMaster II (discontinued), the Oceanic DataMax Pro, and the DataMaster Sport are air integrated computers. The U.S. Divers Data Scan 3 is basically the DataMaster Sport.

Of her DataMax Pro, Carol Kender of Dublin, Ohio, said, "I like the display design, programming, recall feature, audio alarms and air pressure integration." Chuck Tribolet of Morgan Hill, California, told us, "It and its little brother DataMax Sport are the only ones I could figure out without the manual.:"

There were complaints about losing the memory when the battery is changed, and another diver complained about the sensitivity of the ascent rate alarm: "I've had it sound off and go into red because a big wave went over."

Of the DataMaster II, Jerry Ram of Atlanta, Georgia, likes the integrated air pressure gauge, all one unit, but wasn't keen on having to have the batteries replaced only by the factory, and could use a time to fly indicator.

There have been some problems. Sharon Swope of Waynesville, Pennsylvania, said, "My p.s.i. reading malfunctioned, increasing during a dive stabilising at 4,000 p.s.i. then only decreasing very slowly over a period of hours after removal from the air tank." Harold Carson of Berkeley, California told us, "It just quit operating on the fourth dive of the day." And Gary Wise of Brookings, Oregon, wrote, "The decompression indicator on two separate occasions, in fresh water at approximately 45 feet, indicated that I was within five minutes of decompression limit. I had only been in the water a total of 35 minutes."

Conclusion

Those divers who like integrated air pressure gauges with their computer are generally satisfied with all the devices on the market. Pick the one you prefer.

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GETTING IN THE LOOP

A report on aquaCorps' rebreather Forum

Michael Menduno

Like the "Enriched Air Nitrox Workshop" it hosted three years ago, aquaCorps' Rebreather Forum, held from 22/5/94 to 24/5/94, drew industry aficionados from around the diving world including; Canada, China, Germany, Sweden, the UK, and the US, to clear up the many myths associated with rebreather technology and discuss where it will go from here. The difference was there wasn't much controversy. Attendees were interested in getting into the loop.

Over 90 industry participants representing the spectrum of end user communities were in attendance including; nine rebreather manufacturers, a host of training agencies including; BSAC, IANTD, IADRS, PADI and the German Federation of Sport Divers (VDST), government agencies from NOAA and NMRI to EDU, the US Army Special Forces and the UK's HSE, commercial representatives, scientific organisations, the UHMS, and special guests; US Navy physiology guru, Dr Ed Thalmann, Alan Krasberg, one of the godfather's of closed circuit systems, and forum co-chair and circuit guru in his own right, Tracy Robinette of Divematics, “I have been involved in rebreathers for nearly twenty five years and a meeting like this has simply never happened before.” Beamed technical dive store owner, Dennis Pierce, Epic Divers, “The level of collective (diving) consciousness in the room was almost over whelming.”

First conceived of in the 17th century, rebreathers have a fifty year history of successful use by the militaries of the world and are a fundamental component in commercial gas .diving reclaim systems. Now with declining military budgets, inexpensive computer chips and a burgeoning non-military diving community ready to take the plunge, many people believe that rebreathers represent the wave of the future. For good reason. With a virtually unlimited gas supply, read SAFETY, optimal decompression, low bulk and bubble-free silence, closed circuit technology is an idea whose time has surely come. Observed Krasberg, “Rebreathers seem to come back every thirty years and now it looks like they will remain with us for some time.”

The forum kicked off with a “No bubbles, no troubles” tour of the US Army’s Combat Swimmer School where participants were ushered into a room full of rebreathers, racked, stacked, and ready to rock ‘n’ roll. An appropriate starting point; the school has been training closed circuit divers continuously for over 27 years. From there, the forum got down to business; dissecting the knotty issues surrounding rebreather technology; technical requirements, closed vs. semiclosed systems, market economics, training and liability concerns.

Similar to the early days of nitrox, established rebreather manufacturers, whose revenues are derived solely from military coffers, approached the forum cautiously, though those in attendance were seen frantically scribbling notes throughout the “dollars and sense” session on new market applications and economics, conducted by forum co-chair, Michael Menduno. Who wants rebreathers? A lot of divers; public safety officers, scientists, photographers, videographers, harvesters, specialised commercial users and of course, technical divers. And most of these users appear to have the money to pay, “My clients think nothing of spending US$ 5,000-10,000 for camera equipment,” said photographer and wildfire guide, Amos Nachoum. “I don’t think rebreathers are any different.”

Confessed, John Sherwood, one of the principals of Fullerton-Sherwood, which builds the CUMA system for the Canadian Forces, “I was the cynic in our company. But it seems clear to me now there is a real emerging market that we had better address.” The message from users? Do it now. As always-to-the-point wildlife photographer, Marty Snyderman chided “The world is waving them (rebreathers) in front of me, but they won’t let me have one.” (This while threatening the stony-faced panel of manufacturers, pen drawn, with a raised cheque book in hand.) And that is the problem.

At the luncheon sponsored by legal defence farm, Hruska & Lesser, Dr Thalmann gave a refreshing and enlightening discourse on diving physiology. The bottom line? There is still a whole lot of diving physiology we just do not understand. Case in point; CNS oxygen toxicity. According to Thalmann, “Convulsions appear to be a random event at $P0_2$s above 1.3-1.4 atm.”, *this in an era of computerised oxygen toxicity tracking !* What kind of algorithm did you say you were running?

Training ? Forum participants learned they would to be lucky to survive the week with combat swimmer staff instructors, Sgt. Dennis Wardlow and Rob Gardener, as they presented the gruelling details of their six week training course. A weekend rebreather certification ? How about somewhere in between ? Of course, the real problem with training was right there under our nose; or not as the case was. “It’s hard to talk seriously about rebreather training, when none of us can even buy one.” Wings Stocks, technical operator and instructor, made the point; a good one. Though it apparently has not dissuaded some companies from thinking through the loop; offered PADI’s Karl Shreeves, ‘When rebreather technology is ready for the mainstream, PADI will be there to offer training.”

Throughout the forum, the hazards and potential liability problems associated with rebreather diving were discussed at length, and included a closed circuit fatality report from Dr Bill Stone’s Huatla Expedition, and a perspective from a different kind of diver, Bill Booth, the inventor of the single point release parachute and avid skydiver. Overall, the results of the liability session were better than expected. According to diving plaintiff attorney, Bobby Delise of Vosbein, Delise, Amedee, Bertrand, “As long as manufacturers and distributors give the end user a full disclosure relative to a rebreathers specifications, limitations, risks and most importantly, the requisite training and maintenance demands, product liability should not present formidable barriers.” Divemaster Insurance Consultants of London apparently agrees; the company sent a solicitation flyer to be distributed at the forum.

After three gruelling days of discussion, attendees finally had the opportunity to actually dive a rebreather, courtesy of Carleton Technologies and Capt. Billy Dean’s Key West Diver. “It’s like going back to the womb of the mother.” said Amos Nachoum, ‘Very natural, very pleasurable.” Others were equally enthralled. “Rebreathers are the way of the future. There is no doubt in my mind” asserted Graeme Lawrie of the United Kingdom’s Health and Safety Executive. Almost everyone seemed to agree.

The conclusions ? The consensus at the forum seemed to be that semi-closed rebreathers will likely re present the first wave of product due to their relative simplicity and relatively low cost. Even so it will be a while before the technology is generally available on a broad scale. Several rebreather start-ups reportedly plan to offer systems within the year; Cis-Lunar Labs, Prism Life Support Systems and Oceanic. Expect to see them offered at the 95tek. Conference where hands-on training will be available. Training will be an important component of purchase, and a typical training course is likely to run about 40-60 hours.

Finally, forum participants expressed the desire to form an association for advanced diving technologies, code named, "Deja Vu". After all, there is more to come. Confessed, Bishop Museum's Richard Pyle, "I always believed that open circuit was just a stop gap until I got my rebreather. However, on the way to the forum I spent a weekend with Phil Nuytten (inventor of the Newtsuit). Now I am wondering whether rebreathers aren't just another stop gap along the way." Something to think about.

For more information about the forum or the association to be formed, contact

aquaCorps Journal, PO Box 4243, Key West, Florida 33041, USA.
Telephone 1-305-294-3540. Fax 1-305-293-0729.

aquaCorps will announce when a transcript of the Rebreather Forum is available for sale.

THE ENDLESS DEATHS IN COZUMEL
IS THIS AN ANSWER TO THE MYSTERY ?

UNDERCURRENT Editor's introduction

In February, two divers disappeared into the deep in Cozumel. We wrote about that incident in May and, in the last issue, reported another death in Cozumel. Cozumel has the highest death rate in the Caribbean. Why? Subscriber Eric Glanz of Steamboat Springs, Colorado, wrote to tell us about his unusual experience on Santa Rosa Wall in Cozumel. Those who visit there should give heed.

*****

I have been diving for five years, having fewer than 200 dives. My dive companion is a new diver, with only 10 dives prior to our mid-April trip to Cozumel. We stayed at the Club Cozumel Caribe and the dives were quite crowded. Due to the large crowd, many times we were unable to get on the morning dives and instead went out in the afternoon. We always dived well within our tables, even though I also had my computer as a back-up.

One afternoon, the trip was planned to Palancar Gardens but because our boat travelled so slowly the divemaster suggested we stop at Santa Rosa Wall. We were to drop to 24 m (80 ft) and drift along the wall for 20 minutes. At 4.5 m (15 ft), we were to do a two minute decompression stop before surfacing and being picked up by the boat that was following our bubbles.

As we sank to 24 m (80 ft), we began to drift at a comfortable, customary Cozumel drift speed. Fifteen minutes into our dive, I noticed a radical change in the appearance of the wall in front of me. I could see sand rushing down the wall and all of the soft sponges and gorgonians bent over at a steep angle as they were buffered by the propelling water and sand. The south to north drift carried us into this chaos and I quickly lost sight of my dive partner who was drifting only five feet to my side. The divemaster who was in front of me also became unobservable as my head was surrounded by bubbles, making my instruments nearly impossible to read. I assumed the bubbles were my dive partner's, as I was immediately over her, but in actuality, the bubbles were my own, being forced down upon me due to the strong downward current! Turbidity also obscured my vision.

Mild panic set in as I tried to read my gauges and find my dive partner, causing even more bubbles to obscure my vision. Then, after what seemed to be an eternity, the downward ride ended at 37.5 m (125 ft). We were then propelled quickly upwards, how quickly I cannot say, but too quickly, ultimately being pushed to the surface where we joined our dive master. Remarkably, all three of us were still together, yet separated from the rest of the group who surfaced at least 75 m (yards) away.

We had taken quite a ride. The divemaster, who himself was mildly panicked, returned to the surface with 500 psi as did my dive partner and I. I still do not understand what happened, but it was explained that due to the time of year, the ocean was changing temperature and generating underwater waves and extreme currents. As we returned on the dive boat, we observed, in an otherwise choppy sea, large areas of placid water, perhaps 10-30 m (30-100 ft) in diameter, like glass, surrounded by whitecap rapids. Sometimes in the middle of this calmness we could see a funnel directed downwards like a tornado.

The Cozumel drift must have carried us through the down current to a point where we were propelled upwards. It all happened so quickly it is difficult to say. None of us had any nitrogen problems however.

Actually we should never have dived since the telltale signs of the undertow currents were observable to an experienced diver from the surface! We had entered the water without any briefing or warning of what to do if we experienced such a situation. In discussing the experience with other divers at the hotel. I learned that the undercurrents could be so powerful that even inflating your BC vest will not raise you to the surface. You must drop your weight belt. Hopefully, then with an inflated BC one could rise to the surface, perhaps not too quickly if you spread eagle to slow the ascent. Any advice you can give to your subscribers about this type of situation. which apparently is not all that uncommon, would be helpful. Perhaps this phenomenon occurs during very limited periods of time during a year, but if it occurs again, we will be better prepared to deal with it.

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The address of Undercurrent is 3020 Bridgewater Suite447, Sausalito, California 94965, U.S.A.

MORE ABOUT COZUMEL'S HIDDEN DOWNWELLING

Dear Ben

I read the letter in the last issue from Eric Glanz regarding an "unusual experience" in April on Santa Rosa Wall in Cozumel. He described a water flow inversion which forced his diving party downward due to strong current. This phenomenon may not be so unusual.

On January 4, while diving Cozumel's Chankanaab Reef, our group experienced a strong downward current that reversed the ascent with normal kicking. There were six divers and one divemaster, Jose "Portfiro" Barrera: the dive operation was Blue Bubble.

Our dive was our second after a 40 minute surface interval. The first dive was a 30 minute, maximum depth, 21 m (70 ft) drift dive on Punta Tunich. The normal current was in evidence, it was overcast with rain, there was some chop at the surface, and the water temperature was 27°C (80-81°F). In other words, a normal Cozumel dive. Upon arrival at the "jump-off" point at Chankanaab, no unusual surface conditions could be seen to predict events that would occur at the end of this shallow drift dive. At the conclusion of our dive, three of the six divers made an uneventful ascent to the surface to be picked up by the boat. However, the divemaster, one experienced diver (over 100 dives), and two newly certified divers (less than 10 dives) drifted into a down current that, while they kept kicking normally, pushed them from 15 m (50 ft) to 21 m (70 ft). The divers did not immediately realise they were "sinking" as their more buoyant bubbles were sinking at a slower rate than they were. This phenomenon was so subtle that the experienced diver thought his depth gauge was broken as it registered that he was going deeper, not ascending, and yet, all the external input said he should be ascending. The divemaster picked up the situation quickly and signalled to the experienced diver, then held the BCs of both new divers, and the group proceeded to kick strenuously to the surface. As slow ascent was being achieved, no air was put in the BCs and no weight belts were dropped. At about 3-4.5 m (10 to 15 ft), the down thrust was not strong but the divers were now moving in a clockwise circular motion. This circular motion was very evident to those on the pick up boat. Also, in an otherwise choppy sea, a glass-flat, circular area about 21 m (70 ft) across with what appeared to be a vortex (the exact description Eric Glanz reported) was observed.

The divemaster was very professional and calming. Though the three divers sucked a lot of air (none came back with over 500 psi and each started their ascent with over 1000 psi), nobody panicked through a vigorous but controlled ascent. Everyone was convinced that a possible tragedy was averted because of the capability of our divemaster in this completely unexpected phenomenon. Luck played a part because the group had "extra" air (second, shallow drift dive that was not taxing), but a competent divemaster made the difference.

The description of the down flow in April seems to describe a stronger current with a nearby up flow. Both events occurred in the grouping of dive locations south of St. Miguel (Chankanaab on the north to Santa Rosa on the south, Tormentos, Yocab, and Punta Tunich in the middle), but three months apart.

There is no doubt that this natural phenomenon is extremely dangerous. It is totally unexpected, breaks apart a diving group, separates buddies, can be powerful enough to force divers to non-recreational depths, and induces panic even in very experienced divers. The prevailing wisdom is that it is associated with the changes in tide and mixture of warm and cool water. If that is so, this is an event that can unexpectedly occur any time of the year.

Mark A. Anderson

Note to our readers *(by **Editor UNDERCURRENT**)*

Should you get caught in a downwelling or upwelling, stay calm, don't panic. Don't swim directly against it, since you probably won't win. Swim out of it at an angle so you don't fight it full force.

Ben Davison

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The address of Undercurrent is 3020 Bridgewater Suite447, Sausalito, California 94965, U.S.A.

I SINK, THEREFORE I AM

Bob Halstead

With apologies to Descartes, and thanks to Bangkok diver David Glickman.

There is a moment that defines a diver. It is the moment after the surface closes above and the atmospheric world is forgotten. At this instant a diver feels inner warmth, no matter how cold the water; a diver feels calm, no matter how rough the surface; a diver feels welcome, no matter how fearsome the thoughts on the surface. A diver sinks and is going home.

There are people who say that the underwater world is alien. They argue that we are out of our element, that nature did not design us for swimming underwater. We cannot breathe, they say. Well what I say is ... ROT! We might not be born with fins and gills but nature gave us a BRAIN.

Fifty years ago Jacques Cousteau and Emile Gagnan used their brains to invent a device that made breathing underwater with a self contained air supply possible, and scuba diving was born. No doubt, if some of our concerned medical and safety experts had been around in those days, the first Scuba divers would have been bombarded with editorials and letters of the "Just say no to scuba" variety, just as we are hearing today with regard to nitrox. And if it had been Bruce Cousteau from Queensland who had invented scuba they would have been floundering in Laws, Codes of Practice and Scuba Cops. It appears that fifty years ago people were more inclined to let others get on with their adventures and let them take personal responsibility for their-actions, and even reward their successes. Now, as soon as anyone assumes even a minuscule risk, someone will leap up and try to make it illegal. There is a whole lot of difference between offering intelligent advice, which is always welcome, and trying to get an activity banned. That is a sickness.

And I wish these experts would stick to their special areas of knowledge. I recently read a press release given by four concerned doctors about the dangers of diving with asthma. They presented a convincing argument and some scary statistics .... and then blew the whole thing by adding that divers should not dive when the water has poor visibility and there are currents! Oh dear, what silly confused minds they have. Divers can be trained to safely dive in low visibility and high current situations, but no amount of training will overcome the risks of diving with asthma.

So brainy people have solved the technical problems - we can breathe and swim underwater, we can control our buoyancy, protect against heat loss and see as clearly as the turbidity will allow. The process has not ended, computer, rebreathers, mixed gases, personal sonars and who knows what, will make us as well adapted to being underwater as many of the creatures that live in the sea.

The future of diving is exciting and there are plenty of volunteers that are prepared to sacrifice themselves to develop all this new technology. We do not have to shove goats in recompression chambers any more. Why aren't we encouraging the experimentation and collecting the evidence? No pains, no gains, right? How about a posthumous annual award for the most significant diving fatality? Think of the animals we will save! Where are the ASPCA when we need them!!

Unfortunately brains vary in size and efficiency and this is why, during the past fifty years we have witnessed such quaint and curious quirks as buoyancy compensators that could salvage the Titanic, snorkels with more tubes and valves than an oil refinery and masks with tinted lenses that enable you to see the colours that aren't there but would be if the ocean was not filled with water. but, anyway, humans have solved the not very difficult technical problems of swimming underwater. The physical adaptation continues, but has already passed the level necessary for us to tell the "alien environment" freaks to keep their mouths shut and keep to whacking the little white ball with the big stick.

What would be nice is if we could catch up with the mental evolution. It is causing us all sorts of problems.

So lets take a psychological dive and consider the thoughts of a mature, well adjusted, diver. This is not going to be easy since I will have to use my imagination, try to join me.

Just for a minute imagine yourself sitting on a low cliff looking down to the sea. What you actually see is the surface with waves and the reflections of the sun and clouds - but just imagine if the surface was really transparent and that you could see all the fishes swimming around right down to the ocean floor. You are looking at corals, a school of jacks, a pair of manta rays and so on, and you can see them just as clearly as you can see trees and birds and cows in a field. How do you feel about that?

If this were reality we would obviously be far more familiar with marine creatures. Many of their mysteries would be revealed, and we would know what to expect when we went diving, and, more importantly, everybody else would have some idea of what we experience when we go diving.

But the surface of the water is not transparent. Mostly we can't see through the surface at all and, even when the water is clear, refraction distorts what we see so that only vague and uncertain glimpses of the underwater world are possible. So, in the same way that children fear the night, people have a fear of the sea. It is really a fear of the unknown. As we grow up and gain experience our irrational fears of the night are replaced by confidence, or if you live in a city, rational fears of muggers, rapists and murderers, but it seems only experienced divers ever get supreme confidence with the sea. We know that the underwater world is friendly and welcoming, beautiful and fascinating. We do not harbour irrational fears of monsters of the deep or black depths swallowing us up, but we do have rational fears abut the real risks of diving, lack of knowledge and skills, and we use our brains to overcome these.

Anyone looking at the surface of the sea might imagine the horrors of finding themselves, through some terrible accident, abandoned on the surface, struggling against the cold and the waves to keep their heads above water. This nightmare of fighting for survival is not buried too deep in our subconscious minds. We all know of storms and the might power of the sea and how quickly one's boat or ship shrinks as the wind speed increases. The trouble is that the surface can be easily confused with the sea itself.

The surface is the barrier through which a diver must pass in order to be embarrassed by the sea. It is a tricky place. There is plenty of evidence to show that it is in fact the most dangerous place for a diver. Over the years I have observed some interesting phenomena that occur at the surface that I would like to share with you but first I want you to do a self test. Just take yourself to that moment when you have passed down through the surface. The ocean has enveloped you and you are descending to the deep. If you feel happy and relaxed, excited but not afraid, free and welcome as if you have escaped from a mad alien world, then you are a diver. This does not come immediately or naturally, we have to use our brains and learn.

One of the things that is obvious to me is that to experience this joy you have to be self sufficient. It is possible to share this with another self sufficient diver but it is not possible to experience this if you are dependant on another diver, whether your instructor or buddy. You need to be able to recognise and understand all the real risks of diving that are relevant to the particular dive you are making, and know that you have the ability to overcome them. Training is vitally important, you need to master theory and skills and have guided experience, and when I say master I mean just that. I have heard it said that the difference between amateurs and professionals is that amateurs practice until they get it right, and professionals practice until they cannot get it wrong. To be truly at ease underwater you need to be a professional in your preparation for diving.

Let us have a look at some of the strange things that happen on the surface. I like to call them "Surface Tensions", since they are all related to a basic confusion of the surface, with all its problems and stress, and the sea, with all its joys and freedom. Surface Tensions reveal past or present psychological barriers to the full enjoyment of diving. Some of these are actually taught to beginning divers who, without realising, hang on to these bad habits throughout their diving careers.

One of the most popular scuba entries is the "giant stride", now I know this method is sometimes useful, but you may be interested to know that the giant stride was developed from a rescue entry for lifesavers and was designed to keep the head out of the water so that visual contact could be retained with the victim. So if you are using the giant stride you are actually trying to prevent yourself from sinking, which is fine if you have to pick up a camera or rescue your buddy, but silly if you are trying to get to the bottom. Of course any sort of jump/stride entry is unsuitable where there is any possibility of an obstruction just below the surface. Apart from this consideration, how you get underwater is no big deal - but it does get me wondering when I see a diver make a perfect giant stride from the side of the boat without getting a hair on his head damp and immediately follow with a surface dive, when if the diver had simply jumped in with feet together, he would have ended up in the same place with no effort. Symbiotic with the giant stride is the practice of putting air in the BC before entering the water. In the days of horse collar BCs and crotch straps it was easy to demonstrate the disadvantages of this technique, particularly with male divers. But event with modern BCs I cannot think of any reason to inflate before entry only to deflate a few seconds later, apart from a reluctance to go straight through the surface and into the sea an example of the dreaded "Surface Tension".

"Escape to the surface" is a mental set demonstrated by poorly trained divers as the reaction to any unexpected mishap underwater. It may be appropriate to terminate the dive, but an immediate ascent to the surface will, more often than not, put the diver in a worse situation. An example of this is the "lost buddy" procedure. I am embarrassed by the fact that this is still published in the diving texts. If you lose your buddy, they say, you should look around for a minute, then surface, re-buddy and descend again. This is madness. Not only does it encourage multiple ascents, blue water ascents without a reference line and without a safety stop, it takes the diver to the place where most diving accidents occur, where wind and current have the most effec, and where, if the diver tries to call out, he can easily cop a mouthful of water and start drowning. Having left the bottom you are likely to be disorientated and unless you are lucky and the surface is flat calm you might not even be able to see the boat let alone your buddy. And, come to think of it, what are you doing with a buddy anyway? Could it be that the buddy system itself is just a hang over from the fear of being alone in an imagined alien environment? Isn't it something that perhaps we should, as real divers, grow out of? The buddy should be someone that you can share the joy of a dive with and who decreases the danger by acting as a kind of safety factor. Unfortunately most buddies add to the risks if a dive rather than counter them. By the way, if you do lose your buddy, and are concerned about it, the sensible thing to do is to finish the dive, returning the way that you planned, underwater.

To gauge the skills of each new group of guests aboard Telita I have found that I cannot rely on looking at certifications. This is a very sad state of affairs, and a product of the lack of attention to producing self sufficient divers in openwater courses. What I have found to be the most revealing test is to see how each diver handles the surface on their first dive. It is fascinating to see the problems that they get into. Those that are sensibly weighted, enter the water with no fuss and go straight through the surface I know will be fine. Those that deliberately try to get on the surface before diving I watch carefully. If the mask is lifted to the top of the head I immediately prepare for a rescue, most divemasters know to watch out for this. A more subtle indicator of a problem however is if the diver raises his or her head whilst dumping the air from their BC. Instead of looking down into the water the diver is struggling with an unconscious desire to keep his head above the surface. It is actually quite comical to see the obvious attempt to sink by dumping air accompanied by the face being thrust up and, usually, frantic instinctive kicking of the fins to keep the face out of the water until the diver finally gets control, freezes and sinks, still staring at the sky. We also see divers unable to get the air our of their buoyancy compensators that they pumped in five seconds before. Sometimes this is because of poor design or because the BC is new and the diver is not familiar with it. But often it is because the diver "forgets" how to dump the air and I read this not so much as poor technique, thought it can be, as evidence of nervousness and a reluctance to sink. Surface tension strikes again. Divers may occasionally need more weights. How they tackle this problem is very revealing. It is not uncommon to see divers removing their regulators and even masks, then, trying to hang onto the ladder with one hand attempt to put the adjusted weight belt on with the other. Since no human has ever succeeded in performing this impossible skill, I always call the crew over to watch the fun, particularly if the diver has ignored my advice to put the belt on underwater.

Even with correct weights and all the air out of the compensation device some divers are determined to do battle with the surface to start the dive. This usually involves a massive breath and thrashing fins, is it a tiger shark doing battle with a giant hammerhead? No, just Joe Diver making a descent! What happened to gently breathing out and ripple-less submergence?

Another example of irrational behaviour on the surface is found with those that insist that a snorkel be worn, or carried, by scuba divers "for safety". In certain circumstances a snorkel may be useful, for example a beach entry where a surface swim through kelp is necessary to reach the dive site, but for regular boat diving the last circumstance you wish to find yourself in is on the surface snorkelling back to the boat. The whole point of being on a boat is to get directly over the dive site so you start and end the dive at the boat - or better, at the anchor (divers sometimes end up on the surface because they have aimed for the boat or trailing line instead of the anchor or mooring and a current has swept them away). So if you do find yourself on the surface at the end of a dive away from your anchored boat you can bet that you are there because you have made a mistake. If this happens, and the distance is too far for a swim at, not on, the surface using scuba, the safest response is to do the same as you would if you were drift diving and signal the lookout that you need picking up. A safety sausage is invaluable here but if for some reason you do not have one, try scooping handfuls of water up into the air and hope someone will think you are a whale and come and investigate (thanks to Valerie Taylor for that great tip). If there is no pick up boat, and you have no air, still resist using the snorkel, just go onto your back, put a little air into your vest and kick your fins, but it might be worth remembering here that exercise after a dive can precipitate decompression sickness, a pick up is always preferable. The reason the snorkel is such a bad ideas is that, firstly, if you have completed one of the modern dive courses, where it is considered that skin diving is not a prerequisite for scuba, (the "You can run before you can walk" school) you probably will have had very little experience with it and will breathe mainly water. Secondly if you try to snorkel with a tank on your back the tank will push you underwater and you will be trying to breathe with a negative pressure in your lungs, and quickly become exhausted. I you try to overcome that by putting air in your vest this too will compress the lungs (between the tank which is now being lifted out of the water and the bubble of air lifting you). Thirdly if there is any surface chop at all the inertia of the tank and the rest of the scuba gear prevents you from bobbing with the waves and the snorkel will continually flood and you will drown. Is it possible to snorkel using scuba... yes, but in most diving circumstances, it's dumb.

The Surface is not the sea. Next time you go for a scuba dive check yourself to see how you handle the surface - and my advice is to avoid it. If you are an instructor by all means teach surface survival but emphasise the fact that most diving accidents occur on the surface and that divers should be underwater and not on-the-water. After all the whole point of diving is to sink - and to be.

Last newsletter I explained the meaning of life, and now you know how to find out if you really exist!

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SAFE LIMITS: AN INTERNATIONAL DIVE SYMPOSIUM

The SPUMS Journal is privileged to have permission from the organisers, and speakers, of the Safe Limits Symposium, held in Cairns on October 21st to 23rd 1995, to reprint the contents of the symposium proceedings (© Copyright 1994 ISBN 0 7242 6189 3) in order to bring this initiative to a wider audience. This is the first of a number of instalments and starts with the introduction from the proceedings.

INTRODUCTION

The Diving Industry Workplace Health and Safety Committee is established under Section 47 of the Queensland Workplace Health and Safety Act. The role of the Industry Committee is to make recommendations on workplace health and safety standards suitable for the Queensland Diving Industry. *Safe Limits: An International Dive Symposium* is an initiative of the Diving Industry Workplace Health and Safety Committee. The International Dive Symposium aims to explore the health and safety implications for the Queensland diving industry of:

1. Risks associated with multiple dives during multiple days of diving
2. Post diving altitude exposure restrictions
3. The implications for workplace health and safety of *Resort Diving*, and to produce conclusions which are:
   a. internationally valid
   b. relevant to Queensland
   c. form a basis upon which recommendations may be made by the Diving Industry Committee to the Division of Workplace Health and Safety.

Correspondence about diving workplace health and safety issues should be forwarded to:

Chairperson
Diving Industry Workplace Health and Safety Committee
c/- Council Secretariat
Division of Workplace Health and Safety
GPO Box 69
Brisbane, Queensland 4001
Australia

DIVING INDUSTRY WORKPLACE HEALTH AND SAFETY COMMITTEE

The membership of this committee is tripartite, consisting of employer, employee, Government representatives and technical experts, and is designed to represent a broad cross-section of interests within this industry sector. Current membership of the Queensland Diving Industry Workplace Health and Safety Committee is:

Chairperson
Mr David Windsor
Windsor's (Australia) Pty Ltd

Government Representative
Ms Anne Quinnell
Division of Workplace Health and Safety

Employer Representatives
Ms Christine Deacon
Dive Australia
Mr Terry Dodd
BEWR Marine Services
Mr Peter McDougall
Underwater Visual Producers Association of Australia
Mr Rod Punshon
Pro Dive

Employee Representatives
Mr Garry Ihnen
Maritime Union of Australia
Mr Peter Gesner
Queensland Museum
Snr Const Richard Hahn
Officer in Charge Diving Squad, Queensland Police
Mr Colin Hodson
The Dive Bell

Expert Members
Mr Paul Butler
Dr Tom Fallowfield
Townsville General Hospital

CONFERENCE CONVENORS

Ms Meredith Messer, Division of Workplace Health and Safety
Mrs Sylvie Munson, Division of Workplace Health and Safety

PAPERS PRESENTED

SAFE LIMITS
AN INTERNATIONAL DIVE SYMPOSIUM

Des Gorman

Introduction

Underwater diving is employed in industry and by the military, and is an increasingly common recreation. Indeed, based on the number of air cylinders being inspected, between 2.5 and 5% of Australasians dive with self-contained underwater breathing apparatus (SCUBA) for enjoyment more than 10 times each year. This is more per capita than any other region. For example, this is true for only about 1% of North Americans and 0.1% of Europeans. The relative diving exposure of Australasians is even greater still when it is considered that local mild climates allow year-round diving, that most people live close to the coast and that many tourists come to Australia, at least in part, to dive. The Great Barrier Reef is obviously the major tourist attraction in this context. In one year it has been estimated that about 1 million tourist dives occur in this region. When this is added to the estimates of Australian Nationals diving in Australia (400,000 x 10 dives/annum = 4 million dives), the total diving exposure is considerable, 5 million recreational dives per annum. As each dive (including preparation etc) takes about one hour, this translates directly to about 5 million hours of exposure each year for recreational divers alone.

The importance of this estimate of exposure is that such a denominator is required to place the morbidity and mortality associated with recreational diving into perspective and to underline the concern that exists in organisations such as the South Pacific Underwater Medicine Society (SPUMS) about some current trends in diving.

Each year about 350 Australian recreational divers are treated for a decompression illness (DCI) by one of the country's hyperbaric units. This results in a cumulative risk of DCI of 0.7 episodes for each 10,000 hours exposure. Even if the worst treatment outcome data available from Australasian hyperbaric units are used (50% of patients in some series have not recovered fully from an episode of DCI), the risk of long-term problems from DCI is about 0.35 refractory episodes of DCI for each 10,000 hours exposure. The number of recreational divers dying varies considerably from year to year, if the worst of the recent years are considered (about 35 deaths) to determine an upper risk estimate for mortality, the risk of a lethal event is about 0.07 per 10,000 hours exposure. It is clear then that recreational diving has a low associated risk of DCI, morbidity from DCI and a very low associated mortality. Even though a similar treatment can not be performed for aural barotrauma and other diving injuries (the number of cases is not known), a conclusion that conventional recreational diving is "safe" is obviously reasonable.

Any consideration of future limits for recreational diving must be considered in the context of the current low level of risk. Similarly, the impact of new diving practices on this risk must be carefully considered before they are endorsed either privately or publicly. Finally, aspiring divers need to be aware of the risks involved in any diving activity so that they can make a sensible risk-benefit decision.

Three issues will be discussed here in greater detail, these are the need for an informed assessment of fitness for diving, the dangerous use of dive computers and the risks of uncontrolled "technical diving", as they are considered to be good examples of the risk-related philosophy described above.

Assessments of fitness for diving

SPUMS has long argued that any diving candidate requires an assessment of their fitness for diving and that such an assessment must be performed by a medical practitioner with training in diving medicine. The recent acquiescence of the Australian Medical Association to this point of view is a significant victory for the Society.

The need for an assessment of fitness in recreational diving candidates is so that the individual can make an informed judgement about the health risks for them inherent in diving. The need for training of medical practitioners is because of the complexity of the physiological and physical effects of the underwater environment and the essential absence of diving medicine from medical school curricula (this problem is not going to be corrected in the short-term as competition for teaching time in these curricula is actually increasing). SPUMS has published surveys of the ability of medical practitioners, who have not been trained in diving medicine, to perform diving fitness assessments; in general, these practitioners were unable to reasonably determine the candidate's health risks relevant to diving. Indeed, the most famous of these surveys described the assessments performed by the untrained cohort of medical practitioners as "Mickey Mouse".

The assessment of a diving candidate is not only essential, it must also be focused on whether the diver is to dive occupationally or recreationally. The procedure for occupational divers is prescriptive (a standard of fitness is decided and imposed, although central arbitration is needed), while that for recreational divers is often discretionary (the medical practitioner determines the risks associated with diving for the individual and then explains these risks so that the candidate can make an informed decision). Considerable training is required for a medical practitioner to perform such a risk-benefit exercise for the candidate. In this context, it is difficult then to defend the stance that medical practitioners need only to be trained if they are to examine occupational divers. A dogmatic approach to fitness for recreational divers based on a list of absolute contraindications is completely unacceptable for the following reasons. First, most candidates will not have a clear absolute contraindication to diving (eg. medication-controlled epilepsy), but rather will have relative (un)fitness which has to be individually assessed (eg. hypertension, being overweight). Second, the primary risk acceptors in recreational diving are the divers themselves and hence they need to be involved in the risk-benefit decision making. Third, the response of many recreational diving candidates to a dogmatic statement of not being fit to dive (i.e. without detailed explanation and involvement of the diving candidate), is simply to visit another medical practitioner and to not report the problem that induced the negative response in the first practitioner. It must be conceded that the dive instructor has a major role to play in the determination of a candidate's fitness for diving and consequently there needs to be a close relationship between medical practitioners who perform diving fitness assessments and the diving schools in their area. Also, while the need for ongoing assessments of fitness is described in occupational diving standards, this does need to be determined on an individual basis for aspiring recreational divers. The age of the diver will be a major determinant of the desirable frequency of re-assessments.

The dangerous use of dive computers

Any activity that increases the risks of diving, and especially recreational diving, is likely to have one or more of the following consequences:

individual morbidity and mortality will be increased;

relevant health, life and travel insurance premiums will increase; and

external regulation (legislation) will be introduced/increased.

The desirability of external regulation of a recreation is debatable, but certainly many precedents exist. It must also be noted that such control is usually a reflection on the inability of the recreational group involved to self-regulate.

In this context, the current use of decompression computers is disconcerting. With the exception that the actual risk of DCI associated with the use of these apparatus has not been established to any level of confidence, there is nothing intrinsically wrong with decompression computers. The danger lies in the way in which they are being used for multiple day, multiple dives per day diving beyond 30 msw. The inevitable consequence is a significant increase in the incidence of DCI. Such an increase is probably already being seen by

Australasian hyperbaric units and by the North American Divers Alert Network.

SPUMS has just conducted a Workshop on the use of decompression computers. The primary finding of this Workshop was the need for dive planning and "safe" diving practice to have priority, hence the term borrowed from the recreational diving instructor organisations, "computer-assisted diving". An urgent education program is needed to establish adequate diving practice in the context of such computer assisted diving. Not only should this education be the responsibility of Symposia such as this, organisations such as SPUMS and the recreational diving instructor organisations, but also it should be the responsibility of retailers of this equipment. In the context of the latter group, this must also include a more responsible approach to advertising (eg. it is only reasonable to market an apparatus as being able to extend underwater exposures, if it is also noted that such an extension will increase the risk of DCI). The potential conflict between commerce and "safety" in diving is considerable. It is self-evident that "safety" deserves priority here, in addition, retailers of diving equipment should remember that their best strategy for increasing sales is to market "safe" diving.

A final note about this desirable education is the ongoing need to encourage divers who feel unwell after a dive to present to a hyperbaric unit as soon as is possible. The usual delay (on average of more than a day) for recreational divers with DCI to present for treatment in comparison to military and offshore occupational divers who present for treatment within hours of the onset of DCI, probably explains the invariable good outcome in the military and offshore divers and the frequent failure of treatment to obtain a complete resolution in recreational divers.

Technical recreational diving

The range of diving activities described as technical diving (scuba below 50 msw, surface-supplied breathing apparatus (SSBA), oxygen/nitrogen mixture diving, oxygen/helium mixture diving and oxygen/nitrogen/helium mixture diving) represent a greater threat to the integrity of conventional recreational diving (scuba air diving to 40 msw) than any other phenomena; a significant effect is certain unless there is an early introduction of controls of training and conduct. Already, uncontrolled technical diving has been responsible for many diving fatalities, including in Australia. It would be a tragedy if the "safe" aspects of conventional recreational diving were inappropriately regulated because of uncontrolled diving practice by a small part of the recreational diving community.

All of the techniques described above as technical diving are well known to the military and off shore occupational diver, as are the associated risks. Consequently, diver selection processes, diver training programs and diving conduct procedures have been developed by the military and diving companies that result in low levels of risk (eg. a DCI risk of less than 2% and a oxygen convulsion risk of less than 1%). These processes, programs and procedures are available to the recreational diving community, albeit very expensive. The argument here then is that the approval of a type of diving should not be based on the intent of the diver (ie. whether the diver is doing the dive for enjoyment or is being employed), but rather on the actual technique of diving to be employed. This is also the stance being adopted by the United Kingdom's Health and Safety Executive (HSE) (The HSE is the most influential regulatory body in diving worldwide). Recreational divers wishing to undertake technical diving then can choose between a variety of suitable models (for which the associated risks have been quantitatively determined), including those of the military (e.g. Royal Australian Navy), scientific organisations (e.g. National Oceanographic and Atmospheric Administration (NOAA) of the United States Department of Commerce) and offshore diving authorities (e.g. HSE). Unfortunately, while those recreational groups currently wishing to undertake technical diving have well developed and thorough training programs, candidate selection processes and diving conduct are not adequate. The imposition of standards for recreational technical diving is essential to protect the conventional aspects of recreational diving (and the prospective technical divers themselves). These standards can be internally regulated, the Cave Divers Association of Australia is a recreational diving group that could act as a suitable role model in this context. This Association has introduced and imposed sound controls on cave diving, indeed, cave diving was rescued from the same brink that technical recreational diving has now reached. It is nevertheless likely that external standards will be required, those of the HSE are recommended.

Finally, technical diving is an activity both where a thorough awareness of the risks are essential if an informed decision is to be made by an aspiring candidate and where current advertising must become more conservative and balanced. A change in marketing strategy probably will not reduce the appeal of technical diving, as given the perversity of human nature, it is unlikely that a presentation of the risks of such diving would dissuade many of the individuals attracted to this type of pursuit.

Summary

Diving underwater is a popular recreation with an enviable "safety" record. Maintenance of this record is essential to the future of the industry that has evolved to support this recreation. Consequently, everyone in the industry must become active in the "safety" debate, guard

their "safety" record jealously, review potentially high-risk diving activities critically, develop and impose self-regulation regardless of the external legislative environment and ensure that "safety" retains a priority over commerce.

Dr Des Gorman, B Sc, MB ChB, FACOM, FAFOM, Dip DHM, PhD, is a specialist in the area of Diving and Hyperbaric Medicine. He is widely published in Medical textbooks, and has extensive experience in the issue of "Safe Limits for Diving".

Current Position

Surgeon Commander, Royal New Zealand Navy. Director, Occupational, Diving and Hyperbaric Medicine, since 1989. Director, Medical Services, since 1992. Honorary Physician to the Governor-General of New Zealand, since1992.

Current responsibilities include

Co-ordinator, Australasian Divers Emergency Service. President, South Pacific Underwater Medicine Society. Member, Australian and New Zealand Standing Committee on Hyperbaric Medicine Foreign Affairs. Committee Member, Undersea and Hyperbaric Medical Society, Bethesda, Maryland, USA. New Zealand Regional Committee Member, Faculty of Occupational Medicine, Royal Australasian College of Physicians. Executive Committee Member, Australian and New Zealand Society of Occupational Medicine.

Dr Gorman's address is RNZN Hospital, Naval Base, Auckland, New Zealand.

The above paper was presented at the Safe Limits Symposium held in Cairns, October 21st to 23rd 1994. It is reprinted by kind permission of the Division of Workplace Health and Safety of the Department of Employment, Vocational Education, Training and Industrial Relations of the Queensland Government, and of the author, from the symposium proceedings pages11-14.

DIVING IN AUSTRALIA

Terry Cummins

Introduction

The purpose of this paper is to give a brief overview of the dive industry in Australia as it is today. The reason for this approach is to give some context to the other papers which will follow during the symposium.

How big is the scuba diving industry? How many divers are trained each year? How many instructors do we have operating in Australia and in particular Queensland? What is the Dive Industry worth? These are the most common questions we are asked at PADI Australia on a dayto-day basis.

Other papers will address the general theme of the Symposium, Safe Limits in the Workplace.

There are several major elements in the Australian Dive Industry. These include: consumers, instructors, retail dive stores, wholesalers and ancillary services.

Consumers

In recent years them has been much talk about the general observation that the diving industry is growing. Unfortunately, this observation is exactly that, since objective, comprehensive and accurate data on the Australian diving industry simply does not exist. Much of the so called data is purely anecdotal and comes from many isolated sources. Most of these sources do not liaise with each other although Dive Australia is attempting to draw the industry together under a common umbrella.

If the diving industry is to progress successfully further into the 1990s the availability of true data must change from the current situation. In the context of this paper it is extremely frustrating to be unable to relate accurate industry statistics, particularly diver certifications from all agencies.

For example, in Australia, diving certification figures are relatively difficult to come by. This stems from a general reluctance by most of the certification agencies to publicly publish their certification figures.

Having said this, by reference to PADI certification figures, PADI's projected market-share (see Figure 1) and by reference to publications printed by the various certification agencies in Australia, there is absolutely no doubt that the certification of entry level divers and divers involved in continuing education programs has increased quite significantly over the last ten years.

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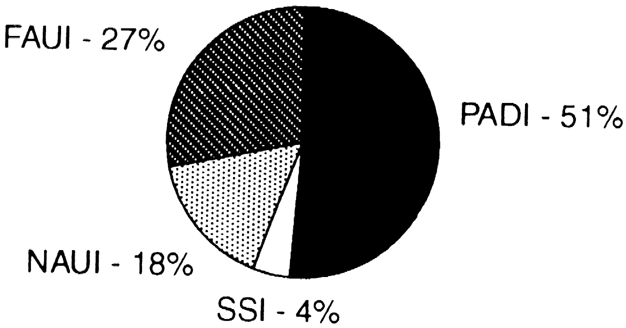
In 1987, the last time that all training agencies in Australia actually supplied certification figures, information gathered showed that all of the major certification agencies reported significant growth. Similarly the advanced open water course showed a significant increase in the number of individuals certified as did other continuing education programs.

On the other hand, during recent studies conducted in Australia by PADI, it has been established that the potential Australian market is extensive. That is, there are

FIGURE 1



The relative market share of individual training agencies from the 1989 Dive Australia Survey.

currently many thousands of Australian residents who would develop an interest in scuba diving in the next few years, particularly if marketing efforts were well targeted. You must also add to this potential market the sizeable tourist marketing strategies especially focused on internationally renowned destinations like the Great Barrier Reef and more recently the north of Western Australia.

In February 1994, PADI announced its five millionth certification internationally since 1967. PADI is just one of the four major agencies operating in Australia and in particular Queensland.

In 1993 PADI issued over 60,000 certifications in Australia alone. More than fifty percent of those divers certified were trained in Queensland.

As a rule of thumb the mainstream PADI programs, entry level, advanced open water and several of the major diver specialities have at least four compulsory open water dives in the program. Given this, in Queensland alone last year, 120,000 dives were experienced by new PADI divers in training. If we add the additional divers trained in Queensland by NAUI (National Association of Underwater Instructors), NASDS (National Association of Scuba Diving Schools) and SSI (Scuba Schools International) the number of dives experienced in training could be as high as 200,000.

To obtain total diving frequency information one needs to add to this figure the dives conducted by the certified diver population including diving professionals. The figure one derives could clearly be in the area of a million individual dives for the year for Queensland alone.

Data collected by Dive Australia indicates that at least 1.9 million dives are conducted nationally each year and already over 700,000 Australians could be classified as divers. These are astounding figures since it means that currently one in every 26 Australians is a scuba diver.

In other areas of Australia outside Queensland, the frequency of dives per year would be much less because the certified diver and tourist diver contribution would be lower. This would be the case in many of the southern states (e.g. Victoria) which have well defined scuba diving seasons. Having said this the industry is definitely expanding nationally, particularly in Western Australia where the world's third largest barrier reef is located. Table 1 shows the relative importance of diving activities in each state in terms of popularity with diver travellers.

TABLE 1

DESTINATIONS FOR AUSTRALIAN DIVE TRAVELLERS IN ORDER OF POPULARITY

Queensland
New South Wales
Western Australia
Tasmania
Victoria
Northern Territory and South Australia (equal)
Overseas

Source: Dive Australia report 1994.

Instructors

In respect to instructor certifications, the industry is seeing a steady growth in the number of instructors trained per year by the instructor training agencies and thus entering the industry as occupational participants. At the present time, indications are that in excess of 370 new instructors join the instructor agencies per annum and although there is a well acknowledged instructor drop out rate, that is, instructors not maintaining their active teaching status, there is a fair indication from anecdotal evidence that the diving industry is growing in this area.

PADI currently has 3,500 active members in Australia. By active we mean they currently run scuba programs, renew their membership with the PADI organisation and generally attend PADI Annual Update Seminars. Given PADI's projected market share in this category there could be as many as 6,000 active instructors affiliated with PADI, NAUI, SSI and NASDS.

The number of instructors and divemasters operating in Queensland alone is estimated as 1,500. Table 2 shows a break down of PADI and other agency instructor distributions in 1993 across the state of Queensland.

TABLE 2

DISTRIBUTION OF PADI AND OTHER AGENCY PROFESSIONALS IN QUEENSLAND

	PADI		Other agencies	
	Instructors	AI and DM	Instructors	AI and DM
Cairns	156	64	?	?
Townsville	16	14	?	?
Rest of Queensland	411	300	?	?
Totals	583	378	267	276

AI = Assistant instructors. DM = Dive masters
Source: PADI Australia survey June 1993

It is impossible to calculate just how many dives per year each individual and this group does collectively, since activity and class size varies considerably between individual instructors and individual operations.

Retail dive stores

Yet another indication of dive industry growth has been the obvious increase in the number of dive stores over the last ten years. Evidence for this trend can be seen nationally and clearly in Queensland. Ten years ago only a handful of dive stores existed. There are now approximately 350 dive stores in Australia.[1] Most are affiliated with one instructor training agency or another.

Some have no clear affiliation and hire individual instructors on availability only. Today in Queensland the market is serviced by over 100 specialised dive stores and numerous other stores which sell scuba equipment along with other sporting goods.

The size and number of retail outlets is commonly used by statisticians as an indication of industry growth. With this in mind one could say that scuba diving, as indicated by the number of dive stores, has grown quickly into a sizeable industry.

Furthermore, by analysis of the individual characteristics of dive store and retail outlets, we are able to see an increase in the professionalism, quality of service offered and the level of professional staff found in these outlets. This also is an indication of a growing market and in turn a greater interest by potential and actual consumers.

The estimated value of retail sales in Australia is $64,300,000.[1] Given an average figure for the cost of a scuba course, the income derived from scuba courses could be as high as $30,000,000. This is for a possible total industry net worth of $94,300,000.

We would also need to take into consideration both the number of individuals involved and the tourist related "intro-dive market" to finalise our picture of the industry's net wealth. It is estimated that 110,000 individuals undertake Discover Scuba Courses, Try Dives or Intro Dives annually in Far North Queensland alone.[2]

PADI Australia's research also clearly shows that most diver training and diver services in Australia are conducted from professional dive stores, live-aboard dive vessels, etc, rather than from independent instructors operating from home.

Wholesalers

The Industry's wholesale market is also growing significantly. An objective observation of the number of diving wholesalers shows a significant increase, not only in their number, but in the volume of accounts they service.

Currently there are 50 wholesalers in Australia. They vary in size of operation and product range.

In a recent survey conducted by PADI Australia, it was revealed that indeed the wholesale industry is growing. In every individual case studied it was indicated that the company had grown. Some wholesalers indicated this growth to be as high as 60% over the last 3 years.

Diving wholesalers commonly distribute products such as masks, fins, snorkels, wet suits, tanks, regulators and instruments to retail dive stores.

Ancillary industries and services

These include dive magazines, dive boats, general travel agents, etc. Also in this group there are large entities that derive some, if not a significant part of their income, from the industry. This group includes airlines, hotels, resorts, etc.

Specialised diver travel is yet another example of our growing industry. This is reflected not only in the growing number of travel retailers and wholesalers specialising in diver travel, but also in the associated growth in diver orientated resorts and charter vessels.

Fortunately, the travel industry has traditionally produced good data on tourist movements and their associated use of travel services. In this section of our industry, airlines also give some significant input in relation to domestic and international travel by divers.

It is extremely difficult to place a figure on the individual contribution to the industry's function and net worth but recent (1994) figures released by Dive Australia included a statement which reads: "The total value of the Recreational Diving business to Australia is conservatively 360 million dollars per annum".

The Dive Australia report goes on to say, "By the year 2000, overseas visitors coming to Australia to dive will form a significant proportion of the Australian Tourist Commission's projected figure of 7,000,000 visitor arrivals". This is not an unrealistic assumption because already 40 per cent of all visitors to our nearest neighbour, Papua New Guinea, go there to dive or at least to have a dive during their visit.

If you were able to add all this information together you would get an impressive picture of a growth activity which is less than a generation old. Figures like those presented here highlight the growth of business in a country. They form the basis for economic planning and development, not only of particular industries, but of whole countries.

It is in the interpretation of these statistics, however, that their value lies. Without proper translation they remain nothing more than bits of raw data expressed in numerical form; useful for filling gaps in tired conversations but not much else.

In an industry that is both as young, and as diverse, as is the Australian Recreational Diving Industry, hard core statistical data has been hard to come by. But now, thanks to a number of privately funded and sponsored research programs, which includes input from universities, industry groups, research companies, Dive Australia and more recently research by PADI Australia, we are beginning to build a true picture of the Australian Diving Industry. The real task ahead is to pull all this isolated information together to form a true and full picture of the industry.

This undertaking will not only assist in the planned growth and expansion of the industry, but will help to change both the public and government perception of scuba diving, placing it in its true perspective as a major component of Australia's biggest and fastest growing dollar earner, the tourism sector. It will also give both quantitative and qualitative balance to false perceptions of our industry, particularly in relation to safety issues.

I make a personal plea to the other training agencies attending the symposium and those reading this paper to publicly release your industry data for the good of the industry. That action alone will go a long way towards decreasing the reliance on guessing and purely anecdotal evidence.

Only with accurate and comprehensive data can we as an industry plan the ways in which we are going to address the expanded customer base, consumer safety issues and occupational health considerations. Simply, all the promotions in the world will be totally ineffective if, when a new market is created, we do not know enough about our industry's true situation to deal adequately with issues that will be raised, like diver safety and occupational health. In other word if the only real information we have is that a diver was injured then the informed (e.g. much of the media) could be excused for falsely reporting the safety record of the industry. Similarly a single and isolated fatal shark attack on a diver becomes the true exception to safe diving rather than an ocean teaming with man-eaters.

Purely from a diver accident management point of view, the available data reflects a significantly safe industry. For example, in the far north Queensland town of Cairns it is estimated, with a reasonable degree of accuracy, that there are some 3,500 dives performed per week. That is 182,000 dives per annum.

In comparison diving accidents nationally and in Cairns specifically are relatively few. Commenting on this particular observation, for example, some diving medical authorities have acknowledged that a far higher accident rate could be statistically anticipated in relation to the acceptable tolerance of existing dive tables. This is what one could describe as an acceptable level of risk for what could be described as an adventure activity.

Although one should never let the acceptable level of risk concept account for accidents, the Australian diving industry can take some degree of comfort and pride in the fact that the available statistics show that our diver accident rate is among the lowest in the world.

We know for certain that scuba diving is an infant industry and that we do have a way to go before we completely understand the total dynamics of the elements involved. Through seminars and symposia like the one currently hosted by the Queensland Government Workplace Health and Safety Division, we can only derive benefit and clarity in respect to the issues which initiated this program.

References

1 1992 Dive Australia Survey
2 GBRMPA survey

Mr Terry Cummins is Chief Executive Officer, PADI Australia. He has had a long association with diving in Australia, with involvement with PADI Australia since its inception in the 1970's. Terry has had numerous articles published in diving industry publications. He is currently appointed to the Editorial Board of PADI's Undersea Journal, which is distributed to the PADI membership internationally. In 1993, Terry was presented with "The Scuba Excellence Award".

The above paper was presented at the Safe Limits Symposium held in Cairns, October 21st to 23rd 1994. It is reprinted by kind permission of the Division of Workplace Health and Safety of the Department of Employment, Vocational Education, Training and Industrial Relations of the Queensland Government, and of the author, from the symposium proceedings pages 15-21.

DIVING MEDICAL SYMPOSIA

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For further information contact

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For further details contact
Dr Bob Thomas
Diving Medical Centre
132 Yallambee Road,
Jindalee, Queensland 4047.
Telephone (07) 376 1056 / 1414

GLEANINGS FROM MEDICAL JOURNALS

MEDICAL ASPECTS OF SCUBA DIVING

Medical aspects of scuba diving.
Sykes JJW. *BMJ* 1994; 308: 1483-1488

A review of aspects of diving medicine that can cause clinical problems but are considered only in specialist postgraduate training. Experience suggests that most problems arise in determining fitness to dive and in recognising and treating medical conditions caused by exposure to raised environmental pressure.

Standards for diabetic divers are workable.
Edge CJ. *BMJ* 1994; 309: 340

Letter referring to the Sykes paper.

Decompression sickness may be due to paradoxical embolism.
Wilmshurst P. *BMJ* 1994; 309: 340

Letter referring to the Sykes paper.

MARINE TOURISM

Health and Safety in Australian Marine Tourism: a social, medical and legal appraisal.
Wilks J and Atherton T. *Journal of Tourism Studies* 1994; 5 (2): 2-16

Abstract

As an island holiday destination Australia offers a large range of leisure activities in the area of marine tourism. This paper examines marine settings as tourist destinations and considers the social, medical and legal aspects of ensuring visitors have a safe and enjoyable holiday experience. Currently there is very little empirical data on tourists' recreational activities in Australia, especially the types of accidents and injuries that do occur. Findings from overseas studies are therefore reviewed, and a research agenda is proposed for investigating health and safety in Australian marine tourism.

Further gleanings on page 68.