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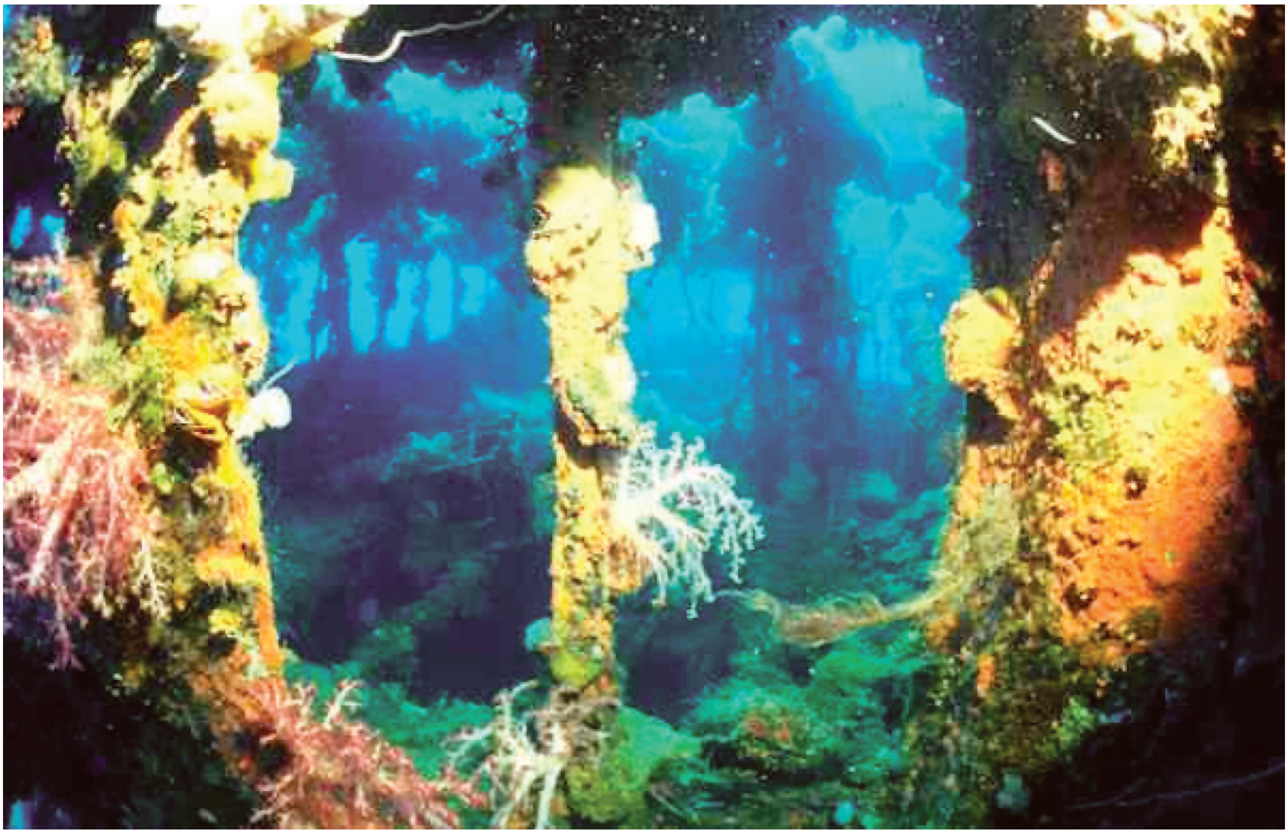

‘Fitness to dive’

Pulmonary oxygen toxicity

South Australian diving fatalities

Dive computers

The Journal changes its name

Tony Slark

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PURPOSES 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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E-mail <spumsj@cdhb.govt.nz>		Christchurch Hospital, Private Bag 4710, Christchurch, NZ
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E-mail <dsmart@postoffice.utas.edu.au>		Royal Hobart Hospital, Hobart, Tasmania 7000
Committee Members	Dr Simon Mitchell	Aromahana, 45 Oanuku Road, Henderson,
E-mail <dr.m@xtra.co.nz>		Auckland, New Zealand
	Dr Douglas Walker	P.O.Box 120, Narrabeen,
E-mail <diverhealth@hotmail.com>		New South Wales 2101

ADMINISTRATION

Membership	Steve Goble	C/o ANZ College of Anaesthetists
E-mail <stevegoble@bigpond.com>		630 St Kilda Rd, Melbourne, Victoria 3004
Journal	Sarah Webb	C/o Office 137, 2nd Floor,
E-mail <spumsj@cdhb.govt.nz>		Christchurch Hospital, Private Bag 4710, Christchurch, NZ
		Phone: +64-3-364-1277, Fax: +64-3-364-1683
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SPUMS Membership,
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The Society's financial year is January to December, the same as the Journal year.
The 2005 subscription will be Full Members A$132.00 and Associate Members A$66.00, including GST.
There will be an additional surcharge of $8.00 for journal postage for all members living outside Australia.

The Editor's offering

I am writing this editorial on September 11, exactly three years after the terrorist attack on the Twin Towers, New York, and in the same week as the school hostage tragedy in Beslan. Terrorism and war have touched all of us in recent years in one way or another. Attendance at our Society's ASM in 2002 was impacted by the severe downturn in travel following 9/11 and a number of members' professional lives have been directly affected by world events. We need to remind ourselves that health professionals have played a part in human rights abuses, and this concern has been expressed again recently in relation to events at Abu Ghraib prison.[1] The irony of caring for the sick and wounded whilst others do their damnedest to undo our work is always with us in the practice of medicine.

I recently attended an excellent workshop for medical journal editors run in association with the BMJ Publishing Group. This raised many issues about the survival of small specialist journals in our rapidly changing world. Electronic publishing is burgeoning, and the Society needs to address how this will affect our journal. Part of this review was the motion passed unanimously at the AGM to change the name of the Journal to something less obviously parochial, whilst retaining the clear link with the Society's name. This change has yet to be ratified by the full membership (see p. 161).

Allied to this, we need to provide a better web-based service for members, a challenge the Committee has been actively pursuing. We still need someone with some computing skills coupled with enthusiasm to act as web site manager with the support of the site development company chosen. We do not think this will be an arduous task but it is certainly a badly needed one, so come on you computer enthusiasts, put your hands up.

Both the workshop and Richard Smith's retirement editorial in the *British Medical Journal*[2] have helped to clarify for me many of the elements of a medical editor's role, and I hope this will be reflected in this journal in the years to come. Smith comments "*words on paper rarely lead directly to change – and thank goodness they don't, considering the rubbish that journals often publish. What journals do best is what the rest of the media do best: stir up, prompt debate, upset, probe, legitimise, and set agendas. They are good at telling readers what to think about but not what to think, and theme issues may be particularly successful in putting important but neglected subjects to doctors.*" Variety is the spice of life even for medical journals!

However, for SPUMS this can only be successful if the membership takes an active part by way of research, education and debate. Too few SPUMS members contribute to these pages, and too few attend the ASMs. The President has indicated she will not seek re-election next year after many years of excellent service for SPUMS, and other committee positions will also be due for re-election in 2005. This is a great opportunity for those who feel they have something to contribute. This is a unique organisation, of which its founders, such as Carl Edmonds, can feel proud, and I have always found participation in its activities great fun, even if there have been disagreements along the way.

The South Australian Coroner's inquiry into the deaths in 2001–2002 has received wide attention internationally. Dr Acott was closely involved with the inquiry and here provides detailed case reports, and comments on the implications drawn from them by the Coroner. In personal correspondence to the Editor, Dr Douglas Walker, well known for his work with Project Stickybeak, expresses a dissenting opinion, "*I believe the diving errors were critical and not the medical factors.*" He goes on to say, "*…that SPUMS should take note of the danger of making disputable claims for 'diving medicals' while ignoring the place of correct diving procedure while giving professional advice to a coroner.*" Readers should decide for themselves. Recreational diving safety is multifactorial, a loose weave rather than a regimented structure; remove one factor and the structure will probably stay intact, but the more that are removed, so the likelihood of disaster increases disproportionately. This is abundantly clear from Dr Walker's and others' reports on diving accidents and deaths.

The unit pulmonary toxic dose (UPTD) for oxygen has been of limited value, in the writer's experience, in the clinical management of divers, and the onset of symptoms attributable to pulmonary oxygen toxicity has seemed quite varied. Leverment and Bennett's study on lung function after treatment of decompression illness appears to confirm these preconceptions. Since the decrement in forced vital capacity from most studies is greater than that predicted by the UPTD, the latter's continued use in enriched air nitrox diving will result in a conservative approach to pulmonary oxygen toxicity limits, which is no bad thing.

The 2003 Workshop raised fundamental questions as to the medical and cost effectiveness of the 'fitness to dive' medical. Dr Michael Bennett was tasked with convening a committee of members to consider the findings and recommendations of this workshop. Volunteers from the membership willing to contribute to this committee are invited to contact him as soon as possible at <*m.bennett@unsw.edu.au*>.

Michael Davis

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1 Doctors in 'torture cover-up'. *Guardian Weekly*. 27 August – 2 September 2004. p. 6.
2 Smith R. Travelling but never arriving: reflections of a retiring editor. *BMJ*. 2004; 329: 242-4.

Front cover photo was taken by Dr Bill Brogan on the *Shinokoku Maru* wreck lying at 45 msw in Truk Lagoon.

Original articles and case reports

Lung function following exposure to Royal Navy treatment table 62

Juliette Leverment and Michael H Bennett

Key words
Pulmonary oxygen toxicity, hyperbaric oxygenation, vital capacity, unit pulmonary toxic dose

Abstract
(Leverment J, Bennett MH. Lung function following exposure to Royal Navy treatment table 62. *SPUMS J*. 2004; 34: 118-23.)
Objective: To quantify any change in vital capacity (VC) measured as forced vital capacity (FVC) in humans, as an index of pulmonary oxygen toxicity (POT) following the Royal Navy treatment table 62 (RN 62) protocol for the treatment of decompression illness (DCI). We assessed whether the observed decrement in FVC was closer to the VC decrement as predicted by the unit pulmonary toxic dose (UPTD) (-2%), or the VC decrement previously described following a similar oxygen exposure (-12%).
Methods: We conducted a prospective, observational study with 20 subjects. Six underwent hyperbaric oxygen therapy (HBOT) for the treatment of DCI, while 14 were healthy volunteers. All subjects underwent the RN 62 protocol and expiratory spirometry was performed immediately before and after this exposure. Participants completed a simple questionnaire after exposure to evaluate symptoms related to POT. The primary outcome was percentage change in FVC following the hyperbaric exposure. Secondary outcomes included changes in other lung function parameters such as peak expiratory flow (PEF) and forced expired volume in one second (FEV_1), and estimation of symptom severity related to POT.
Results: Mean change in FVC after HBOT for all subjects was a decrease of 8.3% (SD 9.4%, P = 0.001). DCI patients showed a significantly greater reduction in VC post exposure than the healthy volunteers (P = 0.04). There was no association between POT-related symptom severity and change in FVC.
Conclusions: Observed decrement in FVC exceeded the VC decrement predicted by the UPTD for the RN 62 HBOT protocol and was closer to the decrease in FVC observed after a similar oxygen exposure in a previous study. Symptoms related to POT do not correlate with decrement in FVC.

Introduction

Pulmonary oxygen toxicity (POT) is a recognised risk of hyperbaric oxygen therapy (HBOT).[1] Early changes resulting from oxygen toxicity include alveolar and interstitial oedema, alveolar haemorrhages and proteinaceous exudates. Further exposure amplifies the inflammatory reaction and leads to a proliferative phase during which type II epithelial cells and fibroblasts proliferate and collagen is deposited.[1,2]

In the development of POT, lung mechanical function is impaired earlier and to a greater extent than gas exchange.[3] The degree of POT can be effectively measured by decrement in vital capacity (VC), where VC is the maximum volume of air that can be exhaled or inspired during a forced (FVC) or slow (SVC) manoeuvre.[1,3-7] Various mechanisms by which POT reduces VC have been proposed, including bronchoconstriction secondary to increased vagal tone and atelectasis,[2-4] but VC changes are probably caused by multiple interacting factors.[3] After a single experimental hyperoxic exposure, any difference in lung function has been found to be reversible within 24 to 72 hours.[2,3,8]

POT is best monitored by serial pulmonary lung function tests but in practice this is difficult and costly.[9] The concept of the 'unit pulmonary toxic dose' (UPTD) was therefore developed in an attempt to quantify the predicted degree of POT as measured by decrement in VC from a single hyperoxic exposure[10,11] (see methodology "Derivation of the UPTD"). The greater the UPTD, the greater the average predicted decrement in VC and severity of POT. The relationship between the predicted decrement in VC and UPTD is summarised in Table 1. Examples of HBOT tables and their designated UPTD and VC predicted decrements are given for clinical relevance.

Despite UPTD calculation being based on observed VC decrements, subsequent studies have shown that the observed changes in VC do not always equal those predicted by the UPTD. For example, when Clark and Lambertsen exposed subjects to continuous 100% oxygen at 2.0 and 2.5 atmospheres absolute (ATA), the observed decrease in VC tended to exceed the decrement predicted by UPTD.[3]

The calculated UPTD for the Royal Navy table 62 (RN 62, Figure 1) is 637 and predicts a 2% decrease in VC (Table

1).[12] To date, observed changes in VC following a series of RN 62 schedules have not been reported. When Clark and Lambertsen exposed subjects to 2.5 ATA (253 kPa) for 3.1 and 4.9 hours they observed a change in VC of -4.9% and -12.2% respectively.[3] Given the P_IO_2/t profile of RN 62, one might therefore expect the subsequent change in VC to lie somewhere between these figures rather than at -2% as predicted by the UPTD.

This study was designed to test the hypothesis that the measured decrease in FVC following an RN 62 treatment schedule significantly exceeds that predicted by the UPTD. In addition we examined any relationship between symptoms of POT and the measured decrement in FVC.

Materials and methods

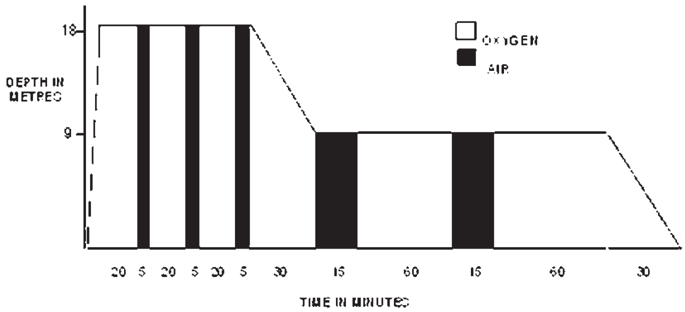
The study was approved by the South Eastern Sydney Area Health Service Research and Ethics Committee prior to volunteer enrolment. Subjects were eligible for entry if over 18 years of age and both qualified to dive with at least an ‘open water’ certification and not suffering from any temporary or permanent contraindication to compression. We accepted both healthy volunteers and patients who were diagnosed with DCI and for whom an RN 62 treatment table had been independently prescribed by their diving physician. Potential subjects were excluded if they were unable to effectively perform lung function testing or had symptoms suggestive of significant pulmonary disease.

Expiratory spirometry was performed immediately before and after hyperbaric treatment (PneumoCheck™, Welch Allyn, Skaneateles Falls, NY) and following instruction by experienced staff. One of the investigators (JL) performed all spirometry and recorded FVC, FEV_1 (forced expired volume in litres in one second following a maximal inspiration), FEV_1/FVC (FEV_1 expressed as a percentage of FVC), FEF_{25-75} (the average forced expired flow in litres over the middle half of expiration), and PEF (peak expiratory flow, the maximal expiratory flow rate $l.sec^{-1}$ achieved on a forced expiratory manoeuvre). The best effort from three attempts was recorded for each examination.

The predicted ‘normal’ FVC for each subject, based on subject’s height, age and sex, was calculated by the spirometer and recorded. The spirometer was calibrated before every test in accordance with the manufacturer’s guidelines.

All subjects were exposed to the RN 62 HBOT schedule in a multi-place chamber. This schedule mandates oxygen breathing at 2.8 ATA (283 kPa) with air breaks, a controlled decompression over 30 minutes to 1.9 ATA (193 kPa) on oxygen, further oxygen breathing periods with air breaks at that pressure and a final 30-minute decompression to the surface to a total time of 4 hours 45 minutes (Figure 1). The breathing system consisted of an airtight mask and demand valve regulator as shown in Figure 2.

Figure 1
Graphical representation of Royal Navy Table 62 HBOT schedule



Total elapsed time 4 hours 45 minutes
(can be extended up to 6 hours 50 minutes)

Following hyperbaric exposure and prior to lung function testing, subjects were asked to record pulmonary-related symptoms using a questionnaire designed for this study. Subjects were asked to rate four symptoms (pain behind the breast bone, tight feeling in chest, shortness of breath, dry cough), each on a scale of 0 to 3 (absent = 0, mild = 1, moderate = 2, severe = 3). If any symptom was exacerbated on inspiration, the subject scored an extra point. The four symptom scores were summed to give a total score for each subject. For example, a subject experiencing mild substernal pain, moderate chest tightness, severe shortness of breath and severe dry cough on inspiration would have a total symptom score of 1 + 2 + 3 + 3 (+1) = 10. This attempt at quantifying symptoms was similar to the method utilised by Clark and Lambertsen.[3]

Table 1
Unit pulmonary toxicity dose (UPTD) values and average expected decrement in Vital Capacity (VC) (adapted from Wright [11])

UPTD	Approximate % decrement in VC	Example HBOT table
270	<2	P_IO_2 1.4 ATA, t = 1.5 hrs
615	2	
637	2	P_IO_2 2.8 to 1.9 ATA, t = 4.45 hrs (RN 62)
860	4	P_IO_2 2.8 to 1.9 ATA, t = 5.45 hrs (extended RN 62)
1035	6	
1230	8	
1425	10	
1815	15	
2061	17	University of Pennsylvania Institute of Environmental Medicine table 7A (50/50 nitrox/air table at 3.0 to 2.2 ATA)

Figure 2
Oxygen mask demand breathing apparatus

Derivation of the UPTD

The UPTD is calculated as the equivalent oxygen exposure at one ATA (101 kPa) in minutes.[5] The UPTD must be described with respect to both partial pressure of oxygen (P_1O_2) and duration of oxygen exposure (t) since POT increases with both parameters. Estimation of the UPTD is usually made with reference to a family of hyperbolic curves.[2,4–6,13] These curves describe the rate of development of POT with increasing P_1O_2 in an individual with 'average' susceptibility and are constructed from VC measurements during oxygen breathing at 2.0 ATA (203 kPa), 1.0 ATA (101 kPa) and 0.83 ATA (84 kPa).[2,4,5,14,15] From these curves a mathematical equation was derived which may be used to convert any $P_1O_2 – t$ combination to an equivalent 1.0 ATA exposure; that is, the UPTD for that exposure.

POWER AND STATISTICAL ANALYSIS

Sample size calculation suggested we recruit 18 subjects in order to have an 80% chance of detecting a predicted reduction in FVC of 12% following hyperbaric exposure, at a significance level of 0.05. We used Student's paired t-test (two-tailed) to quantify the significance of any differences in lung function for each subject, and the independent t-test for estimations made between subgroups. Any correlation between symptoms of POT and FVC decrements were investigated using Kendall's rank correlation (non-parametric equivalent of simple linear regression). All statistical analyses were made using StatsDirect statistical software, version 1.611, Iain Buchan, 2000.

Table 2
Demographic data for the study subjects

Male/female ratio	16/3
DCI patients/healthy volunteers	5/14
Smoker/non-smoker	3/16
Average age (years)	35.8 +/- 7.5
Average height (cm)	178.9 +/- 7.6

Results

Twenty subjects were recruited from November 2002 until February 2003. One subject was excluded from all analysis because spirometry data after RN 62 exposure had become corrupted. The demographic data for the remaining 19 subjects are summarised in Table 2.

There was a statistically significant reduction in mean FVC following the RN 62 protocol of 8.3% (SD 9.4%, P = 0.001). Sixteen out of 19 subjects demonstrated a decrease in FVC while in three subjects FVC increased. There was no statistical difference between FVC measurements in DCI patients and healthy volunteers before exposure to the RN 62 protocol (P = 0.804). However, DCI patients sustained a decrease in FVC of 15.5% (SD 8.2, P = 0.01, 95%CI = 5.4 to 25.7), while healthy volunteers sustained a smaller reduction in FVC of 5.7% (SD 8.6, P = 0.02, 95%CI = 0.7 to 10.7). This difference between subject types was statistically significant (P = 0.04, 95%CI = 0.5 to 19.2). There was no significant difference in FVC reductions between those who smoked and those who did not. The mean FVC decrease in smokers was 6.2% (SD 4.6%, P = 0.14), and in non-smokers 8.8% (SD 10.1, P = 0.003), the difference not being significant (P = 0.69, 95%CI = -5.2 to 17.6). FVC data for all subjects, DCI patients and healthy volunteers, are summarised in Table 3.

FEV_1 for all subjects decreased by a mean of 2.4% (SD 37.4 %). This change was not statistically significant (P = 0.78, 95%CI). Because the decrease in FEV_1 was less than the decrease in FVC, the FEV_1/FVC ratio improved following HBOT. The measured changes in FEF_{25-75} and PEF were highly variable (variance 30%), and there were no significant changes before and after HBOT (Table 4).

Eleven subjects complained of symptoms that might be related to POT. Ten complained of a mild dry cough only, one of a moderate dry cough and one of several symptoms including cough, chest tightness and retrosternal chest pain on inspiration. There was no correlation between symptom severity and change in FVC (Kendall's rank test, P = 0.697).

Discussion

VC, measured as FVC, showed a greater reduction following an RN 62 protocol than that predicted by the pre-existing UPTD calculation. The FVC decrement roughly correlated

Table 3
Forced vital capacity (FVC; mean +/- SD) before and after RN 62 HBOT exposure

Group (n)	Pre RN 62 FVC (l)	% predicted	Post RN 62 FVC (l)	% predicted	% change	P 95% CI
Total (19)	5.19	106.2	4.74	96.1	-8.3	0.001
(SD)	(+/- 0.93)	(+/- 23.1)	(+/- 0.79)	(+/- 15.8)	(+/- 9.4)	-3.8 to 12.8
DCI patients (5)	5.10	105.1	4.3	88.0	-15.5	0.01
(SD)	(+/- 0.82)	(+/- 25.6)	(+/- 0.69)	(+/- 18.6)	(+/- 8.2)	-5.4 to -25.7
Volunteers (14)	5.23	106.5	4.89	99.0	-5.7	0.02
(SD)	(+/- 0.99)	(+/- 23.2)	(+/- 0.79)	(+/- 14.3)	(+/- 8.6)	-0.7 to -10.7

with the observed change shown previously by Clark and Lambertsen.[3]

We enrolled patients suffering with DCI on an opportunistic basis during the healthy volunteer recruitment period and did not attempt to enrol equal numbers of each subject type for comparison. A somewhat unexpected finding was that the decrements observed were significantly greater in individuals suffering with DCI than in healthy volunteers. This finding might be due to increased exposure to oxygen prior to the hyperbaric exposure in the study, both from 100% oxygen administration on the surface and increased P_1O_2 during the in-water dive that precipitated the episode of DCI. It may also have been due to pulmonary bubble injury in the DCI patients. There was, however, no statistical difference between FVC measurements before exposure to the RN 62 protocol, and a number of the healthy volunteers had also dived in the days prior to the study. One further possibility is that the DCI patients underperformed during their spirometric evaluation after treatment. The healthy volunteers were enthusiastic and treated in a motivating group environment, while DCI patients were mostly treated late in the evening, alone apart from the attendant, and were often asked to perform effort spirometry after a long and stressful day.

We chose to use changes in FVC as our primary measure of POT. A reduction in VC has previously been shown to be one of the most sensitive and consistent manifestations of POT, and is progressive throughout oxygen exposure.[2–6,9] It is relatively simple to estimate FVC with acceptable accuracy and reproducibility using easily available hand-held devices such as that employed in this study. An alternative measure of POT is the volume of air able to be inspired from rest (inspiratory capacity or IC, the inspiratory component of VC). Some authors have suggested IC might be more sensitive than VC as an index of POT, since the relative change in IC was greater after HBOT exposure.[2,4]

FEV_1 was not significantly reduced in our study, a similar result to that reported by Clark and Lambertsen, but reductions have previously been observed after HBOT without a fall in FVC.[3,4,16-19] FEV_1 is a measure of small airway conductance. Since the reduction in FEV_1 in our study was relatively less than the reduction in FVC, the FEV_1/FVC ratio appeared to increase. FEF_{25-75} is a more sensitive measure of small airway function than FEV_1 and it has been shown to decrease with increasing oxygen exposure.[3,16,17] However, its normal range is wide, it is less reproducible than FEV_1 and it can also be difficult to interpret.[7] The wide variation in results for FEF_{25-75} in our study confirms this. PEF results were also extremely varied with changes between +229% and -30%. Other studies have shown that PEF decreases or remains unchanged.[8,20]

Our symptom questionnaire was based on previous observations of POT-related symptoms following hyperbaric oxygen exposure.[2–4,12,13] These are likened to the symptoms

Table 4. FEV_1, FEV_1/FVC, $FEF_{25–75}$ and PEF changes for all subjects before and after RN 62 HBOT exposure (FEV_1 – forced vital capacity in 1 sec; FVD – forced vital capacity; PEF – peak expiratory flow; FEF – forced expiratory flow)

Lung function	Pre RN 62	Post RN 62	Absolute change	% change
FEV_1 (l)	3.8 (+/- 0.8)	3.7 (+/- 0.8)	-0.3 (+/- 1.5)	-2.4 (+/- 0.4)
FEV_1/FVC (%)	74.5 (+/- 12.0)	76.2 (+/- 8.1)	+1.6 (+/- 7.6)	+3.9 (+/-13.1)
FEF_{25-75} (l)	3.3 (+/- 1.5)	3.1 (+/- 1.3)	+0.1 (+/- 0.9)	+13.0 (+/- 55.5)
PEF ($l.sec^{-1}$)	9.0 (+/- 2.6)	8.7 (+/-1.7)	+0.3 (+/-2.3)	-7.1 (+/-55.6)

of a tracheobronchitis, originating in the carina and spreading to the bronchial tree.[2,4] Symptoms usually begin as a mild throat irritation accentuated by inspiration or a dry cough and progressing to a tight chest, uncontrollable coughing, painful inspiration and dyspnoea. Ultimately POT culminates in severe asphyxia and death in the experimental animal.[2] Symptoms rapidly diminish within the first few hours following exposure and have usually completely reversed over the next 24 to 72 hours.[2,3,4] We did not document recovery in our study. The lack of any apparent association of respiratory function decrement and symptoms related to oxygen toxicity in individuals confirms previous reports,[3,13] although a general trend towards increasing symptom severity with decreasing VC has been shown.[2,3,4]

By predicting the decrement in VC following a hyperoxic exposure, the UPTD allows the comparison of pulmonary effects of different HBOT treatment schedules and has been widely employed to provide safe guidelines for pulmonary hyperoxic exposure.[5] Our study suggests that the UPTD for the RN 62 schedule significantly underestimates POT as indicated by the immediate effect on VC. The mathematical derivation of the UPTD is one possible source of this underestimation. The UPTD is based on predictive curves from observations of normal, healthy males exposed to a P_IO_2 of 2.0 ATA (203 kPa) and below.[2,5] This, and Clark and Lambertsen's study,[3] used exposures above 2.0 ATA, so using the UPTD in this context is extrapolating outside the test data. However, these rectangular hyperbolae and hence the UPTD have been used in practice to predict the estimated reduction in VC following exposure to a P_IO_2 greater than 2.0 ATA (203 kPa). The curves are drawn with the implicit assumption that there are asymptotes at $t = 0$ and $P_IO_2 = 0.5$ ATA.[2,5]

Conclusions

VC, measured as FVC, decreased after exposure to the RN 62 protocol. Patients with DCI showed larger decrements in FVC than healthy volunteers. The decrease in both groups exceeded that predicted by the UPTD for that oxygen exposure, suggesting that the concept of the UPTD as a predictor of POT is not without limitations. FEV_1, FEV_1/FVC, FEF_{25-75}, and PEF did not change significantly and there was no correlation between symptoms related to POT and observed change in FVC.

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Declaration

The authors declare they have no financial interest in any commercial product involved in this research and received no financial assistance for the conduct of this study.

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Juliette Leverment, BA, MB, BS, DipDHM
Position at time of research:
Registrar in Diving and Hyperbaric Medicine, Prince of Wales Hospital, Randwick, NSW 2031, Australia.

Michael H Bennett is the Medical Director of the Department of Diving and Hyperbaric Medicine, Prince of Wales Hospital, Sydney.

Address for correspondence:
Juliette Leverment,
c/o Shackelton Department of Anaesthetics,
Southampton General Hospital,
Tremona Road, Southampton,
Hants SO16 6YD,
United Kingdom
***Phone:** +44-(0)7973-435424*
***E-mail:** <juliette@medex.org.uk>*

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Contact: Steve Goble, Administrative Officer
E-mail: <stevegoble@bigpond.com>

HISTORICAL DIVING SOCIETY AUSTRALIA, SE ASIA

All enquiries to:
Historical Diving Society ASEA
PO Box 2064,
Normansville, SA 5204, Australia
Phone: +61-(0)8-558-2970
Fax: +61-(0)8-558-3490
E-mail: <bramsay@iaccess.com.au>

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E-mail: <lisa@uhms.org>

Comparing dive computers

John Lippmann and Mark Wellard

Key words
Computers, multi-level diving, repetitive diving, simulation

Abstract

(Lippmann L, Wellard M. Comparing dive computers. *SPUMS J*. 2004; 34: 124-9.)
Introduction: There are few comparative data on dive computers. This study aimed to observe differences in allowed dive profiles for five models of computer.
Methods: Computers were subjected to pressure–time exposures in a small, water-filled compression chamber to compare their decompression requirements with the Canadian Forces (DCIEM) decompression model and its derivative tables, for which extensive data are available. Pressure exposures were similar to actual depth–time diving profiles occurring in the field. Profiles consisted of: Profile 1. a two, rectangular dive series with reducing depths
Profile 2. a three, rectangular dive series with increasing depths
Profile 3. a multi-level dive with reducing depths
Profile 4. a multi-level dive with increasing depths and
Profile 5. a series of deep, repetitive, 'bounce' dives.
All dives were chosen so they could be compared easily with the DCIEM tables. All computers were set in their standard mode with no 'safety' or altitude time reductions implemented.
Results: The decompression requirements varied greatly between dive computers and with respect to the tables. The decompression times (in minutes) indicated at the end of the final dive for each series were: profile 1 – range (min) 0 – 13; profile 2 – range 0 – 25; profile 3 – no-stop time at final depth 23 – 61; profile 4 – no-stop time at final depth 0 – 11; profile 5 – range 0 – 28.
Conclusions: Some dive computers gave more conservative decompression profiles than others on most, but not all, exposures. Occasional idiosyncratic differences emerged. Some computers were consistently less conservative than DCIEM recommendations. The more conservative computers behaved similarly to DCIEM profiles on many exposures.

Introduction

Electronic dive computers utilise a depth (pressure) sensor, timer, microprocessor, display and may also possess various other features. Although the microprocessors in some devices were encoded with decompression tables, most dive computers are now encoded with a decompression algorithm: a set of mathematical equations designed to simulate the uptake and release of inert gas within a diver's body.

Early models assumed that both gas uptake and elimination were symmetrical and both were exponential. However, many current models are programmed to delay the predicted gas elimination rate to allow for the effects of bubble formation, vasoconstriction and various other factors that can affect gas kinetics. Unfortunately there are few data from which to construct appropriate gas kinetic equations.

By reading the depth and recalculating every few seconds, dive computers enable dive times to be extended well beyond those permitted by tables on most dives, especially on multi-level dive profiles. Many of the current dive computers have been re-programmed to become more conservative over the past few years, reducing no-stop times and increasing decompression requirements, even to the extent that external parameters such as temperature and gas consumption are integrated into the determination. Despite many refinements, there remains concern about the efficacy of these devices in determining dive profiles that minimise the incidence of decompression sickness (DCS).

DAN America data indicate that in 2002, 72% of the divers who were treated for DCS had been using a dive computer,[1] similar to the 2000 figure of 73%.[2] 1997 DAN America data indicate that a very high proportion (93.7%) of such cases reported diving 'within the limits' of their devices.[3] DAN SEAP dive injury records also indicate that the great majority of members who were treated for DCS had been using a dive computer and had reported diving within the limits indicated by the computer (Lippmann JL, unpublished data). However, the high proportion of divers presenting with DCS who had been using dive computers does not indicate that the devices are inherently unsafe. The trend is likely to largely reflect the increase in dive computer usage.

Current dive computers vary greatly in the times they allow and the decompression obligations indicated, and it is important that divers appreciate these differences so that they are more able to select the level of risk that they are willing to take. However, there are few useful comparative data available by which to compare dive computers. This study aimed to observe the differences in allowed dive profiles for a small selection of common dive computers over several dive series.

Methods

One each of a group of dive computers commonly used in the diving industry was selected and subjected to several series of pressure exposures in a small, perspex compression chamber, filled with fresh water. These pressure exposures were designed to simulate as closely as possible actual depth–time diving profiles that occur in the field, despite some being somewhat undesirable.

The five dive computers tested were:

- Suunto ‘Solution’
- Suunto ‘Vytec’
- Uwatec ‘Aladin Pro’
- Uwatec ‘Aladin Smart’
- Oceanic ‘Versa’

The Suunto Solution preceded the Suunto Vytec, and the Uwatec Aladin Pro preceded the Aladin Smart. The earlier models were tested as they are still very commonly used by divers; and to determine what differences in dive times and/or decompression requirements were generated by updated decompression algorithms incorporated in the newer models. All computers were set in the standard mode with no ‘safety’ or altitude time reductions implemented.

The series of profiles tested were (times shown are bottom times):

1. Repetitive series with reducing depth
   36m / 10 minutes
   Surface interval 60 minutes
   30m / 18 minutes

2. Repetitive series with increasing depth
   27m / 18 minutes
   Surface interval 32 minutes
   30m / 16 minutes
   Surface interval 32 minutes
   36m / 10 minutes

3. Multi-level dive with reducing depth
   30m / 5 minutes
   20m / 10 minutes
   15m / as indicated by dive computers

4. Multi-level dive with increasing depth
   15m / 15 minutes
   21m / 10 minutes
   27m / as indicated by dive computers

5. Cyclic repetitive dive series*
   45m / 5 minutes
   Surface interval 60 minutes
   45m / 5 minutes
   Surface interval 60 minutes
   45m / 5 minutes

   * The cyclic repetitive dive series (5) was chosen as it had been shown during in-water trials by the Royal Navy to be unsafe due to an unacceptable incidence of DCS.[4]

Computers were allowed sufficient time to reset between each series of profiles.

The no-stop times allowed and the decompression requirements indicated by the computers were then compared with those generated by the Canadian Forces (DCIEM) tables.[5] These tables were chosen for comparison as they are widely considered to be a benchmark for determining decompression risk.

Table 1
Repetitive dive series with reducing depth (* - see text for explanation)

		Solution	Vytec	Aladin Pro	Aladin Smart	Versa	DCIEM tables*
Dive 1	Depth = 36 msw						
	Bottom time = 10 min						
	No-stop time allowed (min)	10	10	11	11	13	10 (10)
	Ascent time = 3.5 min						
Surface interval = 60 min							
Dive 2	Depth = 30 msw						
	Bottom time = 18 min						
	No-stop time allowed (min)	17	10	16	15	16	10 (11)
	Decompression 6 msw	0	0	0	0	0	3 (0)
	Decompression 3 msw	1	13	1	1	0	9 (11)

Table 2
Repetitive dive series with increasing depth (* - see text for explanation)

		Solution	Vytec	Aladin Pro	Aladin Smart	Versa	DCIEM tables*
Dive 1	Depth = 27 msw						
	Bottom time = 18 min						
	No-stop time allowed (min)	22	22	20	19	25	20 (20)
	Ascent time = 3min						
Surface interval = 32 min							
Dive 2	Depth = 30 msw						
	Bottom time = 16 min						
	No-stop time allowed (min)	12	10	10	12	11	9 (9)
	Decompression 6 msw	0	0	0	0	0	3 (0)
	Decompression 3 msw	9	20	8	8	9	9 (11)
Surface interval = 32 min							
Dive 3	Depth = 36 msw						
	Bottom time = 10 min						
	No-stop time allowed (min)	6	5	6	7	9	5 (6)
	Decompression 6 msw						5 (0)
	Decompression 3 msw	18	25	7	6	0	10 (12)

Table 3
Multi-level dive with reducing depth (* - see text for explanation)

		Solution	Vytec	Aladin Pro	Aladin Smart	Versa	DCIEM tables*
Dive 1	**Level 1** Depth = 30 msw						
	Time at level 1 = 5 min						
	No-stop time allowed (min)	18	16	16	16	20	15
	Ascent to level 2 = 1 min						
	Level 2 Depth = 20 msw						
	Time at level 2 = 10 min						
	No-stop time allowed (min)	32	29	27	14	39	23
	Ascent to level 3 = 0.5 min						
	Level 3 Depth = 15 msw						
	No-stop time allowed (min)	44	40	37	23	61	35 (29)

Table 4
Multi-level dive with increasing depth (* - see text for explanation)

		Solution	Vytec	Aladin Pro	Aladin Smart	Versa	DCIEM tables*
Dive 1	**Level 1** Depth = 15 msw						
	Time at level 1 = 15 min						
	No-stop time allowed (min)	72	69	65	56	87	75
	Descent to level 2 = 0.5 min						
	Level 2 Depth = 21 msw						
	Time at level 2 = 10 min						
	No-stop time allowed (min)	27	24	25	13	31	23 (15)
	Descent to level 3 = 0.5 min						
	Level 3 Depth = 27 msw						
	No-stop time allowed (min)	10	7	6	0	11	0 (0)

Table 5
Cyclic repetitive dive series (* - see text for explanation)

		Solution	Vytec	Aladin Pro	Aladin Smart	Versa	DCIEM Tables*
Dive 1	Depth = 45 msw						
	Bottom time = 5 min						
	No-stop time allowed (min)	6	6	6	4	7	6 (6)
	Ascent time = 4.5 min						
	No-decompression limit						
Surface interval = 60 min							
Dive 2	Depth = 45 msw						
	Bottom time = 5 min						
	No-stop time allowed (min)	6	4	6	4	5	5 (6)
	Decompression 6 msw	0	0	0	0	1	0 (0)
	Decompression 3 msw	0	3	0	1	10	0 (0)
Surface interval = 60 min							
Dive 3	Depth = 45 msw						
	Bottom time = 5 min						
	No-stop time allowed (min)	5	4	6	5	0	5 (6)
	Decompression 6 msw					3	0 (0)
	Decompression 3 msw	0	2	0	1	25	5 (0)

Results

The results are shown in Tables 1 to 5. The first number in the DCIEM column is the time given by the DCIEM tables.[5] The number in brackets is the time given by the actual DCIEM model (provided courtesy of Ron Nishi, DCIEM).

The Vytec yielded times similar to the DCIEM tables and model more consistently than the other computers tested on these profiles. The Vytec was consistently more conservative than its predecessor, the Solution.

The Aladin Pro and Aladin Smart generated similar no-stop times and decompression times on the rectangular profiles tested. However, the Aladin Smart was considerably more conservative on the multi-level profiles than the Aladin Pro and all the other units tested.

The Oceanic Versa was consistently less conservative than the other dive computers and the DCIEM tables except on the series of deep, repetitive 'bounce' dives. In this case it required decompression times well in excess of the DCIEM tables and model and the other dive computers. The decompression times indicated in these cases appear to be excessive, when compared with other decompression tables.

Discussion

All computers examined generally yielded longer no-stop times than the DCIEM tables and model. The Versa was less conservative than the others over most of the profiles tested. With the cyclic bounce dives of known high risk (Table 5), the computers required a decompression stop earlier, suggesting that the models used in the computers are incorporating some additional off-gassing factors compared with the base DCIEM model.

Decompression models include a series of mathematical equations that are designed to simulate inert gas kinetics within the body. These models are mainly based on Haldanian theory, utilising a set of tissue compartments with varying half-times that act independently, 'in parallel', of each other. By contrast, the DCIEM decompression model uses a set of four tissue compartments 'in series', rather than independently of each other.

Many of the algorithms incorporated in dive computers are derived from the work of the late AA Buehlmann.[6] Incarnations of this Haldanian model are incorporated in the Uwatec series of computers, as well as many other brands. The basic equations used in a Buehlmann model are shown below. The other major dive computers on the market use similar concepts and basic equations, with unique modifications.

1. CALCULATING THE PARTIAL PRESSURE OF NITROGEN IN THE INSPIRED GAS

$$pN_2insp = (p_{amb} - 0.063 \text{ bar}) \times 0.79$$

where pN_2insp = inspired nitrogen pressure
p_{amb} = ambient pressure
0.063 = the constant water-vapour pressure in the lungs

2. CALCULATING SATURATION / DESATURATION

$$pN_2 = pN_2^0 + (pN_2insp - pN_2^0) \times (1 - 2^{-\Delta t/T})$$

where pN_2 = partial pressure of nitrogen
pN_2^0 = initial partial pressure of nitrogen
T = tissue compartment half-time
t = time of exposure

Saturation is generally assumed to occur exponentially. In earlier models, desaturation was also assumed to occur exponentially, and at the same rate. However, desaturation is now usually treated as a modified exponential, with factors such as presumed or estimated bubble formation affecting and slowing down the rate of desaturation. One method to incorporate this concept is to include multiplicative factors or coefficients in this equation.

3. CALCULATING THE TOLERATED NITROGEN PRESSURE / AMBIENT PRESSURE

For each tissue compartment, it is assumed that there is a maximum nitrogen pressure that can be tolerated at a particular ambient pressure before bubble formation and/or decompression sickness occurs. Tissue compartments with shorter half-times, presumed to represent body tissues with high blood supply such as blood and brain, are set to be able to tolerate higher nitrogen pressures at a given depth (ambient pressure) than the 'slower' tissue compartments,

$$Pamb_{tol} = (pN_2 - a) \times b$$

where $Pamb_{tol}$ = minimum ambient pressure to which ascent can be made, and a and b are constants, verified through experimentation by Buehlmann.

Buehlmann conducted a variety of experiments including chamber trials with human volunteers. During these trials, certain mild symptoms of decompression sickness were deemed acceptable and adjustments were not always done to try to eliminate these (Buehlmann AA, personal communication). However, with this model, alterations to the no-decompression limits (NDLs) and decompression requirements are easily made by adjusting the values of the constants a and/or b and this has been done by various dive computer programmers. In addition, user-selected 'added safety' adjustments can readily be made by alterations to the constants.

Most dive computers display similar NDLs for an initial, rectangular profile dive. This is because the decompression models on which they are based generally perform similarly on the initial pressure exposure. The initial NDLs for the computers tested, and for the DCIEM tables are shown in Table 6.

Greater differences in decompression advice emerge with repetitive pressure exposures. In addition, further divergence may occur with situations such as a rapid ascent, increased breathing rate, cold water exposure and increasing depth of dive or repetitive dives. The so-called 'adaptive' dive computers are programmed to try to account for events that may increase inert gas load and/or bubble formation during the dive. However, although such events should reduce allowed no-stop dive time or increase decompression obligations and so inherently increase safety, there are unfortunately still relatively few data on which to base accurate computations.

Bubble formation has been handled by entering data into a separate set of equations or conversion fractions (e.g., the reduced gradient bubble model used in the Suunto Vytec[7]) designed to determine the amount and effect of bubble formation, or by adding multiplication factors to existing saturation–desaturation equations, and others.

In addition to altering the constants, increasing the number and range of tissue compartments can also affect the decompression times, as well as the recommended interval to flying after diving. The longer half-times may come into play for multi-day, repetitive diving, as they allow for a presumed nitrogen load to be tracked for an extended period.

Table 6
Initial no-decompression limits (min) for depths from 9 to 42 msw

Depth (m)	Solution	Vytec	Aladin Pro	Aladin Smart	Versa	DCIEM
9	222	204	334	324	283	300
12	127	124	121	124	184	150
15	72	72	70	70	85	75
18	52	52	50	50	59	50
21	37	37	30	36	41	35
24	29	29	28	27	32	25
27	23	23	22	21	25	20
30	18	18	16	16	20	15
33	13	13	14	13	17	12
36	11	11	12	11	14	10
39	9	9	10	10	11	8
42	7	7	9	9	9	7

Table 7
Dive computer tissue compartments and half-times

Computer	Tissues	Half-times (min)
Solution	9	2.5,5,10,20,40,80,120,240,480
Vytec	9	2.5,5,10,20,40,80,120,240,480
Aladin Pro	6	6,14,34,64,124,320
Aladin Sm	8	5,10,20,40,80,160,320,640
Versa	12	5,10,20,40,80,120,160,200,320, 400,480

In practice, the range and number of half-times (Table 7) alone and the published initial dive NDLs (Table 6) may well paint a misleading picture of how a particular dive computer will perform in the field on real dives. As seen in this experiment, the decompression advice displayed by different computers can and often does vary greatly, especially with repetitive dives. The decompression times indicated result from the interplay of a variety of factors, including the particular base decompression used; the amount and type of real dive data, if any, used to adjust the sensitivity of the base model; and if or how adjustments are made to attempt to cater for bubble formation and other variants.

Conclusions

On occasions, the five models of dive computer tested in this study indicated quite different decompression advice with up to 25 minutes' variation on decompression stop time and up to 38 minutes of allowable no-stop time on some profiles. Certain computers were consistently less conservative than the DCIEM tables and the DCIEM model when assessed with a set of essentially rectangular pressure exposures. In these exposures, only the relatively conservative dive computers yielded decompression advice similar to that of the DCIEM tables and the model. The performance of the different computers diverged for dive profiles that were less than optimal.

To minimise the risk of decompression sickness, divers who plan to use a dive computer are advised to choose one that is relatively conservative on the types of dive profile that they are planning to conduct.

Acknowledgement

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John Lippmann, BSc, DipEd, is the Executive Director of Divers Alert Network (DAN) S.E. Asia-Pacific
PO Box 384, Ashburton,
Victoria 3147, Australia.
***Phone:** +61-(0)3-9886-9166*
***Fax:** +61-(0)3-9886-9155*
***E-mail:** <johnl@danseap.org>*

Mark Wellard, PhD, is a Research Fellow at the Brain Research Institute, Melbourne, Australia.
***E-mail:** <m.wellard@brain.org.au>*

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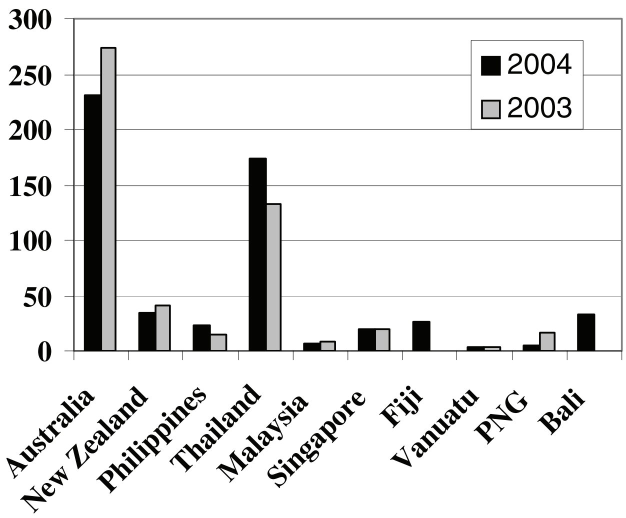

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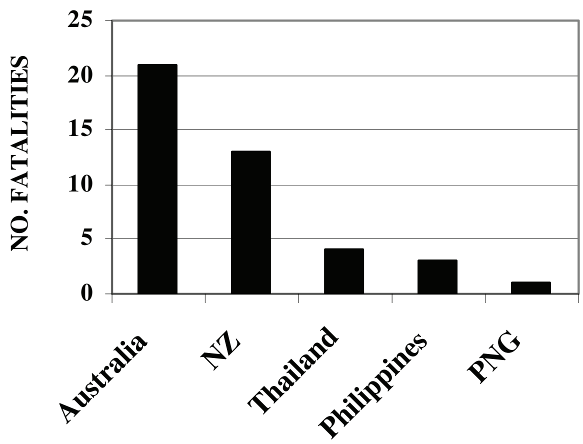

South Australian diving-related deaths 2001–2002. A coroner's inquiry

Christopher J Acott

Key words
Deaths, scuba, case reports, medical conditions and problems, coroner's findings

Abstract

(Acott CJ. South Australian diving-related deaths 2001–2002. A coroner's inquiry. *SPUMS J*. 2004; 34: 130-6.)
Nine recreational diving-related deaths occurred in South Australia in a twenty-month period (2001–2). Five of these deaths were associated with medical conditions that were incompatible with safe diving: a body mass index >30, cardiomyopathy, asthma, lung bullae, pleural adhesions, poor physical fitness and controlled cardiac failure. Because of the similarities in these deaths they were the subject of a single coroner's inquest and the findings are presented.

Introduction

Nine diving-related deaths occurred in South Australia over a twenty-month period. Five of these deaths were associated with medical conditions that were incompatible with safe diving, such as a body mass index (BMI) of greater than 30 $kg.m^{-2}$, cardiomyopathy, asthma, lung bullae, pleural adhesions, poor physical fitness and controlled cardiac failure, and were the subject of a coroner's inquest. A sixth death is reported in a separate case report.[1] The seventh death was that of an obese man in his 50s, who died on his first dive on water entry with no submersion. His death was not the subject of a coroner's inquiry. Another death was due to a shark attack involving a professional scallop diver. The ninth was the death of a bystander involved with the resuscitation of one of the other divers; he was shown to have a coarctation of the aorta at post mortem.

The five deaths that were the subject of a coroner's inquest are described in detail here and the Coroner's recommendations presented. Further details of these deaths can be found on the South Australian Coroner's web site.[2] Each death will be presented in order of occurrence and diving details are quoted from the Coroner's reports.[2] The author attended all post mortems and supplied 'expert' witness evidence at the inquest. The South Australian State Coroner requires the presence of a suitably qualified medical practitioner in diving medicine to be present at all post mortems involving diving deaths.

Death 1

The deceased was a 44-year-old female doing a 'diving refresher' course. She had passed her diving medical, which was performed by a medical practitioner with an 'interest in diving medicine'. Of note in this case was that two diving medical forms were presented, one in which the deceased ticked 'chest problems' and the other submitted later to the doctor where 'chest problems' was not ticked. Details from her medical notes obtained from a public hospital revealed that she had suffered from a pneumothorax in 1996 and used salbutamol regularly for 'shortness of breath'.

Details of the dive are quoted from the Coroner's report.[2]

"*We both left the boat at the same time,…met her at the rear of the boat. At that point she seemed a little stressed,...I asked her if she was okay to descend, she indicated that she wanted to go to the boat and she held onto the mermaid line, then I went to her and then I asked her again and she indicated with the okay signal that she was ready to go...I reconfirmed the okay signal and then we began our descent.*

We went straight down under the boat to the bottom, to the wall where we were going to dive. We settled on the bottom, a depth of 20.7 metres…We communicated through the use of hand signals,...she was okay and ready to go and…we headed off and dived along the wall…We played with the seals and started looking for crayfish. Every time I looked back she was there behind me, just waiting for me.

At about an average time into the dive,…Jenny came to me, tapped me on the shoulder and…indicated she wanted to go up. I indicated could I stay and could she make it back okay on her own. She agreed that she could. We agreed on the direction of the boat, we couldn't see the boat but you didn't have to swim far before you could see the boat. I watched her head off and…I continued looking for crayfish.

About 10 to 15 minutes later I returned to the boat. I came directly up underneath the boat, and when I got to the surface, Angie, the crew member on the boat, asked me where Jenny was. I told her I thought she was on the boat. Angie thought she may have been over by the rocks, which were about 15 to 20 metres away because she thought she had heard somebody call for help. I carried my scuba unit onto the boat and then set off and snorkelled to the rocks area that Angie had indicated to me.

I was only a few metres from the rocks when I saw her on the bottom. I had to observe her for a couple of seconds to see if she was diving or not, she was laying on her back. No air bubbles were coming from her or

her equipment. On looking down I could not see the regulator hanging out of her mouth. I believe it was still in her mouth. I feel I would have noticed that straight away. I tried to dive down to her but not having a weight belt on I couldn't get down to her. She would have been in about 5 metres of water. Another person came to me and he was only on a snorkel as well and couldn't get down there.
Within a few minutes a scuba-equipped diver was there and brought her to the surface. She did not have the regulator in on the way to the surface. She was at the surface with all her gear on. I tried to inflate her BCD [buoyancy compensator device] *with the low pressure inflator but it didn't appear to be working, I then tried manual inflation, I realised that was going to take too long so we ditched her weight belt immediately. I checked to see if she was breathing, and it was fairly obvious that she hadn't been. I then tried to start mouth to mouth. We started dragging her towards the boat and frequently giving her mouth to mouth. I couldn't find any indication of breathing. I couldn't check for a pulse as I had gloves on. It took about 5 minutes to get her to the boat. It took so long because we were trying to resuscitate her.*"

COMMENTARY ON DEATH 1

The relevant post-mortem findings are reported in Table 1. The deceased was diving in a group of three. When she was low on air she indicated to the dive master with her gauge and then, with the instructor's knowledge, ascended alone. This is contrary to safe diving practice.[3,4] Also noted in the narrative was that a boat member thought she had heard a cry for help but did nothing.

The rescue attempt was poor. The dive master and another rescuer snorkelled to the area where the deceased was thought to be but were not weighted to enable them to submerge if necessary. When the victim was on the surface, they attempted to obtain positive buoyancy by trying to inflate her BCD instead of releasing her weight belt. In-water resuscitation attempts delayed getting the deceased onto the boat and a hard surface. Other relevant details in this case history are listed in Table 2.

The Coroner found that '*…the cause of death was salt-water drowning due to ascent barotrauma.*'

The postulated mechanism of death would be that the victim's asthma and pleural adhesions would have changed the compliance in areas of her lungs leading to ascent pulmonary barotrauma and cerebral arterial gas embolism (CAGE). Her bitten tongue would indicate a convulsion (hence CAGE).

Death 2

The deceased was a 58-year-old male, qualified diver, diving for crayfish.

Details of the dive are quoted from the Coroner's report.[2]
"*The three of us entered the water, we were the last group to go into the water. The water was clear, with a little bit of current and about 6–8 metres of visibility. The object of the dive was crays. We were diving in about 9 metres of water…I checked our contents gauges…Jan and I had 100 bar left and Neville had 50 bar.*
I motioned to Jan to stay where she was and motioned to Neville to ascend. He signalled back OK and we started ascending. I don't know if he was over-weighted or not but he wasn't going up very fast...I took hold of the front of his jacket to stop him coming up too fast if he decided to inflate his BCD vest. We surfaced about 40–50 feet south east of the boat. I asked him if he was OK and he said "Yes, fine". I told him to lay on his back and inflate his BCD and just fin back to the boat on his back, with his mouthpiece in. He said he was OK with that and I said I would go back down and get Jan and come back up to the boat. By the time I got down and got up with Jan, Neville was a bit further north of us. He was lying on his back and I thought he was hanging onto the mermaid line...I thought he was enjoying the sun. I got into the boat and took my gear off and called out to Neville but he didn't respond...I put my facemask back on and re-entered the water and swam over to Neville and grabbed hold of his vest and spoke to him but he didn't acknowledge me at all. I pulled him back to the boat, from about 30 feet from the stern. Whilst I was dragging him I noticed some vomit around his mouth. His mouthpiece wasn't in and his mask was in place and was clear. When I left him to go back for Jan his vest was about half inflated and when I returned to him from the boat it was fully inflated, it was almost drum tight. I can't understand why he had it so tight.
Dennis, Kate and Judith were in the water with Jan when I went back to get Neville...We manhandled him into the boat…After we got him on board I saw he wasn't breathing and checked his airway and saw it was clear and started CPR and mouth to mouth and Dennis grabbed the DAN oxygen kit. We couldn't get a pulse or any response. We had him on his side and he sounded like he was full of water. We did CPR and mouth to mouth for about 10 minutes and Kate said he was dead (she is a physiotherapist)."

COMMENTARY ON DEATH 2

Of note were his tight wetsuit, pleural adhesions, bitten tongue, enlarged heart and air found in the heart at post mortem and on chest X-ray (CXR). Relevant post-mortem findings and details are found in Tables 1 and 2. The deceased was diving in a group of three, did not ascend alone, but died on the surface alone.

The Coroner found that the deceased "*…died because he suffered a cerebral arterial gas embolism (CAGE) while ascending…*"

The postulated mechanism of death would be that the victim's pleural adhesions would have altered his pulmonary compliance, leading to pulmonary barotrauma and CAGE on ascent. A bitten tongue would indicate a convulsion and air noted in his heart at post mortem and in a CXR taken soon after death would indicate that a CAGE had occurred. In addition, if the convulsion had occurred while he was inflating his BCD, tonic hand contractions would have caused the BCD to over-inflate.

Death 3

The deceased was a 52-year-old, experienced, male diver, diving with a buddy on surface supply. A non-diver boatman who was a compressor attendant also subsequently died suddenly after attempting to resuscitate the deceased.

Details of the dive are quoted from the Coroner's report.[2]

"*We both jumped in the water. We swam together the*

Table 1. Post-mortem details of the five 'coroner' deaths
* 0.50 kg considered upper range of normal

Death	Sex	Age	Post-mortem findings
1	F	44	Adhesions right middle and lower lobes, pulmonary oedema, tongue bitten Weight – 83 kg (ideal 72 kg); Height – 177 cm
2	M	58	Adhesions upper lobe left lung, enlarged heart (0.655 kg),* enlarged left ventricle with thickened wall, tongue bitten, pulmonary oedema, air in right atrium and on CXR Weight – 113 kg (ideal 86 kg); Height – 186 cm
3	M	52	Heart enlarged (0.55 kg), ischaemic fibrosis, 60% occlusion of right and left main arteries, left lower lobe bullae bilaterally Weight – 132 kg (ideal 83 kg); Height – 183 cm
4	F	42	Food in larynx and bronchi, pulmonary oedema with bilateral pleural effusions, scars on abdomen and lumbar spine Weight – 104 kg (ideal 66 kg); Height – 171 cm
5	M	55	Enlarged heart (0.652 kg), hypertrophic left ventricle, air in right atrium and ventricle, mild interstitial fibrosis of myocardium, mild pulmonary oedema, CXR showed air in right atrium and ventricle, hyperinflated with oedema mainly in the apical areas, bitten tongue Weight – 127 kg (ideal 91 kg); Height – 191 cm

Table 2. Other relevant details of the five 'coroner' deaths

Death	BMI*	Relevant details
1	26 $kg.m^2$	Frequent chest infections, Ventolin user, pneumothorax 1996, recent hospitalisation for laparoscopic appendectomy, two differing diving medical forms – one which had 'chest problems' ticked while the other not
2	32 $kg.m^{-2}$	Antihypertensive medication, left-sided chest injury in a motor vehicle accident – no CXR post accident, very tight wetsuit
3	38 $kg.m^{-2}$	Very tight wetsuit
4	35 $kg.m^{-2}$	Oesophageal reflux on medication, chronic back pain, on Panadeine forte, tight 7 mm wetsuit, overweighted with 18 kg of weight, unfit, cylinder out of test and unused for 12 months, BCD not maintained, inflator salt encrusted and stuck open when operated
5	35 $kg.m^{-2}$	Recent myocarditis, told not to dive by cardiologist, medications: Digoxin and Coversyl, tight wetsuit

* BMI = body mass index = weight (kg)/height^2 (m)
Range: 24–25 $kg.m^{-2}$ = normal; 25–30 $kg.m^{-2}$ = overweight; >30 $kg.m^{-2}$ = obese

whole time looking for crays…We had been down for about 15 minutes...We were in sight of each other the whole time. My ears started to hurt a little bit and I was getting a slight pain on the side of my temple...so I thought that it was time to go up, I signalled to Rex using my thumb indicating to go up and he signalled back with his thumb. We were down about 20–25 feet and were slowly ascending. Once at the surface we were swimming side by side back to the boat. We were about 10–12 feet from the boat. On getting to the side of the boat, I looked back and suddenly couldn't see Rex any more. I quickly looked around and then looked underwater and saw him on the seabed, he was lying on his back. He had both arms up in front of him with his palms up, there was no air coming out of his regulator and he wasn't moving at all. I still was getting air through my regulator and was not having any trouble breathing. I went and swam straight down to him and I could see that (his) face looked different. He is fairly well tanned and I noticed that even under water he looked pale and pinkish. I think his eyes were open. I grabbed him on the chest and shook him and there was no movement and I got no other response. I then unclipped his BCD vest and unbuckled his weight belt. I had to get his arms out of the harness and vest. This took a bit of time and was difficult. I just dropped all that gear and then I lifted him straight to the surface. At the side of the boat I got him half in and I got Paul to grab hold of him. I went around the ladder at the rear of the boat and hoisted myself in and Paul and me pulled Rex into the boat."

COMMENTARY ON DEATH 3

The victim was obese, with an enlarged heart and left lower lobe emphysematous bullae. He was wearing a tight wetsuit. The relevant post-mortem findings are in Table 1 and other details are listed in Table 2. Emphysematous bullae, obesity, a tight wetsuit and immersion would cause a decrease in functional residual capacity (FRC) causing hypoxaemia. The combination of hypoxaemia and sudden exercise (surface swimming) in someone with a hypertrophic left ventricle with 60% of the left main artery occluded would probably lead to arrhythmia, unconsciousness, drowning and death.

Death 4

The deceased was a 42-year-old, inexperienced, female diver. She was obese, unfit, on medication and diving with an equally inexperienced buddy. She was overweighted with 18 kg of weights. Relevant post-mortem findings are in Table 1 and other details are listed in Table 2.

Details of the dive are quoted from the Coroner's report.[2]

"*…The conditions on that day as 'ideal', with calm water, a slight swell and clear skies…they swam out to Centre Rock, about 250 metres offshore, on the surface using their snorkels. They had a couple of rest stops on the way.*

When they reached the area of the rock, and began diving, Ms C had trouble getting down because…she was 'too buoyant'. He put another weight on her belt. They began diving in only 3 to 4 metres of water.

After about ten minutes, Ms C indicated that she wanted a rest. They surfaced, and headed for some rocks so that they could climb out and rest. Mr R described what happened next:

What happened next is still somewhat blurry to me and seemed to happen all very quickly but probably occurred over several minutes. A wave caught us by surprise, it wasn't a large or exceptional wave but pushed us into the rocks, I saw Deb still had the regulator in her mouth at this time as she was forced under the water a couple times and appeared to be struggling for buoyancy.

The waves kept forcing us into the rocks and Deb was continually going under the water and I don't believe at this stage the regulator was in her mouth properly. Deb was still going under the water and I was attempting to pull her up, I struggled with her weight belt and was also trying to get some air back into her buoyancy vest but it did not appear to be going up, eventually I managed to get her weight belt off which helped increase her buoyancy. I was able now to keep her above the water and noticed her lips had gone blue. I took the regulator out of her mouth and started to give her mouth to mouth but was getting no response. I was yelling and screaming for help and someone must have heard me because a short time later a boat arrived to assist."

The Coroner's findings were "*…that the cause of Ms C's death was salt-water drowning. The major factors which caused this tragic outcome were Ms C's obesity, her lack of cardio-vascular fitness, her inappropriately heavy weight belt, and her inexperience which led her to become excessively fatigued. Added to that there were Ms C's health problems, including oesophageal reflux, and her back condition for which she was taking sedative medication.*"

COMMENTARY ON DEATH 4

Of note here was the combination of surface difficulty, swallowing water and probable oesophageal reflux causing aspiration and laryngeal spasm. Food and vomit were found in the victim's trachea at post mortem. The pulmonary oedema found at post mortem may have been due to drowning, aspiration of gastric contents, a result of negative pressure breathing caused by laryngospasm or a combination of these factors.

Death 5

This is the death of a 55-year-old, experienced, male diver who had been warned by a cardiologist not to dive because of his cardiomyopathy and controlled cardiac failure. Relevant post-mortem findings are in Table 1 and other details are listed in Table 2.

Details of the dive are quoted from the Coroner's report.[2]

> "*…Bob had told me earlier this morning that he intended to dive for only 7 to 9 minutes due to his heart condition, it was a viral condition and his doctor advised he shouldn't dive.*
> *When they reached the top of the anchor chain, about 1½ metres from the bottom Mr W swam up to Mr S and gave him a quick 'out of air' signal. He then removed the regulator from Mr S's mouth and began using it himself. Mr S then took Ms R's regulator from her mouth and began using it, and she then used her spare.*
> *The three divers then commenced their ascent to the surface, connected in a 'daisy chain' via their regulators…Mr W was the first of the group above and behind Mr S, who was above and behind Ms R. Mr S was not able to maintain eye contact with Mr W during the ascent. He said: 'We then commenced our ascent up the anchor line. Bob was above me and Magdelena below me. We went up with a quick ascent rate…I couldn't see Bob as he was behind me, I wasn't looking for him, I just assumed he was on my reg. Once we had gone a few metres it felt like we were ascending at the same rate, in control. At about thirty metres, I'm not exactly sure of the depth but I believe we were about ten metres off the bottom, I noticed that my reg, the one that Bob had been on, was unattended by my left side. I believed that Bob mustn't have needed it any more and had let it go. I picked it up to use it myself and noticed that the mouthpiece was missing from the second stage. This was unusual and it made me anxious, I didn't understand it. I indicated to Magdelena to continue the ascent as rapidly as possible. By rapid I mean as fast as I could get up, I wanted to find out what Bob's situation was…We continued up the anchor line until we reached the gear line attached to it a couple of metres below the surface. At this time I let go of Magdelena's reg and continued up the last couple of metres on free ascent because it was quicker and I wanted to look for Bob.*
> *On reaching the surface I could see two pairs of legs under the surface at the rear of the boat so I swam over there. I saw that Graham was supporting Bob's head out of the water, on seeing me he asked for help to get out of the water. I immediately dropped all my dive gear and finned over to the side into the boat. We got Bob's dive gear off and eventually got him into the boat with the use of ropes…we had to place ropes on various parts of his body to get him out of the water...I noticed whilst still in the water there was froth around Bob's mouth and nostrils and it wasn't moving. I don't think he was breathing. I checked for a carotid pulse but it was non existent.*"

The Coroner's findings were that "*…Mr W suffered a CAGE at some stage of his ascent leading to a convulsion, unconsciousness and drowning.*"

COMMENTARY ON DEATH 5

The physiological effects of immersion, tight wetsuit and obesity in combination with a cardiomyopathic left ventricle are demonstrated here. Immersion centralised the victim's peripheral blood volume increasing his 'preload', which could not be accommodated by his cardiomyopathic left ventricle (Laplace's law). A decreased FRC due to immersion and a tight wetsuit plus the decreased chest wall compliance from the wetsuit and immersion added hypoxaemia to these cardiovascular effects. Dyspnoea due to left ventricular failure and hypoxaemia depleted his air supply, and rapid shallow breathing on ascent would have caused unequal alveolar emptying with the inevitable ascent pulmonary barotrauma and CAGE. Cardiac air was found at post mortem and on CXR taken soon after the death. In addition, the bitten tongue would indicate a convulsion.

Discussion

Various factors are common to all these deaths (Table 3). Obesity is associated with many medical problems. The incidence of mortality in overweight men is nearly four times greater than in those of normal weight. There is an increased rate of chronic diseases, many life threatening, including peripheral vascular disease, cardiorespiratory disease, liver disease, diabetes, polycythaemia, hyperlipoproteinaemia, hiatus hernia, oesophageal reflux and malignancies.[5] Many of these conditions, particularly oesophageal reflux, hiatus hernia, cardiorespiratory disease and polycythaemia, are incompatible with 'safe' diving. The physiological effects of immersion may add further stress to the cardiorespiratory systems in obese subjects. Immersion increases the alveolar–arterial (A-a) oxygen gradient due to a decreased functional residual capacity (FRC), which is the result of a pressure differential between the abdomen and chest displacing the diaphragm into the chest thereby compressing the basal lung segments. Immersion also increases left ventricular work by centralising blood from the peripheral circulation.

All five cases would have been considered medically 'unfit' to dive by a majority of diving medical physicians. However, it is difficult to conduct a good risk assessment when the candidate is untruthful about his or her medical condition. Three had enlarged hearts and the physiological effects of immersion would have caused additional myocardial stress. Ventricular hypertrophy would have been evident on electrocardiography and CXR and would have led to additional cardiovascular testing (particularly stress testing and echocardiography). The pleural adhesions would have been evident on CXR, the bullae perhaps not.

None of these deaths was associated with equipment problems, although in deaths 3, 4 and 5 there were equipment issues to note. In death 3 the deceased had modified his weight belt by adding braces to it, which would have prevented it from being quickly released; this is contrary to safe diving practice.[3,4] This had been done to enable him to carry an excessive amount of weight, 20 kg, because of buoyancy problems related to his obesity. His BCD oral inflation valve was also malfunctioning. In death 4, the victim's buddy did have trouble with releasing the deceased's weight belt and inflating her BCD, which was later found to have a poorly functioning inflator. In death 5, one of the divers was lacking an 'octopus' regulator, which meant there was a 'daisy chain' effect when the deceased ran out of air.

All were diving with a buddy or buddies. Three were diving in a group of three. These deaths were associated with the dilemma of one being low on air whilst the other two were not and wanting to continue the dive. The 'correct' response is for all to ascend together; this did not occur in these cases.[3,4]

Three were wearing tight wetsuits, which would compress veins and centralise peripheral blood volume, increasing preload and stressing both ventricles. A tight wetsuit would also decrease chest-wall compliance and would cause an upward displacement of the diaphragm into the chest compressing basal lung segments. The combination of an increased central blood volume, basal collapse and decreased chest-wall compliance would further decrease the FRC increasing the A–a gradient, which would compromise a person with decreased cardiovascular and pulmonary reserves.

These cases emphasise that, although salt-water drowning was described as the ultimate mechanism of death, a cause for the drowning must always be sought.

Table 3
Common factors in five divers' deaths in S. Australia

- All were medically 'unfit' to dive.
- Five had BMIs* in excess of 25 kg.m^{-2}, four in the obese range.
- Four had medical conditions associated with obesity (musculoskeletal problems, cardiac disease and poor physical fitness).
- Three had enlarged hearts.
- Three had pulmonary conditions incompatible with fitness to dive (bullae, pleural adhesions, asthma and a past history of pneumothorax).
- Three had bitten tongues, which would indicate a convulsion.
- All had pulmonary oedema and had suffered from salt-water drowning.
- All were diving with a buddy.
- No faulty equipment could be implicated in the deaths.
- Three had tight wetsuits, which would have compromised their cardiorespiratory reserve.

* BMI = body mass index = weight (kg)/height^2 (m)
Range: 24–25 kg.m^{-2} = normal; 25–30 kg.m^{-2} = overweight; >30 kg.m^{-2} = obese

South Australian Coroner's recommendations[2]

The general recommendations from the SA Coroner are reproduced here.

"*Pursuant to that Section, I make the following recommendations:*
1. All persons engaged in recreational underwater diving should undergo an examination by a registered general medical practitioner trained in hyperbaric medicine on a regular basis, preferably annually but not less frequently than every two years.
2. Medical practitioners should decline to conduct such examinations unless they are appropriately qualified to do so.
3. Medical practitioners conducting such examinations should, if they are not the subject's regular medical practitioner, require the subject to produce a referral letter detailing the subject's medical history as far as it is known.
4. Medical practitioners conducting such examinations should warn the subject that diving is a potentially lethal activity if undertaken by a person with certain medical conditions, and that absolute honesty in providing background medical history is called for.
5. If there is any doubt about the subject's health, the medical practitioner should arrange such follow-up tests as chest X-rays, hypertonic saline tests, or whatever else may be indicated, before passing the subject as fit to dive. Any doubt should be resolved against passing the subject as fit, until such follow-up tests demonstrate fitness to dive.
6. The recreational diving industry should conduct an awareness campaign among its member organisations and the diving public about the dangers of diving with certain medical conditions, the need for regular medical examinations at least every two years, the need for absolute honesty during such examinations, and the responsibility a diver has both personally and to his or her diving colleagues to ensure that he or she is fit to dive."

Comments on the Coroner's recommendations

Diving medical examinations performed only by medical practitioners trained in diving medicine have at last been recommended. Referral letters with medical information, if the diver's regular medical practitioner is not performing the examination, would eliminate much of the inaccurate medical information prompted by other interested parties and omission or concealment by the diver of conditions they know about.

Some may consider the suggestion of a medical every two years excessive but this could be replaced by a self-assessment every two years, with notification to a medical referee if there has been a change in the diver's medical health in the interim. This would be in line with the current practice for employed divers in New Zealand.[6]

The Coroner also recognises that divers have a 'duty of care' to each other and should take responsibility for their actions.

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Christopher J Acott, MBBS, Dip DHM, FANZCA
Physician in Charge Diving Medicine, Hyperbaric Medicine Unit,
Department of Anaesthesia and Intensive Care,
Royal Adelaide Hospital, Adelaide,
South Australia 5001, Australia.
Co-ordinator of the Diving Incident Monitoring Study,
30 Park Avenue, Rosslyn Park,
South Australia, 5072
Phone: *+61-(0)8-8222-5116*
Fax: *+61-(0)8-8232-4207*
E-mail: *<cacott@optusnet.com.au>*

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SPUMS Annual Scientific Meeting 2005

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Smithsonian Institution, USA

Conference Convenor:
Dr Cathy Meehan

McLeod Street Medical,
67 McLeod Street,
Cairns, Queensland 4870,
Australia
E-mail: <cmeehan@ozemail.com.au>

SPUMS Annual Scientific Meeting 2003

The Australian diving medical. A look at the standards in Australia and overseas

Catherine Meehan

Key words
Medicals – diving, standards, medical conditions and problems, fitness to dive, review article

Abstract

(Meehan C. The Australian diving medical. A look at the standards in Australia and overseas. *SPUMS J*. 2004; 34: 137-41.)
This paper outlines the requirements for diving medicals in Australia and the differences between the States. It also looks at the requirements in Australia, the United Kingdom and the internationally-used Recreational Scuba Training Council diving medical form and compares the advice given for diving candidates with a history of asthma, diabetes, hypertension and epilepsy.

Introduction

There are two Australian standards covering diving medicals. These are AS 4005 for recreational diving and AS 2299 for occupational diving.[1,2] In Queensland, however, unlike the other states, there are three documents relevant to recreational diving. The first is the diving medical written and produced by the South Pacific Underwater Medicine Society (SPUMS).[3] The second is the Australian Standard 4005.1, minimum requirements for entry-level scuba diving. The medical appendage is based on the SPUMS Diving Medical, and is formulated after consultation with a committee comprising representatives from the diving and tourism industries, Workplace Health and Safety, the Australian Medical Association and SPUMS. The third publication is the compressed-air recreational diving and recreational snorkelling industry Code of Practice.[4] In Queensland, the Code directs the industry to follow the Australian Standard. Not all states have a code of practice, but each state has its own regulations (Table 1). In Queensland, the industry Code of Practice also covers workers in the recreational diving industry, i.e., diving instructors and dive masters.

Medical fitness-to-dive assessments

In Queensland, the certificate of medical fitness to dive provided to the applicant must follow the specified guidelines set out in the Code of Practice as follows.

RECREATIONAL DIVING

> *"The Medical Certificate should be provided in English, preferably by a medical practitioner with experience in diving medicine."*

OCCUPATIONAL DIVING

> "*The certificate is issued by a doctor who has satisfactorily completed training in diving medicine approved by the Board of Censors of SPUMS.*"

SPUMS no longer has a Board of Censors, this having been replaced by an Academic Board in 2000. This gives some idea of how long it takes for legislation once in place to be changed. Thus the medical certification of divers in Australia appears complex at first sight, but generally defers to a medical standard based on the SPUMS medical for recreational divers and AS 2299 for occupational divers.

There are differences around the world with regard to the requirements for a pre-dive medical. Some examples are given here.

In Queensland, the requirements are clearly outlined in the Code of Practice.[4]

> "*1.3 2C Entry-level certificate divers*
> *The employer/self-employed person should ensure that any person training for an entry-level recreational diving certificate is certified as being medically fit for diving in accordance with Appendices A and B of Australian Standard AS4005.1-2000 Training and certification of recreational divers – Part 1: Minimum entry-level SCUBA diving. The two appendices, that is A and B, give medical information and show the medical form which should be used for a pre-diving medical examination for prospective recreational scuba divers. The medical certification should be provided in English, preferably by a medical practitioner with experience in diving medicine, within 90 days prior to the commencement of training."*

Table 1
Australian state regulations for employed divers

• ACT	Does not regulate
• New South Wales	Occupational Health and Safety Regulation 2001
• Northern Territory	Work Health Regulations 1996
• Queensland	Workplace Health and Safety Regulation 1997
• South Australia	Occupational Health, Safety and Welfare Regulation 1995
• Tasmania	Annotated Workplace Health and Safety Regulations 1998
• Victoria	Does not regulate
• Western Australia	Occupational Safety and Health Regulations 1996

In the USA, the Recreational Scuba Training Council (RSTC) medical statement is used.[6] On this form, under the heading of *Divers Medical Questionnaire*, are directions to the participant as follows:

"***To the Participant***:
The purpose of the Medical Questionnaire is to find out if you should be examined by your doctor before participating in recreational diver training. A positive response to a question does not necessarily disqualify you from diving. A positive response means that there is a pre-existing condition that may affect your safety while diving and you must seek the advice of your physician prior to engaging in dive activities."

In the United Kingdom, the UK Sport Diving Medical Committee (UKSDMC)[7] advises the British Sub-aqua Club, Sub-aqua Association and Scottish Sub-aqua Club on diving medicine issues, including assessment of fitness to dive. This is conducted through a national network of medical referees with accredited diving medicine expertise, using a uniform set of medical standards that are continually reviewed as new research is published.

Recently, the UK moved to a questionnaire-based system. The UKSDMC self-declaration medical system recommends that:

- "*A newly designed Medical Declaration Form has to be completed annually on renewal of membership. The Form is a legal document and the signed declaration confirms that the answers are truthful.*
- *If the response to all questions on the Medical Declaration Form are answered 'No' the form can be signed and is to be held by the SAA Club/BS-AC Branch until the following year.*
- *The member should retain a copy of the form with their qualification book.*
- *If the response to any of the questions on the Medical Declaration Form is 'Yes' or the diver has a query on any of the questions; if the member has not previously seen a medical referee and has answered 'Yes' or has a query on any question on the Medical Declaration Form, the member should not sign the form but telephone their local medical referee for advice.*"

From this telephone inquiry, the medical referee may need only to endorse this form on the diver's behalf. However, if the medical referee advises further assessment and needs to see a diver for assessment, this is performed at the member's expense, although this will only be required in a minority of cases. Such assessment may include physical examination or specialist investigations, such as breathing tests or heart scans for example. The expense, over and above the initial consultation fee (British Medical Association guidelines suggested £61.50 for an initial consultation in 2000) is a matter between the medical referee and the member concerned. For members holding a current 'Certificate of Fitness to Dive' signed by a medical referee, a copy should accompany the annual Medical Declaration Form.

Guidelines for specific medical conditions

Guidelines for assessing candidates with various medical conditions differ from country to country. Examples are given here of the recommendations for assessing candidates with diabetes mellitus, asthma, hypertension and epilepsy from the relevant bodies in Australia, the UK and USA.

DIABETES MELLITUS

The Australian SPUMS Diving Medical states:

"***A4.14 General***
(a) Dip-stick test of urine shall be performed and urine tested for albumin and sugar. Glycosuria calls for investigation before acceptance. Albuminuria may be innocent, but acceptance should be considered after 24 hour protein excretion studies. Any abnormal findings should be fully investigated. Diabetes requiring medication with insulin is a contraindication to diving. Any haematological abnormality should be fully assessed."

The British UKSDMC recommends:

"***General - diabetes mellitus***
A diver with diabetes mellitus may have a hypoglycaemic attack while in the water, which may be fatal to himself or to his diving partner. The hypoglycaemic attack may be brought on by poor

control of the diabetic condition or by an increase in physiological stress due to exercise, cold, etc."

The UKSDMC has decided that diabetics may be allowed to dive provided that they are able to pass the standard medical examination and, in addition, satisfy the following criteria:

1 "*The diabetic has not experienced any hypoglycaemic attack within the last year.*
2 *The diabetic has not been hospitalised for any reason connected with diabetes in the last year.*
3 *The physician in charge of the diabetic at the diabetic clinic must consider the level of control to be satisfactory. This implies that the long-term control of the diabetic condition must be good. A guide to this may be obtained from the HbA or fructosamine level. The physician must also be able to state that he/she considers the potential diabetic diver to be mentally and physically fit to undertake the sport of diving.*
4 *There must be no microalbuminuria present. Any degree of retinopathy beyond background retinopathy is not allowed. There must be no evidence of neuropathy (sensory, motor or automatic), nor of vascular or microvascular disease beyond the background retinopathy in the eye.*"

Two forms, completed annually, together with a leaflet, are provided. One form is completed by the diver and the other by the physician in charge of the diabetic diver. Copies of both forms are sent to a member of the UKSDMC. The examining physician is meant to discuss the risks of diving with diabetes with the diver to ensure they have a good understanding.

The American RSTC is more succinct, stating:

"***Severe Risk Conditions***
The potentially rapid change in level of consciousness associated with hypoglycemia in diabetics on insulin therapy or certain oral hypoglycemic medications can result in drowning. Diving is therefore generally contraindicated, unless associated with a specialized program that addresses these issues."

ASTHMA

The Australian SPUMS Diving Medical states:

"***A4.10 Respiratory System***
(a) A full history and examination should be normal. Any abnormal findings should be fully investigated. Such investigations should include provocation testing if any doubt concerning the possibility of bronchial hyperreactivity exists.
Particular attention must be paid to any condition that might cause retention and trapping of expanding gas in any part of the lungs during recompression (e.g. asthma)
(b) The following conditions may disqualify:
(i) Any chronic lung disease past or present.
(ii) Any history of spontaneous pneumothorax, penetrating chest injuries, or open chest surgery.
(iii) Any fibrotic lesion of the lung that may cause generalised or localised lack of compliance in lung tissue.
(iv) Any evidence of obstructive airways disease e.g. current asthma, chronic bronchitis, allergic bronchospasm."

The British UKSDMC recommends:

"***Respiratory – asthma***
Asthma may predispose to air-trapping leading to pulmonary barotrauma and air embolism, which may be fatal. An acute asthma attack can also cause severe dyspnoea which may be hazardous or fatal during diving. These theoretical risks should be explained fully to the asthmatic diver. There is little if any evidence that the mild controlled asthmatic who follows the guidelines below is at more risk

- *Asthmatics may dive if they have allergic asthma but not if they have cold, exercise or emotion induced asthma.*
- *All asthmatics should be managed in accordance with British Thoracic Society Guidelines.*
- *Only well-controlled asthmatics may dive.*
- *Asthmatics should not dive if he/she has needed a therapeutic bronchodilator in the last 48 hours or has had any other chest symptoms.*"

The American RSTC states:

"***Pulmonary***
Any process or lesion that impedes airflow from the lungs places the diver at risk for pulmonary overinflation with alveolar rupture and the possibility of cerebral air embolization. Many interstitial diseases predispose to spontaneous pneumothorax: Asthma (reactive airway disease), Chronic Obstructive Pulmonary Disease (COPD), cystic or cavitating lung diseases may all cause air trapping. The 1996 Undersea and Hyperbaric Medical Society (UHMS) consensus on diving and asthma indicates that for the risk of pulmonary barotrauma and decompression illness to be acceptably low, the asthmatic diver should be asymptomatic and have normal spirometry before and after an exercise test. Inhalation challenge tests (e.g.: using histamine, hypertonic saline or methacholine) are not sufficiently standardized to be interpreted in the context of scuba diving."

HYPERTENSION

The Australian SPUMS Diving Medical states:

"***A4.9 Cardiovascular System***
(a) A full examination of the CVS should be normal. There must be no evidence of heart disease or arrhythmias. Any abnormalities should be fully investigated.

(b) The resting blood pressure should not exceed 150/95
(c) Further cardiovascular assessment including ECG, exercise ECG or specialist opinion may be indicated where any doubt concerning a candidate's cardiac fitness for exercise exists. The exercise ECG may be a valuable addition to the medical examination of all divers over the age of 45 and even those younger where significant coronary risk factors are present. These factors include obesity, smoking, elevated serum lipids and positive family history."

The British UKSDMC recommends:
"***Cardiovascular system – hypertension and diving***
Hypertension may predispose to pulmonary oedema when diving (1) and is a risk factor for other cardiovascular events, (e.g. stroke and myocardial infarction) which could prove fatal if they occurred in the water.
Diving is permitted by mild hypertensives if their diastolic blood pressure does not exceed 90 mm Hg in new entrants or 100 mm Hg in established divers and their systolic blood pressure does not exceed 160 mm Hg. These pressures are acceptable if they are attained without treatment or by means of approved treatment.
Approved treatments consist of dietary measures including salt restriction, diuretic therapy (when being used to treat hypertension but not if also being used to treat cardiac failure) and low doses of mild vasodilators (e.g. prazosin, nifedipine or ACE inhibitors). Occasionally a medical referee may approve the use of a low dose of a beta-blocker (preferably cardioselective) or other antihypertensive agent to control hypertension provided the heart rate response to exercise stress is unimpaired. The diver should be able to attain a heart rate which is at least 90% of (220 minus his age in years) beats/minute. If beta-blockers are used there must be no evidence of bronchospasm, preferably assessed by lung function tests performed on and off treatment.
Diving is not permitted even if blood pressure control is adequate if there is evidence of end organ damage resulting from hypertension (i.e. renal, eye or cardiovascular complications, including cardiac enlargement)."

The American RSTC states:
"***Relative Risk Conditions***
- *History of Coronary Artery Bypass Grafting (CABG)*
- *Percutaneous Balloon Angioplasty (PCTA) or Coronary Artery Disease (CAD)*
- *History of Myocardial Infarction*
- *Congestive Heart Failure*
- *Hypertension*
- *History of dysrhythmias requiring medication for suppression*
- *Valvular Regurgitation*"

EPILEPSY

The Australian SPUMS Diving Medical states:
*"**A4.8 Central Nervous System***
(a) A full examination of the central nervous system should show normal function. Any abnormalities should be accurately documented for future reference.
(b) A candidate with a history of fits (apart from childhood febrile convulsions), or unexplained blackouts, or a history of migraine requires further assessment."

The British UKSDMC recommends:
*"**Neurological – epilepsy***
An epileptic attack occurring underwater while using conventional scuba equipment is usually a fatal event, since the mouthpiece is likely to be lost and large quantities of water inhaled during the clonic phase of the fit. It is therefore imperative that no epileptic should dive if there is any serious possibility of an attack occurring underwater.
A second factor which has to be considered is the nature of the drugs used to control epilepsy, which are all, to some degree, sedative in nature and would thus exacerbate nitrogen narcosis or cause it to come on at an unexpectedly shallow depth. For this reason, it is not considered safe for any epileptic to dive if he/she is currently taking any anti-epileptic medication.
Since hyperbaric oxygen is known to provoke convulsions in normal individuals, it was formerly considered that epileptics would be at increased risk when exposed to the raised partial pressure of oxygen in compressed air breathed at depth. However, it is now known that the mechanism of the attack is different, and epileptics are not more susceptible to convulse under pressure. Thus, this factor can be disregarded.
The relapse rate in epileptics who are taken off medication decreases exponentially, with the majority of those relapsing doing so within the first eighteen months of ceasing treatment and the rate of relapse becoming insignificant after three years (1,2).
The suggested requirements for an epileptic to be permitted to dive are therefore set at five years free from fits and off medication. Where the fits were exclusively nocturnal, this can be reduced to three years.
A past history of petit mal should not disqualify, provided that no attacks have occurred for five years and that the condition has not progressed to epilepsy.
Pyrexial convulsions in childhood may be disregarded if not followed by epilepsy.
Post traumatic epilepsy: see medical standard on Head Injury and Diving."

The American RSTC states:
"***Severe Risk Conditions***
Any abnormalities where there is a significant

probability of unconsciousness, hence putting the diver at increased risk of drowning. Divers with spinal cord or brain abnormalities where perfusion is impaired may be at increased risk of decompression sickness.
Some conditions are as follows:
- *History of seizures other than childhood febrile seizures*
- *History of Transient Ischaemic Attack (TIA) or Cerebrovascular Accident (CVA)*"

It is easy to see that there are many differences within Australia as well as between countries in the way the diving candidate is assessed. This usually means that there is no single best way. Problems arise when a diver has been assessed overseas as fit to dive, but does not comply with the Australian recommendations. What happens then? Hopefully with time, the medical standards in Australia will become more discretionary and include a risk assessment and risk acceptance of all the parties involved: the diving candidate, dive operator or instructor and the diving doctor.

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Catherine Meehan, MB, BS, is a general practitioner and Secretary of SPUMS. She is the SPUMS representative on the Standards Australia CS-83 Recreational Underwater Diving Committee.
McLeod Street Medical,
67 McLeod Sreet,
Cairns, QLD 4870, Australia
Phone: *+61-(0)7-4052-1583*
E-mail: *<cmeehan@mcleodstmed.com.au>*

Standards for diving in Europe – the present situation

Jürg Wendling and Peter HJ Müller

Key words
Medicals – diving, standards, policy, diving industry, review article

Abstract

(Wendling J, Müller PHJ. Standards for diving in Europe – the present situation. *SPUMS J.* 2004; 34: 141-4.)
Professional and recreational diving has a low accident, but high mortality rate. The European Diving Technology Committee (EDTC) was founded thirty years ago to help reduce the risks of offshore diving. All European countries nominate delegates representing various national interests to the Committee. The EDTC meets every nine months to create harmonised standards that should lower the rate of accidents to an acceptable residual risk level. During the last five years, the EDTC has produced four major standards, the most recent being the *Fitness to dive standards for professional divers (2003)*, which is presented here. This latter standard abandons a prescriptive approach, introducing a more discretionary assessment of possible medical risk factors. This allows the doctor to determine individual fitness relative to the techniques and objectives of the diver's work. A discretionary approach requires a higher (certified) level of competence in the examining doctor. The training standards for diving medicine physicians define three levels of competence: the medical examiner of divers, the diving medicine physician, and the diving/hyperbaric medicine consultant. The programme contains in-depth assessments, annual routine assessments and return-to-diving assessments (e.g., after decompression injuries). The cycle of in-depth assessments is five yearly for young healthy people and more frequent with age. This flexibility provides the diver with improved cost/benefit of medical support, and this is in line with worldwide trends. It should be possible to create similar expert groups in other continents to achieve a worldwide consensus on the criteria for fitness to dive and the examination procedures required.

Introduction

Politically, Europe is converging rapidly into a union with common norms, standards and regulations. Diving, however, has not been one of the important issues focused upon and therefore national standards are still usual. Besides that, there is extreme variability between European countries, some being over-legislated, some others completely lacking any regulation for diving activities. Where legislation exists, its development has historically depended on the need to develop regulations for tunnelling work or the off-shore diving industry.

While a few European representative organisations have been created in order to produce harmonisation of standards and/or guidelines, there are few examples of national standards melding together by voluntary and/or bilateral agreement. One example is the fitness-to-dive standard for recreational diving for Germany, Austria and Switzerland, which has been developed by a subcommittee from all three national scientific societies. The work leading to these guidelines for the assessment of the fitness to dive of recreational divers has been published as a single desk reference recently,[1] but the work has been influenced strongly by the history of multiple approaches to harmonised standards within Europe.

Professional diving: the European Diving Technology Committee (EDTC)[2]

Thirty years ago professional diving was just developing and caused an extremely high number of fatalities and severe accidents. In order to reduce the risks of complications in offshore diving, a multinational committee was founded in Europe, the European Diving Technology Committee (EDTC). The Committee presently includes 17 nations. Every country has nominated delegates representing the government (ministry of the directorate concerned with professional diving), the diving industry, the divers/unions, and diving medicine. The goal is to create harmonised standards that should lower the rate of accidents and incidents to an acceptable residual risk level. This goal has actually been achieved very satisfactorily, as at present the risk for professional divers to suffer from diving accidents is no higher than that for recreational divers.

During the last five years four major European standards have been produced:

- The goal setting principles for uniform diving standards in Europe (1997)[3]
- Training standards for diving and hyperbaric medicine (1999)[4]
- Competence standards for divers training (2002)[5]
- Fitness to dive standards for professional divers (2003)[6]

Looking at the two standards involving medicine we note some important trends:

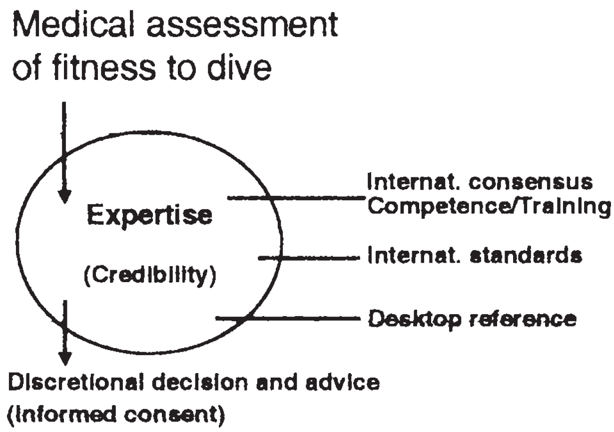
MEDICAL FITNESS-TO-DIVE STANDARD FOR PROFESSIONAL DIVERS

A new approach abandons the prescribed pass/fail checklists and introduces a discretionary approach to known and possible medical risk factors. This allows the doctor to determine divers' fitness on an individual basis relating to the diving techniques to be used and the purpose of the diver's work. This discretionary approach implies a higher and controlled (certified) level of competence for the examining doctor (Figure 1). The appropriate levels of medical training are described in another standard, presented below. The assessment programme contains in-depth assessments, annual routine re-assessments and return-to-diving assessments, e.g., after decompression injury. The cycle of in-depth assessments starts at five yearly for young, healthy individuals and is shortened as required during the ageing process. This flexibility provides the divers with an occupational health assessment that has a good cost/benefit balance. Annual assessments are still routine, designed as an interview and basic physical exam without major technical investigations. This allows the diving medicine physician to monitor the diver and to build up a confidential base for communication.

MEDICAL TRAINING STANDARDS

Descriptive, individualised assessments for divers are acceptable only when the examining doctor has an approved capability to judge the situation. Therefore, four levels of competence have been defined in a consensus paper, namely the medical examiner of divers (level I), the diving medicine physician (level IIa) or hyperbaric oxygen physician (level IIb) and finally the diving/hyperbaric medicine consultant or expert (level III) (Table 1). Level II specialists are competent to perform their task in the diving or hyperbaric field; however, under supervision of an expert or consultant. This level is important in order to create a certain pool of specialists in the hyperbaric centre or diving rescue organisation. These standards were agreed together with the other European Committee (ECHM, see below) and are now implemented through national coordinators.

Figure 1
Competence for the examining doctor



Competency standards for dive training

These standards mainly define the way that divers are trained and the levels of competency needed in the industry. These standards, which are based on the International Marine Contractors Association (IMCA) and the Health and Safety Executive (HSE) regulations, include definition of some medical staff such as the 'diver medic', a diving emergency medical technician mainly used in offshore diving. Inshore divers use so-called 'hyperbaric first-aiders'; essentially assistant diver medics. They are trained to go under pressure with an injured diver and communicate with the diving medical physician by phone during a treatment.

Recreational diving: the European Underwater Federation[7]

Recreational diving is not regulated in most European countries. However, insurance companies have created some limitations and the dive training organisations have all developed their own guidelines. In order to overcome differences that may create tension, the European Committee for Standardization[8] (CEN) has promoted a consensus process that has become possible under the newly created organisation, the European Underwater Federation (EUF), which includes all training organisations operating in Europe. The CEN is creating a standard for tourism services, including dive operators and dive training schools.

So far, the levels of competence of a diver as well as those of instructors have been defined (Table 2), and risk assessments, contingency plans and responsibilities for diving schools and dive boat operators have been prepared. This is a great step forward in mutual recognition and to facilitate diving across national borders. Diving services are defined as being one of the three following types:
a) Organised dives, which are services to autonomous divers who are diving in buddy teams
b) Guided dives, for divers being accompanied and supervised by a dive guide or instructor
c) Training dives, which include not only training activities but also diving beyond the certified level of competence of the individual and which should only be performed in the presence of an instructor.

Medical treatment standards for diving accidents: the European Committee for Hyperbaric Medicine (ECHM)[9]

The ECHM was created fifteen years ago to standardise hyperbaric treatment programmes. The standards were produced through a consensus procedure following a well-defined protocol. Standards for medical treatment of diving injuries were agreed in 1996 in Marseille. At a consensus conference in Geneva in 2003, guidelines for prevention of hyperbaric injuries were discussed and recommendations published on the ECHM web site. These consensus recommendations of an expert panel are very valuable in the situation we find in many countries where hyperbaric treatment is not fully or sometimes not at all considered an established therapy and therefore not funded by insurance companies who argue a lack of evidence for its usefulness.

Multinational standards: the fitness-to-dive standards of Germany, Austria and Switzerland

In 1986, the German Society for Diving and Hyperbaric Medicine (GTÜM)[10] published the first issue of its guidelines for the assessment of fitness for recreational diving to address the needs of the recreational diver.[11] At that time it was felt that the recreational diver was not covered appropriately by the standards on fitness to dive issued by the Workers Compensation in Germany for professional divers. A second edition of the GTÜM recommendations was published in 1992, and revised again in collaboration with recreational diver training organisations in 1994 following the Edinburgh *Conference on Medical Standards for Fitness to Dive*.[12]

In 1995, Wendling and colleagues produced the first edition of the fitness to dive manual, *Tauchtauglichkeit Manual,*[13] as a publication of the Swiss Underwater & Hyperbaric Medical Society (SUHMS).[14] This book became an important desk reference for the medical examiner of divers in all German-speaking countries. When the GTÜM reorganised its subcommittee on fitness to dive in 1997, it included as members on the committee both Swiss and Austrian doctors.[15] The third edition of the GTÜM recommendations was published in 1998 as a collaboration of this multinational German-speaking group.[16] In 2000 the same group, representing the three national societies,

Table 1
European Standards ECHM/EDTC
Levels of training: 'jobs'

I	Medical examination of divers
IIa	Diving medicine physician
IIb	Hyperbaric oxygen physician
III	Hyperbaric expert or consultant (hyperbaric and diving medicine
IV	Associated specialists (e.g., otorhinolaryngologist)

Table 2
Existing CEN norms for recreational diving

Training modules and certifications		**Norm**
Level I:	Supervised diver	EN 14153–1
Level II:	Autonomous diver	EN 14153–2
Level III:	Dive leader	EN 14153–3
Instructor I:	Trainee	EN 14413–1
Instructor II:	Autonomous instructor	EN 14413–1

agreed to sponsor a new edition of the Swiss manual. [1] This was published in 2001 and subsequently translated into French and English, recently reviewed in this journal.

Although this manual does not replace the German guidelines, it is a useful desk reference for the medical examiner of divers, as well as other interested groups or individuals. It is a great step forward in the creation of a uniform standard for Europe, which is expected to be initiated by the CEN in the near future.

Taking a broader perspective, from the above it may appear that the non-German continental countries such as France, Italy and Spain, and in particular the countries within the United Kingdom, which are all very active from a diving point of view, might just as well not exist. It must be admitted that the German-speaking group, which was the first to implement multinational standards, has so far not related to the activities of other countries besides making translations of the GTÜM-SUHMS-ÖGTH standards available and participating actively in seminars on fitness to dive in Europe. However, as mentioned in the introduction, in some countries existing national standards overrule European attempts on harmonised standards, and the work of harmonisation has yet to be acknowledged.

Conclusions and outlook

Establishing uniform procedures is not only a very useful tool to improve communication, it is the only way to increase credibility in a scientific field where randomised double-blind prospective studies are difficult to design and generally do not exist. We have made important steps forward during the last decade, and it is time to think of enlarging the group and coordinating efforts with other continental representative organisations.

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Dr. med. Jürg Wendling is a general and hand surgeon at Spitalzentrum Biel, Switzerland. He is a diving and hyperbaric medicine specialist, committee member of the European Committee for Hyperbaric Medicine and chairman of the Medical Subcommittee of the European Diving Technology Committee and Director of DAN Europe Suisse.
Faubourg du Lac 67,
CH-2502 Bienne, Switzerland
Phone: *+41-(0)32-322-3876*
Fax: *+41-(0)32-322-3839*
E-mail: *<mail@wendling.ch>*

Dr. med. Peter Müller is a consultant in anaesthesiology, intensive care medicine and diving and hyperbaric medicine and Medical Director of the Rhein-Neckar Diving and Hyperbaric Medicine Centre, Diakoniekrankenhaus in Mannheim. He is a member of the Working Group 'Education' for the European Commission, Editor of the ***European Journal of Underwater and Hyperbaric Medicine*** *and Secretary General of the GTÜM.*
Diakoniekrankenhaus, Speyerer Str. 91-93,
D-68163 Mannheim, Germany
Phone: *+49-(0)621-8102-390*
Fax: *+49-(0)621-8102-393*
E-mail: *<dr.mueller@hbo-mannheim.de>*

A review of the British Thoracic Society guidelines on respiratory aspects of fitness for diving

The British Thoracic Society guidelines on respiratory aspects of fitness for diving
British Thoracic Society Fitness to Dive Group, a Subgroup of the British Thoracic Society Standards of Care Committee: Godden D, Currie G, Denison D, Farrell P, Ross J, Stephenson R, Watt S, Wilmshurst P. *Thorax.* 2003; 58: 3-13. <www.thoraxjnl.com>

Summary and commentary

Michael Davis

In explaining the need for recommendations on respiratory aspects of fitness to dive, the British Thoracic Society (BTS) Committee states that "*existing guidelines...on respiratory aspects of fitness to dive are...not consistent*". Cited are the discussion document of the Thoracic Society of Australia and New Zealand, the SPUMS policy statement on fitness to dive and the United Kingdom Sport Medical Diving Committee (UKSMDC) medical standards.[1-3] UKSMDC has recently introduced a questionnaire-based declaration of fitness, similar to that used by the Recreational Scuba Training Council (RSTC), that is, medical examination is required only if positive responses are obtained in the questionnaire.[4]

The purposes of the BTS Committee recommendations are summarised as follows:

- to promote understanding of factors influencing respiratory fitness to dive
- to provide an authoritative, up-to-date literature review
- to provide practical evidence-based advice
- to describe situations requiring further specialist advice.

In order to achieve these aims, they first undertook an extensive literature review using a number of strategies. Literature search topics included the diving environment and physiological effects, diving-related illness, diving deaths and adverse events (epidemiology), specific respiratory conditions and diving, and the available sources of specialist advice (Table 1). Databases searched included Medline, Embase, Cinahl, the Cochrane Library, Healthstar and Sportdiscus. Also searched was material from the British and Scottish Sub-aqua Clubs, the Diver Alert Network, the Professional Association of Diving Instructors, Diving Medicine Online and the SPUMS Journal.

> "*Papers identified were reviewed independently by two members of the Working Party, graded according to the Scottish Intercollegiate Guideline Network (SIGN) guideline criteria for levels of evidence, and recommendations were developed from the literature review according to SIGN principles.*" (Table 2)

A draft document was prepared, sent to selected reviewers and placed on the BTS web site for a month for commentary. The final summation of this evidence was then presented as a summary of key points and recommendations, which is reproduced here (p.148-9).

Specific issues in the guidelines

A number of interesting issues emerge from this extensive literature review, and the provided list of over 80 references is particularly useful.

LONG-TERM EFFECTS

The long-term effects of diving on the lung are unclear from this body of literature. Old data suggest that divers have larger lung volumes than the standard reference population. With time, forced vital capacity (FVC) increased more than the forced expiratory volume in one second (FEV_1), leading to a reduced FEV_1/FVC ratio, and expiratory flows at low lung volumes are inversely related to the number of years of diving. However, it is unknown

Table 1
BTS Guidelines: background literature review topics

The diving environment and physiological effects:
Pressure/volume relationships
Partial pressure relationships
Gas density effects
Immersion in water
Use of breathing apparatus
Types of diving
Long-term effects of diving on the lung

Diving-related illnesses:
Barotrauma
Decompression illness
Pulmonary oedema associated with immersion

Diving deaths and adverse events:
Epidemiology

Specific respiratory conditions and diving:
Pneumothorax
Lung bullae
Asthma
Sarcoidosis
Other diseases

Table 2
BTS Guidelines: levels of evidence

Ia	Meta-analysis of RCTs
Ib	At least one RCT
IIa	At least one CT (non-randomised)
IIb	At least one other well-designed trial
III	Descriptive studies - e.g., case-control, correlation studies
IV	Expert reports and/or opinions

Grading of recommendations

A (Ia, Ib)	At least one RCT in a body of literature of overall good quality
B (IIa, IIb, III)	Well-conducted studies, but no RCTs
C (IV)	Committee reports, respected authorities, expert opinion

whether screening air flow at low lung volumes is of greater value than FEV_1/FVC ratios in screening divers, or to this writer what it all means.[5]

PULMONARY BAROTRAUMA

The Committee states that *"The risk of pulmonary barotrauma is increased where there is localised or generalised airway narrowing, bulla formation or any localised weakness of the lung parenchyma. The risk...during submarine escape tank training is inversely related to FVC measured before training."*[6]

This last statement is based on a 20-year review by the Institute of Naval Medicine in the UK of submarine escape training.[7] Between 1965 and 1984 there were 140 cases of barotrauma, with one death. Respiratory features only were shown by 16.4%, arterial gas embolism (AGE) only by 42.2% and 41.4% showed mixed features.

The report goes on to say that "*The relationship between underlying lung disease and the occurrence of pulmonary barotrauma remains contentious*", and that, based on autopsies of fatal cases "*In cases of barotrauma there was no constant association between lung scars or fibrous tissue and the site of barotrauma.*"

DECOMPRESSION SICKNESS

In relation to decompression sickness (DCS), the Committee states that "*There is some evidence that pulmonary abnormalities are associated with an increased risk of* [DCS] *and obstructive airway disease has been identified as an independent risk factor.*" The only data quoted to support these statements are from a single meeting abstract.[8]

Turning to pneumothorax, the aviation evidence for risk of recurrence in aircrew and the evidence that pleurectomy is protective is reviewed, but the Committee concludes that there are no data concerning continued risk of AGE or pneumothorax in diving.

ASTHMA

The difficulties are even more obvious for asthma where the "*literature...*[is] *contentious and inconclusive*". Data from Australasia and the USA suggest that the prevalence of asthma among those developing AGE and DCS is similar to that of the general population.[9,10] A case-controlled study of 196 AGE victims concluded asthmatics had a 1.6 fold increased risk, increasing to 1.98 if they had current asthma.[11] This appeared as a meeting abstract in which the difference was not statistically significant and these data have not been published in the peer-reviewed literature.

> "*It is unclear whether pulmonary function testing can predict risk of diving related illness*." From their assessment of the results of several studies, they conclude "*current evidence does not support routine use of bronchial provocation testing in assessment of fitness to dive.*"[12-14] "*Despite the inconclusive epidemiology and reservations about pulmonary function testing there is a consensus among diving experts that asthmatics should be advised not to dive if they have wheeze precipitated by exercise, cold or emotion*."

The Committee advocates an exercise stress test as being more suitable than provocation testing, and this is summarised in Table 3.

However, in both the UK and USA asthmatics are allowed to dive if currently well controlled and they have normal lung function tests and a negative exercise test. The specific advice to asthmatics on the management of their asthma during the diving season is provided at the end of the review. An algorithm for assessing respiratory fitness for diving is presented. The reviewer doubts the usefulness of this as in essence what it says is that if the diver has no relevant history pass them fit to dive; if they do have a respiratory history investigate them, and if those investigations are

Table 3
Exercise test for screening divers with a history of asthma
(PFR – Peak expiratory flow rate ($l.min^{-1}$);
FEV_1 – Forced expiratory volume in one sec (l))

- Step test (height – 43 cm) for 3 min, or
- Running outside to heart rate 80% predicted maximum
- Followed by serial PFR or FEV_1 measurements

Exclusion criteria: Decrease of
>15% PFR 3 min post exercise, or
>15% FEV_1 up to 30 min post exercise

positive do more and/or turn them down. This is an interesting example of medicine by committee!

FUTURE RESEARCH

The Committee identifies several areas for future research:
- high-quality epidemiological investigations
- further evaluation of the predictive value and optimal choice of screening tests
- the predictive value of chest CT scans versus standard chest X-ray and
- information on perception of risk in diving community in order to direct dive safety advice better.

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Michael Davis is the Editor, SPUMS Journal.
This commentary is based on a presentation at the SPUMS Annual Scientific Meeting, Palau, 2003.

The Summary of Key Points and Recommendations on pages 148 and 149 and direct quotations are reproduced with kind permission from:
British Thoracic Society guidelines on respiratory aspects of fitness for diving. British Thoracic Society Fitness to Dive Group, a Subgroup of the British Thoracic Society Standards of Care Committee (Godden D, Currie G, Denison D, Farrell P, Ross J, Stephenson R, Watt S, Wilmshurst P). *Thorax*. 2003; 58: 3-13. <www.thoraxjnl.com>

Summary of key points and recommendations – British Thoracic Society Fitness to Dive Group [see p. 147 for full reference]

The diving environment

- Diving is an arduous underwater activity in which environmental conditions affect bodily structure and function.
- For every 10 metres descent in sea water, ambient pressure increases by 100 kPa, equivalent to 1 atmosphere (1 bar). The volume of a given mass of gas changes inversely in proportion to pressure. The gas in bodily cavities such as the lungs, sinuses, middle ear and intestine is therefore subject to compression during descent and expansion during ascent. This may lead to tissue damage.
- Partial pressure of gases increases in direct proportion to the increase in ambient pressure. Greater quantities of inert gas, mainly nitrogen, therefore dissolve in tissues at depth and come out of solution on ascent.
- The density of inhaled gas increases with pressure, restricting breathing.
- Immersion displaces blood from the periphery into the thorax, reducing lung volume.
- Work of breathing increases due to a combination of increased gas density, increased hydrostatic pressure, and altered respiratory mechanics.
- Underwater breathing apparatus adds dead space and increases resistance to breathing.
- During diving, carbon dioxide retention may result from the above listed effects on the body.

Potential risks of diving

- General risks: panic, hypothermia, physical trauma, and drowning.
- Equipment/technique problems: hypoxia, hyperoxia, or poisoning by inappropriate gas mixtures or contaminant gases may result from equipment malfunction or poor dive planning. A malfunctioning respiratory regulator may result in aspiration.
- Barotrauma: is caused by compression or expansion of gas filled spaces during descent or ascent, respectively. Compression of the lungs during descent may lead to alveolar exudation and haemorrhage. Expansion of the lungs during ascent may cause lung rupture leading to pneumothorax, pneumomediastinum, and arterial gas embolism.
- Decompression illness: may occur when gas, which has dissolved in tissues while at depth, comes out of solution as bubbles. Clinical manifestations vary, the most severe being cardiorespiratory and neurological.
- Loss of buoyancy control: is a cause of many accidents, usually when it leads to rapid uncontrolled ascent.

It is also essential to consider comorbidities such as diabetes and epilepsy which may influence capability for diving but are outside the scope of this document.

The physician should bear the following general concepts in mind when assessing respiratory fitness to dive:

- The subject may be required to swim in strong currents.
- The subject may be required to rescue a companion (dive buddy) in the event of an emergency.
- The diving environment is associated with a risk of lung rupture.
- The gas breathed by the diver may be very cold.
- Buoyancy control is essential and requires training, experience, and use of appropriate equipment.

The following recommendations are therefore made.

Assessment of respiratory fitness to dive

- In the history, particular attention should be paid to current respiratory symptoms, previous history of lung disease including childhood history, previous trauma to the chest, and previous episodes of pneumothorax. **[B]**
- Respiratory system examination should be performed. **[B]**
- Forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), and peak expiratory flow rate (PEF) should be measured. **[C]** FEV_1 and PEF should normally be greater than 80% of predicted and the FEV_1/FVC ratio greater than 70%.
- Routine chest radiography is not considered necessary in asymptomatic subjects with no significant respiratory history and normal examination findings. **[C]** However, all professional divers, including recreational divers, who plan to work as instructors are recommended by the Health and Safety Executive to undergo prior chest radiography.
- Chest radiography is appropriate if there is a previous history of any significant respiratory illness—for example, pleurisy, pneumonia, recurrent respiratory infections, sarcoidosis, chest surgery or trauma, pneumothorax—and in those with current respiratory symptoms and/or abnormal examination findings. **[C]**

- Routine measurement of the expiratory flow-volume loop, exercise testing, or bronchial provocation testing are not considered necessary although these tests may be useful in specific cases. **[C]**
- Thoracic CT scanning, which has greater sensitivity than standard chest radiography to detect lung structural abnormality, may be useful in specific cases. **[C]**

An algorithm assessing respiratory fitness for diving is shown in fig 1. A specimen recording form, which could also be used for audit purposes as discussed in Appendix 3, is shown in fig 2.

Recommendations on specific respiratory conditions

- Lung bullae or cysts increase risk of barotrauma and are contraindications to diving. **[B]**
- Previous spontaneous pneumothorax is a contraindication unless treated by bilateral surgical pleurectomy and associated with normal lung function and thoracic CT scan performed after surgery. **[C]**
- Previous traumatic pneumothorax may not be a contraindication if healed and associated with normal lung function, including flow-volume loop and thoracic CT scan. **[C]**
- Subjects with asthma should be advised not to dive if they have wheeze precipitated by exercise, cold, or emotion. **[C]**
- Subjects with asthma may be permitted to dive if, with or without regular inhaled anti-inflammatory agents (step 2 of the BTS guidelines), they: **[C]**
  - are free of asthma symptoms;
  - have normal spirometry (FEV_1 >80% predicted and FEV_1/VC ratio >70% predicted); and
  - have a negative exercise test (<15% fall in FEV_1 after exercise).
- Subjects with asthma should monitor their asthma with regular twice daily peak flow measurement and should refrain from diving if they have: **[C]**
  - active asthma—that is, symptoms requiring relief medication in the 48 hours preceding the dive;
  - reduced PEF (more than 10% fall from best values);
  - increased peak flow variability (more than 20% diurnal variation).
- COPD carries a theoretical increased risk of barotrauma and reduced exercise tolerance. Subjects will probably be advised against diving on the basis of reduced pulmonary function (FEV_1 <80% predicted). **[C]**
- Sarcoidosis has been associated with pulmonary barotrauma. Diving is contraindicated in subjects who have active sarcoidosis. Those in whom sarcoidosis has resolved should have normal chest radiography and pulmonary function testing before being advised that they may proceed with diving. **[C]**
- Tuberculosis is a potentially transmissible disease that may cause residual impairment of lung structure and function. A subject with active tuberculosis should not dive. After curative treatment they may dive if lung function and chest radiograph are normal. **[C]**
- Cystic fibrosis is often associated with abnormal pulmonary function and increased risk of pneumothorax. Diving is contraindicated in those patients who have pulmonary involvement. **[C]**
- Fibrotic lung disease reduces lung compliance and impairs gas transfer. Diving is therefore contraindicated in subjects who have fibrotic lung disease. **[C]**

Long term effects of diving on the lung

- Divers tend to have large lung volumes with proportionately greater increases in vital capacity than in FEV_1. This may be attributable in part to the effects of repeatedly breathing dense gas through increased resistances. **[III]**
- Divers may have reduced expiratory flow rates at low lung volumes, possibly reflecting small airway disease. **[III]**
- Vital capacity of divers may decline with age at an increased rate. **[III]**
- Saturation diving causes a fall in carbon monoxide transfer which, once the dive is completed, gradually returns to pre-dive values. **[IIb]**

Sources of specialist advice

In the United Kingdom, advice on sports diving may be sought from the medical referees of the British Sub Aqua Club, the Scottish Sub Aqua Club, or the Sub Aqua Association. Information is available on the UK Sport Diving Medical Diving Committee website (<*http://www.uksdmc.co.uk*>). The Royal Navy Institute of Naval Medicine is also willing to discuss cases with both divers and physicians.

The Health and Safety Executive (HSE) is responsible for commercial diving policy and regulation. Individuals who are diving at work require a current HSE certificate of fitness to dive following examination by an approved medical examiner of divers.

SPUMS ASM 2003 Workshop

Designing a recreational diving medical for the 21st Century

Michael H Bennett

Key words
Medicals – diving, fitness to dive

Abstract

(Bennett MH. Designing a recreational diving medical for the 21st Century. *SPUMS J*. 2004; 34: 150-2.)
The main theme of the 2003 SPUMS Annual Scientific Meeting was *Risk, diving and the pre-dive medical*. The Workshop built on this theme in looking at how diving medical assessments for the recreational diver might be improved or developed for the foreseeable future. Whatever the current approach, there is no quantitative evidence published to support or refute the routine usefulness of dive medicals when employed in any capacity. Many members of the Society have expressed the desire to re-visit the diving medical. This paper presents a summary of the Workshop discussions and the main conclusions and recommendations reached by the participants. The Workshop resolved to convene a committee of interested members to consider these and to make a report to the Executive Committee on these matters.

Introduction

The South Pacific Underwater Medicine Society (SPUMS) recommends all recreational dive candidates receive a 'fitness to dive' medical examination from an appropriately trained medical practitioner. The Society publishes a recreational diving medical guide and certificate for the use of practitioners,[1] and this examination has formed the basis of Australian Standard 4005.1.[2] This in turn formed the basis for legislation in Queensland, where entry-level dive medicals are a legal requirement.

Originally designed as a 'pass or fail' examination modelled on the commercial dive medical approach, the SPUMS medical has been modified on a number of occasions. Most significantly, in 1996, the certificate issued to the diver was amended to replace the statement 'fit for scuba diving' with the more flexible 'I can find no medical condition incompatible with (diving)', and to allow for qualifying statements at the discretion of the medical practitioner.

To be useful, any dive medical screening process would need to prevent poor health outcomes associated with diving while not unnecessarily restricting the activity. What is meant by the second half of that last statement is very difficult to define. At one extreme, if there were no diving ('if man was meant to breathe underwater we would have gills') there would be no poor outcomes. At the other, unrestricted diving would lead to a number of deaths that might easily be predicted and prevented, e.g., an active epileptic diving.

Whatever the approach, there is no quantitative evidence published to support or refute the routine usefulness of dive medicals when employed in any capacity. In a recent review of 300 occupational dive medicals, Greig et al have suggested that the AS/NZ 2299 medical questionnaire used for occupational diving has little utility in picking up significant information predictive of disqualification.[3] This approach is likely to prove very useful to refine our approach, but begs the question of whether our criteria for disqualification are useful in truly preventing death or injury. While a range of standard approaches have been put in place in different settings, no attempt has been made to prospectively analyse the effect of any change in recreational dive medical policy. Research in this area would be very useful.

Many Society members have expressed the wish to re-visit the diving medical and, for this reason, the Workshop at the 2003 Annual Scientific Meeting addressed this issue.

Objectives

1. To discuss the SPUMS current approach to recreational 'fitness to dive' medicals
2. To consider whether this approach continues to reflect best practice
3. To recommend changes for consideration
4. To consider how our approach may be integrated with an international approach
5. To recommend the course of action most appropriate to proper consideration of the recommended changes

Problems with the current diving medical

The meeting was asked if there were any perceived problems with the medical as currently formulated. Several points were raised for the consideration of the workshop:

1. The process is time-consuming and expensive for the candidate
2. It has proved difficult to deliver trained physicians to

the candidates when and where they are required. This is particularly so in those States where there is no legal requirement
3 The medical is geared to a fit/unfit decision, particularly in Queensland, to the detriment of a meaningful risk assessment process
4 The system is structured so that the medical practitioner is working for the candidate and there is a consequent bias toward a positive outcome
5 There is little element of risk assessment

The system requires the medical practitioner to assume a ‘medicolegal risk’ beyond the strictly medical scope. There is an element of competency assessment beyond the ability of the medical consultation to address. The system allows dive training organisations to shift risk from the instructor to the physician in an inappropriate way.

Following this identification of problems in the present system, the Chair posed a series of questions. Those questions and a summary of the responses follow.

Is there a continuing role for the physician in relation to a candidate for dive training?

There was widespread support for the involvement of a physician at some level during the process of assessing candidates for dive training.

Conclusion: Agreed the physician continues to have a part to play.

If there is a role for the physician, does that physician require training and expertise in diving medicine?

There was no dissent expressed to the proposition that any assessment of risk or fitness for scuba should be made by a trained physician.

Conclusion: Agreed that physicians involved in these assessments need specific training.

Do all candidates require assessment by a physician in person?

This proposition generated considerable discussion. Many physicians present considered the face-to-face consultation with all candidates was not a justified use of the resources of either the candidate or the trained physician.

There was no resolution for this question at the workshop. The main options expressed were:
1 Routine, thorough consultation with all candidates, much as at present
2 Selection of those requiring consultation using a screening tool such as the Recreational Scuba Training Council questionnaire used internationally, properly administered and assessed by the dive training agency
3 Consultation by candidate preference after a discussion of the special risks associated with scuba diving

Conclusion: More discussion is required to attain consensus on this question.

If not all candidates are required to consult a physician, how is a rational decision made as to who should do so?

As this question was highly related to the previous question, there was no consensus here either. Several options were discussed, and they may be pooled into the following general headings:
1 Administration of a questionnaire (as in 2. above)
2 Self referral where the candidate, in the course of their initial training, makes a decision to seek a medical opinion and risk assessment
3 Decision by dive trainer. In this option, the dive trainer would identify individuals who should be requested to seek medical consultation

Conclusion: More discussion required.

Whatever the method chosen, what is the most rational classification of ‘medical fitness’?

There was general consensus that dive candidates could be divided relatively neatly into three groups for the purpose of medical suitability to undertake scuba training:
1 Those with absolute contraindications. These candidates are not recommended for dive training. This is likely to be a small group numerically, but of high importance from a medical point of view
2 Those with relative contraindications. For these candidates, risk assessment and explanation is of prime importance. It is likely this group will constitute a reasonable proportion of the population
3 Those able to undertake training with no specific medical advice. In this group, the emphasis would be on appropriate situational training and instruction by the dive training agency. This group is likely to be a large proportion of the dive-training population

Conclusion: General agreement these three groups could be identified.

For whom is the doctor working?

There are three groups who might see themselves as employing the medical practitioner in some sense. Any combination of these three may operate in the real world:
- The candidate
- The dive training organisation
- The society within which candidate, physician and dive trainers live

Within a number of occupational groups, the aviation industry being a good example, there is a clear responsibility on the physician to consider the ‘greater good’ when examining for medical fitness. Pilots are clearly responsible for passengers, their aircraft and other aircraft in their vicinity. Any medical condition associated with impaired ability in the cockpit should be notified not only for the good of the individual pilot, but for society as a whole. The same might be said for private driving licences, and most general practitioners must have been asked questions concerning 'fitness to drive'.

The Workshop was asked to consider the relative roles of all involved when a school or dive training organisation invited the medical practitioner into the premises, state school or commercial, and asked that they perform dive medicals on a group of candidates. In these situations there might be considerable, if subtle, bias placed on medical decision making.

The Workshop identified the potential problem in primarily considering the candidate as the individual purchasing a service, with the expectation of being 'satisfied'. There was support for the position that this is a widespread potential dilemma, but that a professional approach implicitly recognises this and 'ensures' an appropriate outcome. Experience in the aviation industry suggests otherwise; that this bias to satisfy our patients with the outcome they desire is a powerful influence.[4]

Conclusion: The responsibility of the practitioner in this regard requires consideration.

What should be the outcome of the medical consultation?

The Workshop expressed the view that there were members of the Society who felt a pass/fail result was appropriate and necessary in protecting themselves from unnecessary medicolegal risk. Others were strongly of the opinion that the decision whether to undertake diving or not was a personal one, but one that should be informed by appropriate risk/benefit analysis and advice. The decision by the dive training organisation whether or not to train an individual is theirs to make, and not the responsibility of the physician.

Conclusion: More work is required to define the most appropriate outcome of the consultation.

Should the 'fitness to dive' medical be subject to audit?

Clinical audit of the medicals performed and the appropriateness of recommendations is likely to reinforce appropriate practice. Ideally, a system would be put in place to sample the population of dive medicals and subject this sample to clinical review, including feedback to the individual practitioner. This practice, often seen as threatening by doctors, might actually have benefits in terms of medicolegal risk, and would be, at the very least, an open commitment to provision of a high-quality service.

The Workshop felt, however, that such a system is most unlikely to be developed in the absence of specific funding for this purpose. Such a move would be unprecedented for a recreational activity. It might be useful to further consider what kind of quality process could be applied in this area.

Conclusion: More consideration is required in relation to this question.

Where to from here?

The Workshop identified several areas in which further consideration is justified. At a fundamental level, questions have been raised as to the medical and cost effectiveness of the 'fitness to dive' medical.

The Workshop resolved to convene a committee of interested members to consider the findings and recommendations of this workshop and to make a report to the Executive Committee on these matters. This report would be presented for discussion at a subsequent ASM of this Society.

The author of this report was appointed as interim chair of this committee for the purpose of recruiting members. I therefore ask any members of the Society who wish to contribute thoughts on the issues discussed above to contact me at <*m.bennett@unsw.edu.au*>. All volunteers willing to actively contribute to this committee will be welcome. A list of those participating in the committee will appear in the December 2004 issue of the Journal. This is an important task for the Society.

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Michael H Bennett FANZCA, DipDHM, is Medical Director, Diving and Hyperbaric Medicine, Prince of Wales Hospital and Senior Lecturer at the University of New South Wales. He was the Scientific Convenor for the 2003 ASM.

Department of Diving and Hyperbaric Medicine, Prince of Wales Hospital,
Randwick , NSW 2031, Australia.
Phone: *+61-(0)2-9382-3880*
Fax: *+61-(0)2-9382-3882*
E-mail: *<m.bennett@unsw.edu.au>*

Articles reprinted from other journals

Adjunctive treatment of decompression illness with a non-steroidal anti-inflammatory drug (Tenoxicam) reduces compression requirement

M Bennett, S Mitchell, A Dominguez

We report a randomized trial examining adjunctive administration of the NSAID, tenoxicam, to divers suffering with DCI. 180 subjects were graded for severity on admission and randomized according to a stratified random number schedule. Subjects were recompressed and treatment continued daily until symptom stabilization or complete resolution. Tenoxicam 20mg or a placebo preparation was administered at the first air break during the initial recompression and continued daily for seven days. The subjects were assessed using a recovery status score at the completion of treatment and at 4-6 weeks. The proportion of patients with mild residual symptoms at discharge and final follow-up was not significantly different (discharge placebo 30% versus tenoxicam 37%, P =0.41; six weeks placebo 20% versus tenoxicam 17%, P = 0.58). There was a significant reduction in the number of treatments required to achieve discharge (median treatments placebo 3, tenoxicam 2, P = 0.01). 61% of patients in the tenoxicam group required less than 3 compressions, versus 40% in the placebo group (P = 0.01, RRR 33% [95%CI 9%-56%], NNT = 5 [95%CI 3-18]). There was no evidence of increased complications of treatment in the tenoxicam group. When given this NSAID, patients with DCI require fewer hyperbaric oxygen (HBO_2) sessions to achieve a standard clinical end-point and there is likely to be an associated cost saving.

Reprinted with kind permission from Bennett M, Mitchell S, Dominguez A. Adjunctive treatment of decompression illness with a non-steroidal anti-inflammatory drug (Tenoxicam) reduces compression requirement. *Undersea Hyperb Med.* 2003; 30: 195-205.

Key words
Decompression illness, treatment, non-steroidal anti-inflammatories, treatment sequelae, hyperbaric research

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Measurement of fatigue following 18 msw dry chamber dives breathing air or enriched air nitrox

R.J.D. Harris, D.J. Doolette, D.C. Wilkinson, D.J. Williams

Many divers report less fatigue following diving breathing oxygen rich N_2-O_2 mixtures compared with breathing air. In this double blinded, randomized controlled study 11 divers breathed either air or Enriched Air Nitrox 36% (oxygen 36%, nitrogen 64%) during an 18 msw (281 kPa(a)) dry chamber dive for a bottom time of 40 minutes. Two periods of exercise were performed during the dive. Divers were assessed before and after each dive using the Multidimensional Fatigue Inventory-20, a visual analogue scale, Digit Span Tests, Stroop Tests, and Divers Health Survey (DHS). Diving to 18m produced no measurable difference in fatigue, attention levels, ability to concentrate or DHS scores, following dives using either breathing gas.

Reprinted with kind permission from Harris, RJD, Doolette DJ, Wilkinson DC, Williams DJ. Measurement of fatigue following 18 msw dry chamber dives breathing air or enriched air nitrox. *Undersea Hyperb Med.* 2003; 30: 285-91.

Key words
Air, enriched air nitrox, performance, hyperbaric research

Editor's comments: As a journal policy, abstracts of publications by SPUMS members in the fields of diving and hyperbaric medicine will be reprinted whenever possible in the Journal. Members who publish elsewhere are invited to inform the journal office of the full reference details of their work.

Treatment of 137 cases of decompression sickness*

By A. G. Slark, Surgeon Lieutenant, Royal New Zealand Navy
Royal Naval Physiological Laboratory, Alverstoke, Hants.

***Reproduced by permission of the Royal Naval Personnel Research Committee (U.P.S.215) and the Institute of Naval Medicine from: Slark AG. Treatment of 137 cases of decompression sickness. *Journal of the Royal Naval Medical Service*. 1964; 50: 219-25.**

Summary

The treatment of 137 cases of decompression sickness is reviewed and the various routines used in treatment are compared. Special attention is paid to the recurrence rate after the initial treatment. Some suggestions are put forward for more efficient treatment, using methods other than the traditional stage system of decompression from fixed pressure levels.

Introduction

During the course of the last decade the incidence of decompression sickness within the Royal Navy has markedly increased. Whereas in the past such cases were largely the result of accident or negligence and fortunately rare, the testing of new techniques and tables has produced sufficient material to make some analysis of the various methods of treatment worth while. This paper consists of summaries of the histories of those cases treated by recompression in the Navy of which I have been able to find some record, together with an examination of the effectiveness of treatment employed. The records used have been reports to Naval Medical Officers of Health, records of Courts of Inquiry, Hospital case notes, and the reports of various diving trials. Unfortunately these are neither as accurate nor as detailed as would be desirable, and many gaps exist in the reports. What proportion these cases are of the actual number which occurred is problematical, though I would think that most have been found. In all cases where it has been possible the information given has been cross-checked between the various records. A total of 137 cases are summarised, of which 6 occurred before 1952. During 1962 there has been further experimental diving, and more cases of decompression sickness, some of them of considerable interest, particularly with regard to the management of the more serious cases. These however are to be reported separately, and they do not affect any general conclusions drawn in this paper. Following the case summaries are some comments on the symptomatology, types of treatment and its effectiveness, then a brief discussion of the findings.

Symptomatology

The occurrence of skin rashes and itching has not been recorded in the case histories nor in the list of symptoms because it is so common that in very many instances it has undoubtedly occurred but neither been mentioned by the diver nor recorded by the medical officer.

Table 1 shows the preponderance of upper extremity bends in contrast to tunnel and caisson workers, whose bends usually occur in the lower limbs. The spread and combination of symptoms is very similar to that in the series by Van Der Aue, Duffner and Behnke (1947). A further contrast with tunnel workers is the much greater number showing symptoms other than pain, here designated group B – a third of the total, whereas in the Dartford Tunnel series (Campbell Golding, Griffiths, Paton, Walder and Hempleman, 1960) only 5 per cent had such symptoms. This suggests that although some of the divers may have the type 2 syndrome described there, the majority have a decompression sickness of the same aetiology as the 'simple

Table 1

TABLE 1A

CASES	SYMPTOMS	NUMBER
Group A	Pain in upper limbs	77
	Pain in lower limbs	26
	Pain in both extremities or limbs and trunk	22
	Pain in trunk	22
Group B	Disorder of power	16
	Disorder of sensation	11
	Shock	8
	Nausea and sickness	7
	Vertigo	6
	Headache	5
	Unconsciousness	4
	Disordered vision	3

TABLE 1B

	No	%
Patients exhibiting group A symptoms only	89	64.9
Patients exhibiting group B symptoms only	5	3.6
Patients having symptoms of both group A & B	43	31.4
Total	137	

bends', but of a more serious degree. The group B Systems probably tend to be an underestimate, since minor degrees of these disorders would tend to get neglected in the giving and recording of the history, particularly in the presence of a severe pain, and when rapid treatment has been applied. I am inclined to think that some degree of shock is much more common than it appears from the table. With regard to this I should mention that it does not seem to be routine practice in experimental diving for the diver to receive any blood pressure or pulse recording immediately before or after his dives, or any other clinical examination apart from his ears, which must detract from the value of any findings made in the course of investigating illness caused by the diving.

Types of treatment

The various schemes of treatment are shown for reference purposes in appendices. The earlier cases were all treated according to BR155/43 which uses a multiple phase system also described in '*Deep Diving and Submarine Operations*' and is attributed to Haldane. All the later cases were treated by the American tables, described by Van Der Aue, Duffner and Behnke, (1947), or the British modification of them. In these latter tables oxygen breathing is treated as a bonus, but is not used to shorten the time under pressure, and the table 2A has been reduced from 4 hours at 10 feet to 2 hours. The first of these changes was made because it was felt that it was dangerous to surface directly from 30 feet after oxygen breathing, and that anyway, it was difficult in practice to keep anyone on oxygen for any length of time. The change in table 2A was made because it was thought illogical to have 4 hours at 10 feet on this table and only 2 hours on tables 3 and 4, (Crocker, 1962). The Eaton modification of the British table 1 (Eaton, 1958) was used once without success. With this system stage decompression has been avoided by a continuous 'leakway' of gas from 100 feet. However, the case on which it was used was too serious for a table 1 decompression to be effective, and the failure was not surprising. The American tables were devised after a series of experiments described by Van Der Aue, White Hayter, Brinton, Keller and Behnke, (1945). They were tested on a series of 113 cases of decompression described by Van Der Aue, Duffner and Behnke, (1947). Following these reports they have been very widely accepted throughout the world, and have become hallowed by time and inclusion in many diving manuals. There has not however been any other critical examination of their effectiveness, as far as I know. The Haldane system of BR 155/43 used prior to their introduction was felt to be unsatisfactory because of a series of recurrences, but there were no figures of statistical value to compare its effectiveness with the newer system when this was introduced.

The effectiveness of treatment

The effectiveness of the various methods of treatment are here judged by the rate of recurrence of symptoms requiring further recompression for their relief (Table 2).

It will be seen that about one in five of all the cases treated by recompression require additional pressurisation, and it does not appear to matter much which system is used. The 20 per cent recurrence is surprisingly constant. It is also interesting to note that of 24 incidents at Submarine Escape Training Tank, where these tables have been used, 6 required further recompression. (UPS 199, 1961). The somewhat higher recurrence rate for American table 2 might seem to justify the British fears of the oxygen breathing tables, but in fact it is doubtful if all the 35 cases recorded as treated by this system received oxygen, and much more likely that they were decompressed on the longer air table and the explanatory A left out of the record.

The 35 cases of line 1 include any in which the records indicate that even minor symptoms coexisted with the usual pain of bends (Table 3). The increased recurrence rate of these cases suggests that such symptoms indicate a considerably greater severity of the decompression sickness and have a significance which may well not have been appreciated during treatment. It is also possible that rapid recompression has avoided the appearance of symptoms to be expected with a certain severity of decompression sickness, but that the degree of nitrogen over-saturation

Table 2

TREATMENT	NO.	RECURRENCES	%
B.1 : A. 1A:	42	9	21.4
A.1	21	4	19.0
A.2	14	4	28.5
A.2A	1	0	-
B. & A. 3 & 4	10	2	20.0
B.2	20	4	20.0
155/43	26	5	19.2
Other	3	2	-
Overall Total	137	30	21.9
Total A & B except B.2	88	19	21.5

B – British table. A – American table.
Note: The British table 2 is listed separately because of the difference of the time given at 10 feet mentioned earlier.

Table 3

TYPE	NO.	REC.	RATE
Cases treated on tables 1 or 2 with symptoms other than pain	35	11	31.4
Cases of pain only	65	11	16.9
Complicated cases apparently properly treated	8	1	12.5

becomes apparent by resistance to treatment on the briefer tables.

Only in 109 cases has the time of onset of symptoms been recorded but judging by the recurrence rate these are a fairly representative selection. It is a little surprising that cases with symptoms presenting soon after surfacing appear to be more prone to recur than those occurring during the decompression or immediately at the surface. It would be interesting to tabulate the recurrence rate according to the time interval between onset of symptoms and return to pressure, but nowhere is this information available.

Discussion

Although some recurrence rate must be inevitable there can be no doubt that an average of 20 per cent is too high. By recompression and subsequent prolonged decompression it is not only bubble effects which are treated, but a general state of nitrogen supersaturation, and while treatment must be based on the clinical state of the patient and his response to the treatment, this itself is by no means an accurate indication of the extent of the saturation. Nevertheless it is possible to achieve better results than these.

It can be argued that the tables have not been properly applied, and this has certainly been so in many instances. But even when used with rigid exactitude for the most straightforward cases there is still a high recurrence rate. However, any scheme of treatment must stand or fall by the results it achieves when interpreted by those for whose guidance it has been designed, in this case, by supervising diving officers, and medical officers. The tables tend to make the management of a case of decompression sickness appear easier than it often is and of course they can give no help with the diagnosis of the many apparently minor symptoms which may complicate the normal picture of a case of bends.

Table 4

TIME OF ONSET OF SYMPTOMS	NO.	RECURRENCE	%
During decompression or immediately on surfacing	43	9	20.9
Within ½ hour	19	8	42.1
½ to 1 hour	11	1	-
1-2 hours	14	3	21.4
2-4 hours	7	1	-
4-6 hours	8	-	-
6-8 hours	3	-	-
8-10 hours	-	-	-
10-12 hours	3	1	-
12-14 hours	-	-	-
14-16 hours	-	-	-
16-18 hours	1	-	-
18-24 hours	-	-	-
Total	109	23	21.1

The most obvious illogicality of these tables is their adherence to a staging system of decompression. Staging was introduced into diving as the best practical method of approximating to the curve of nitrogen elimination, but it has little point when using a recompression chamber. Either a system of multiple phases, or a continuous leakaway would be more preferable. I suppose that stages have an advantage for the unskilled operator at an RCC but the inexperienced should not be attending those with bends. Anyway valves which are capable of being pre-set should be an integral part of any chamber. It seems quite extraordinary that such expensive therapeutic equipment should not be thus furnished more often, for if it is worth having at all, it should surely be properly equipped. The prolonged soak at 30 feet which is generally assumed to be the strength of tables 3 and 4 could equally well be embodied in a system which did not employ rapid fluctuations of pressure change at other pressures.

The advantages of using a continuous leakaway of pressure, instead of stages, has been demonstrated by W. J. Eaton (1958) in his series of 110 cases of decompression sickness in goats. Using a similar time schedule to table 1A (American) he has virtually eliminated recurrences when treating simple bends in goats. Since the publication of this paper he has treated many more with equal success. This is surely very relevant to the treatment of bends in divers and I feel sure that the potential benefits of using such a technique have been insufficiently recognised.

The system evolved by P. Griffiths for the treatment of bends in Tunnel workers, (Campbell, Golder, *et al*, 1960) in which the minimum effective therapeutic pressure is employed, enables him to treat his type 1 cases in an average time of 2 hours with a negligible rate of recurrence. This method minimizes the contribution that nitrogen absorbed during treatment may make to the recurrence of symptoms. Most cases of simple bends treated on the present tables could have avoided 30 - 60 minutes at an additional atmosphere of pressure.

These two series show how better results can be achieved with other methods, and indicate the sort of possible improvements in treatment which should be tested. The Haldane and American systems appear to have a similar degree of effectiveness, if judged by their recurrence rate in the cases here presented. The best feature of the former is its relatively even release of pressure, and of the latter, its longer time schedules at lower pressures. These should be combined in a new set of scales for therapeutic decompression. The Griffiths concept of 'minimum effective pressure' could also be used with such scales in the treatment of limb pain only, though where other symptoms coexist such as those listed in group B of table 1, immediate resort to high pressure should remain in the standard treatment for there is considerable evidence to suggest that such symptoms, vague though they may be, indicate that the decompression sickness is of a much more serious degree. In this series they have nearly doubled the recurrence rate of the more straightforward bends. Recent experience has also shown how an initially effective pressure may be insufficient to prevent the recrudescence of serious symptoms (Mackay, 1962).

To sum up I would suggest that because the tables at present in use are unsatisfactory, future therapeutic decompression should be experimentally conducted in an effort to achieve a more effective system, and that a new set of decompression scales be devised combining multiple phases of pressure relief or, even better, a continuous leakaway, with the time schedule of the present tables. With the most straightforward cases of uncomplicated bends the minimum effective pressure could be employed. By these means it may be possible to make therapeutic decompression more effective, and ultimately a briefer and less arduous procedure than it now is.

Acknowledgements

I wish to thank Surgeon Lieutenant Commander D. E. Mackay, RN for access to all his records and for continual help and much instructive discussion. I would also like to thank all the staff of the Royal Naval Physiological Laboratory for their help during my time at the establishment.

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Obituary

Surgeon Commodore Anthony George Slark RNZN (Rtd), MB BS (Lond), Dip Obst (RCOG), DPH, DIH, RCP (Lond) and RCS (Eng), MRCGP, FACPHM, MFOM

It was the Christmas university holidays of 1971-72; one Seaman Officer Ensign Peter Robinson RNZNVR was the duty ‘doctor’ at the RNZN Hospital when it was signalled that Surgeon Lt Cdr A G Slark RNZNVR was accompanying a diver suffering from the ‘bends’ back from the RNZN deep diving trials off Whitianga. Just as Tony had discovered in 1957 when he was the medical officer on board *HMNZS Pukaki* at the Christmas Island hydrogen bomb tests, the subject of the ‘bends’ had been singularly missing from the medical undergraduate curriculum. I met an impressive man who had time for the questions of a poorly informed medical student, an expert in a field of medicine that he could truly say he helped shape, an active diver and one who was to become mentor to many young doctors who shared his passion for the Navy and naval medicine.

These traits must have been noted early by the then Director of Naval Medical Services who decided it was time the RNZN had a Medical Diving Officer. On Tony’s return to New Zealand from the bomb tests, he recalled a discussion that went like this, “Read this, my boy, you are to be the doctor to the divers.” The Royal Navy Diving Manual was handed across. This must have impressed Tony immensely as, on reviewing his service documents recently, I noted he actually signed for the manual but has never given it back according to the records.

Tony always placed higher medical qualification as a priority, and many naval doctors owe their careers to his support. He added to his own qualifications when he returned to the UK for postgraduate study, which included six months at the Royal Naval Physiological Laboratory. The accompanying paper was the product of this study.[1] In this, Tony classifies decompression sickness into two groups which he called Type A and Type B. As often happens, it was the work of another researcher that stuck having instead used the terms Type 1 and Type 2.

In 1964, Tony went into general practice in Devonport but retained his naval connection by joining the RNZNVR. He continued in the role as consultant in underwater medicine, looking after many ‘bent’ divers over three decades. He was active in the New Zealand Medical Association and, in particular, the never-ending debate over maternity subsidies.

In 1977, Tony was approached to rejoin the Navy to take up the reins of the Naval Medical Service, which he did in the rank of Surgeon Captain. In this second period of Tony's naval service, the operating theatre and wards were upgraded, and the first plans were discussed as to the expansion of the Naval Hospital.

It was during this time that an old friend visited from the UK, one Dr David Elliott. I clearly remember the three of us being anchored off Goat Island on Tony's boat. David and I decided the water did not look inviting, but the Surgeon Captain, New Zealand's leading diving doctor, just could not help himself, so he kits up and goes for a dive. There ensued one of those 'ivory tower' academic debates as to how we, David and I, would explain things if anything went wrong; it was a very long time up there on the surface. The problem for us was that every rule in the diving book had just been broken: diving alone, no dive plan, no emergency plan if he didn't return, no dive flag…here, I think I should stop.

During this period as ADMS (Navy) a steady stream of sixth-year medical students on elective came to the Navy Hospital to study diving medicine. The first part of their initiation was to be put on the navy diver basic course with its zero visibility during the daytime diving, the claustrophobic night diving under the ships in the Naval Basin and, of course, the infamous 'mud run', one of the most physically exhausting exercises a military could devise. Many 'projects' were devised by Tony so the students could add a research paper to their elective ordeal.

Tony was still active in part-time general practice, and it was a difficult decision when he was invited to move to Wellington to take up the post of Director General of Defence Medical Services. History shows that he did, and, as such, became the first ever one-star ranked RNZN medical officer (Surgeon Commodore, on 1st December 1983). This was a post at times frustrating, but the politicking of Wellington was something he enjoyed being involved in. He stood for excellence in military medicine, and the appointment of the first trauma surgeon to the Army based in the Auckland Medical School and Hospital was one of his many achievements. Tony could be terse when interrupted from important matters, but usually he was easy of smile and considered in his advice. He was known in the Army Medical Corps as 'The Admiral' but they could never get the Navy ranks right!

Tony was active in the South Pacific Underwater Medicine Society from its early days. He attended numerous ASMs, presenting papers and case reports, chairing sessions and taking a vigorous part in discussion from the floor of the meetings. He was on the Executive Committee between 1987 and 1996, serving as President from 1987 to 1990 at a time when its affairs were far from settled.

In terms of the contribution Tony made to naval and diving medicine in New Zealand, only part of which I have touched on, one only has to look to the facilities at the Navy to see how far we have come from those days when he was detailed off to be the 'doctor to the divers'.[2]

Tony died in May 2004 after a short illness. The Society extends its best wishes for the future to his wife, Eileen, and children, Matthew, Jon and Cindy.

References

1 Slark AG. Treatment of 137 cases of decompression sickness. Medical Research Council RN Personnel Research Committee Report 63/1030, London.

2 Slark AG. Doctor to the divers. *SPUMS J*. 2003; 33: 145-8.

Peter Robinson

Key words
Obituary, underwater medicine

SPUMS notices and news

South 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 medically qualified financial member of the Society.
2 The candidate must supply evidence of satisfactory completion of an examined two-week full-time course in Diving and Hyperbaric Medicine at an approved Hyperbaric Medicine Unit.
3 The candidate must have completed the equivalent (as determined by the Education Officer) of at least six months' full-time clinical training in an approved Hyperbaric Medicine Unit.
4 The candidate must submit a written proposal for research in a relevant area of underwater or hyperbaric medicine, and in a standard format, for approval by the Academic Board before commencing their research project.
5 The candidate must produce, to the satisfaction of the Academic Board, a written report on the approved research project, in the form of a scientific paper suitable for publication.

Additional information

The candidate must contact the Education Officer to advise of their intended candidacy, seek approval of their courses in Diving and Hyperbaric Medicine and training time in the intended Hyperbaric Medicine Unit, discuss the proposed subject matter of their research, and obtain instructions before submitting any written material or commencing a research project.

All research reports must clearly test a hypothesis. Original basic or clinical research is acceptable. Case series reports may be acceptable if thoroughly documented, subject to quantitative analysis, and the subject is extensively researched and discussed in detail. Reports of a single case are insufficient. Review articles may be acceptable if the world literature is thoroughly analysed and discussed, and the subject has not recently been similarly reviewed. Previously published material will not be considered.

It is expected that all research will be conducted in accordance with the joint NHMRC/AVCC statement and guidelines on research practice (available at http://www.health.gov.au/nhmrc/research/general/nhmrcavc.htm) or the equivalent requirement of the country in which the research is conducted. All research involving humans or animals must be accompanied by documented evidence of approval by an appropriate research ethics committee. It is expected that the research project and the written report will be primarily the work of the candidate.

The Academic Board reserves the right to modify any of these requirements from time to time. The Academic Board consists of:
Dr Chris Acott, Education Officer, Professor Des Gorman and Associate Professor Mike Davis.
All enquiries should be addressed to the Education Officer:
Dr Chris Acott,
30 Park Avenue
Rosslyn Park
South Australia 5072
Australia
E-mail: <cacott@optusnet.com.au>

Key words
Qualifications, underwater medicine, hyperbaric oxygen, research

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Minutes of the Annual General Meeting of SPUMS held in Noumea on 5 June 2004

Opened: 1800 hr

Present: All members attending the Annual Scientific Meeting

Apologies: Drs D Smart, S Mitchell, G Long, J Marwood, H Turnbull

1 Minutes of the previous meeting
Unratified minutes of the previous meeting have been posted on the meeting notice board and appeared in *SPUMS J* 2003; 33: 171.
Motion that the minutes be taken as read and is an accurate record.
Proposed Dr M Davis, seconded Dr B Trytko, carried.

2 Matters arising from the minutes
None

3 Annual reports received
3.1 President's Report.
3.2 Secretary's Report
3.3 Education Officer's Report. An informal report was given.
3.4 President's Committee Report. The Committee has

not met this year and so there is nothing to report.

4 Annual Financial Statements and Treasurer's Report

4.1 Motion that the financial statements be accepted.
Proposed Dr G Williams, seconded Dr V Haller, carried.
4.2 Subscription fees for the coming year to remain the same.
Proposed Dr M Bennett, seconded Dr D Davies, carried.

5 Election of office bearers

Nominations have been called for the position of Treasurer. One nomination was received for Dr Andrew Patterson.

6 Appointment of the Auditor

Proposal regarding the appointment of Mr David Porter as the auditor for 2004.
Proposed Dr B Trytko, seconded Dr V Haller, carried.

7 Business of which notice has been given

7.1 Changes to the SPUMS Statement of Purposes and Rules. The following motions have been proposed and seconded (as printed in the SPUMS Journal):

Motion 1
Purpose 4
Proposed amendment: Replace the word *newsletter* with *journal* to read
To promote communication between members of the Association and to publish a journal for the Association.

Motion 2
Rule 12 (a)
Proposed amendment: Replace the number *42* with *21* and *his address* with *their address* to read
The Secretary of the Association shall at least 21 days before the date fixed for the holding of any annual general meeting of the Association and at least 14 days before the fixed date for the holding of any special general meeting of the Association, cause to be sent to each member of the Association at their address appearing in the register of members, a notice by prepaid post stating the place, date and time of the meeting and a description of the purpose and a summary of the business to be transacted at the meeting.

Motion 3
Rule 22 (a) & (c)
Notice of motion published in *SPUMS J*. 2003; 33: 226.

Motion 4
Rule 26
Proposed amendments: Delete the words *in books provided for that purpose*, and add the word *ratified* before copy of the minutes to read
The Secretary of the Association shall keep minutes of the resolutions and proceedings of each General Meeting and each Committee Meeting together with a record of the names of persons present at the Committee Meetings. A ratified copy of the minutes of the proceedings of all meetings of the Committee shall be incorporated in the next edition of the Journal for the information of all members of the Association.

Motion 5
Rule 28 (b)
Proposed amendment: Delete the words *by the Treasurer* and replace by the words *jointly by at least two approved signatories* to read
Any cheque, draft, bill of exchange, promissory note or other negotiable instrument may be signed jointly by at least two approved signatories.
Passed with minor change: "Any cheque, draft, bill of exchange, promissory note or other negotiable instrument MUST (not may) be signed jointly by at least two approved signatories."
Change proposed by Dr A Patterson, seconded Dr M Bennett.

Motion 6
Rule 29
Proposed amendment: In the second sentence replace the word *will* with *may*, and also after the word *meet* insert the phrase *as authorised by the Executive Committee* to read
This standing committee will be composed of life or ordinary members who have served at least one year as the President of the Society. The Committee may meet as authorised by the Executive Committee at the Annual Scientific Meeting of the Society, at the members' expense, and at the same time as the Executive Committee at one other time during the year, at the Society's expense. The Presidents' Committee will also be able to conduct telephone conferences. Chairmanship of the Committee will be the responsibility of the Immediate Past-President and minutes will be kept by members in rotation. The Presidents' Committee will answer directly to the current Society President and be responsible for the development of actual and draft Society policy on issues identified by the Society. The Presidents' Committee will report its activities in the Society Journal and provide an annual report to the Society at the Annual Scientific Meeting.

Motion 7
Rule 39
Proposed amendment: Replace the words *the "SPUMS Journal"* with the words *"Diving and Hyperbaric Medicine: The Journal of the South Pacific Underwater Medicine Society"* to read
A Journal to be known as "Diving and Hyperbaric Medicine: The Journal of the South Pacific Underwater Medicine Society" or other such name as may be adopted by the Association in general meeting, shall be produced and distributed to all members of the Association.

Income from subscriptions may be applied by the Committee for such publication.

Motion 8
Rule 40
Proposed amendment: Subject to adoption of the motion amending Rule 39, replace the words *the SPUMS Journal* with *Diving and Hyperbaric Medicine: The Journal of the South Pacific Underwater Medicine Society* to read
The Committee may coopt or appoint such persons to an editorial board for the journal Diving and Hyperbaric Medicine: The Journal of the South Pacific Underwater Medicine Society as it deems necessary to assist the Editor. The Editor shall be responsible for its publication and shall be Chairman of the Editorial Board. The Editor shall have regard to the view, if any, expressed by the majority of the Committee as to editorial policy and publishing of material.

Motions 1 to 8 were passed unanimously by the meeting

7.2 Notice of motion (as printed in *SPUMS Journal*. 2004; 34: 50.).
Proposed Dr J Marwood, seconded Dr Geoff Long.
Not passed

7.3 Matters regarding the appointed conference travel agents, Dr H Turnbull.
This was placed on the table and will not be discussed further unless a formal motion is given.

Closed: 1915 hr

Notice to Members

"Motions, other than those conferring membership, passed at general meetings shall have no effect until approved by the full membership. Approval of the above passed motions will be assumed if no member informs the Secretary, in writing, of any objections to the motions within one calender month of the publication of this issue of the Journal. If an objection is received a postal ballot will be held."

President's report 2004

Another year has passed to see us gathered here in Noumea for our Annual Scientific Meeting. This year's meeting has again been excellent due to the wonderful presentations by our guest lecturers, Dr Peter Fenner (marine envenomation) and Dr David Doolette (decompression modelling). The Committee strives to select speakers and topics that will interest and educate our membership, and we trust we have fulfilled this goal once more this year. For Society members who are unable to attend the meeting, these presentations will be available as usual in the Journal in due course.

The SPUMS Journal has continued to provide an excellent reference source for both diving and hyperbaric medicine issues under the expert guidance of our Editor, Dr Michael Davis. The quality of the Journal continues to improve and it is rightly recognised as the leader in its field.

The Committee has undergone some changes this year with the resignation of Dr Barbara Trytko from the position of Treasurer. Dr Andrew Patterson has accepted our request to fulfil this quite time-consuming role and has brought with him enthusiasm and expertise in guarding and monitoring the Society's finances.

The Committee has also accepted with regret the resignation of Dr David Doolette from the position of Education Officer. David has reinvigorated this position and provided superb guidance as mentor for those members pursuing the SPUMS Diploma. His replacement will be Dr Christopher Acott.

Dr David Smart has been appointed as the SPUMS representative on the Standards Australia Occupational Diving Committee, replacing Dr John Knight. The Society owes a great deal to the members who willingly give up many hours of their own time to ensure the business of the Society continues. I add my personal thanks to the retiring members of the Committee for the assistance they have provided to me over the previous years.

It is also with regret that I note the recent passing of one of our SPUMS Life Members and previous Presidents, Dr Tony Slark. Tony had an unbridled enthusiasm for diving medicine and life and he will be sadly missed by all. Our condolences go to his wife Eileen and their family.

The Committee continues to make progress on a number of issues. The Society's members are advancing in age and I believe it is important for us to pursue strategies to capture the interest of our younger medical colleagues. The SPUMS web site needs to be brought forward into the 21st Century and will undergo a major revamp. We aim to have this functioning within the next few months and it will include the provision of a secure gateway for joining up from the web site and for the payment of membership and conference registration expenses. This may increase our attraction for overseas members allowing for easy access to the Society.

SPUMS sponsored a number of lunchtime meetings at the recent Undersea Hyperbaric Medical Society meeting in Sydney and scheduled our Annual Scientific Meeting to follow on immediately, with the aim of capturing some new delegates. This has had limited success but we welcome all our first-time members who have joined us here in Noumea.

Following on from last year's workshop in Palau, work is being progressed on the SPUMS diving medical, with additional advice to be provided on some of the contentious diving medical issues.

The SPUMS guidelines for our Annual Scientific Meeting

Convenors undergo continual revision with each meeting to ensure we meet our members' expectations.

Finally I am advising that this, my sixth, will be my last year as President. The Committee is there to meet the needs of the Society and I firmly believe that new ideas, new approaches and new faces are required to keep the Society progressing forwards. I will happily accept responsibility for Society matters that occur during my watch, but would suggest that the dedicated few who run the Society and the meetings get somewhat jaded with time and with criticism which appears to greatly override encouragement and offers of assistance. There is as yet no identified replacement for me as President. Whilst I strongly believe that time on the Committee is advantageous prior to accepting this role, if there are any interested volunteers I would urge you to contact me at your earliest convenience.

I look forward to another productive year and hope to see you all in the Maldives in 2005.

Robyn Walker

Secretary's report 2004

At present the SPUMS membership is 805 *(807)* members. There are 107 (*130)* outstanding renewals for this year. There have been 13 (*9)* resignations this year. There are 63 (*59)* new members since the last AGM.

Once again I would like to thank the SPUMS administrator, Mr Steve Goble, for all his hard work. I would also like to thank Dr Andrew Patterson for standing in as SPUMS Treasurer. I also thank the rest of the Committee for putting aside time for the tasks of committee meetings and memos.

Special thanks go to Guy Williams for putting together another successful meeting.

We are again committing to another year and hope that during this year we will increase the SPUMS membership. To assist with this, SPUMS will endeavour to improve the functionality of the web site.

We look forward to a healthier membership next year.

Cathy Meehan

Treasurer's report 2004

I am pleased to be able to report to the members that at present your Society is in healthy financial position.

The audited accounts show that at the end of December 2003, the end of the Society's financial year, the Society's accounts were in surplus by over \$116,000. This sum included \$96,000 in the investment account, representing an accumulation over many years, together with a small amount of interest from investing the principal in a secure but reasonably easily accessed account with the ANZ Bank. The remaining \$20,000 is in the Society's operating accounts, and from time to time some of this amount is transferred to the investment account.

In the Statement of Income and Expenditure it is particularly pleasing to note that there is a surplus of over \$18,000. As this represents a turnaround of over \$22,000 from the small operating loss of the previous financial year, I suggest to members that the Committee have been working hard for the benefit of the Society. A large part of the improvement can be attributed to computer costs in the financial year ending December 2002, which represent an unusual item and one that we will attempt to avoid in future. Spreading the purchase of equipment or upgrades over a number of years or leasing equipment over a similar period are two methods we will have to consider. Costs of the ASM are of course dependent on the location and members will note the difference in this item between last year and the year before. As far as possible, the Committee tries to ensure that each ASM is essentially self-funding. At this point I am reasonably confident that ASM 2004 will break even.

The costs of administration of SPUMS are borne largely by unpaid volunteers, with support from some dedicated paid contractors. In the near future we hope to be able to make many of these mundane tasks less time consuming and more cost effective through replacing the Society's web site with one that will provide better communication with members and will enable them to complete various tasks, such as renewal of subscriptions, on line. Initial inquiries suggest that this change will not be cheap, but we expect that savings in administrative costs alone will make it worthwhile.

Andrew Patterson

Executive Committee resignation

Dr Michael Bennett has recently tendered his resignation from the Executive Committee. Dr Bennett served for several years as the ANZHMG Representative on the Committee and then as an Ordinary Member. He was Scientific Convenor of the 2003 ASM and recently of the highly successful Undersea and Hyperbaric Medicine Society meeting in Sydney. His input will be sadly missed.

Audit report to the members of the South Pacific Underwater Medicine Society

I have conducted various tests and checks as I believe are necessary considering the size and nature of the Society and having so examined the books and records of The South Pacific Underwater Medicine Society for the year ended 31 December 2003 report that the accompanying Income and Expenditure and Balance Sheet have been properly drawn up from the records of the Society and gives a true and fair view of the financial activities for the year then ended.

Dated: 02 June 2004
Suite 304, 20 Bungan Road
Mona Vale, New South Wales 2103

David Porter
Chartered Accountant

THE SOUTH PACIFIC UNDERWATER MEDICINE SOCIETY BALANCE SHEET
AS AT 31 DECEMBER 2003

	2003	2002
MEMBERS' FUNDS		
Balance at 1 January 2003	114,856	118,788
Surplus/(Deficiency) for year	18,381	(3,932)
	$133,237	$114,856
represented by:		
CURRENT ASSETS		
ANZ Bank 1998 ASM Account	13,632	9,212
ANZ Access Cheque Account	6,447	8,085
ANZ VZ Plus	96,400	92,825
Accounts receivable	5,889	1,235
Prepaid 2004 ASM expenses	10,333	-
Sundry loan	-	1,456
GST recoverable	536	2,043
NET ASSETS	$133,237	$114,856

These are the accounts referred to in the report of D S PORTER, Chartered Accountant, Mona Vale 2103.
Dated 02 June 2004

THE SOUTH PACIFIC UNDERWATER MEDICINE SOCIETY STATEMENT OF INCOME AND EXPENDITURE FOR THE YEAR ENDED 31 DECEMBER 2003

	2003	2002
INCOME		
Subscriptions & Registrations	100,264	90,122
Interest	3,579	3,135
Advertising & Journal sales	316	2,045
ASM 2003	37,275	34,070
Sundry Income	1,102	1,094
	$142,536	$130,466
EXPENSES		
ASM costs	39,406	45,741
Bad debt written off	1,456	-
Secretarial wages	14,527	13,532
Stationery & Printing	450	812
Journal	27,645	18,288
Postage, Facsimile & Internet	1,672	3,883
Conferences & Telephone	5,766	8,819
Computer Equipment	747	10,732
Miscellaneous/Subscriptions	386	1,755
Bank Charges	4,799	5,764
Audit	1,800	1,600
Editor's honorarium	19,335	18,263
Insurance	6,166	5,409
	$124,155	$134,398
SURPLUS FOR THE YEAR	$ 18,381	$ (3,932)

These are the accounts referred to in the report of D S PORTER, Chartered Accountant, Mona Vale 2103.
Dated 02 June 2004

THE SOUTH PACIFIC UNDERWATER MEDICINE SOCIETY MOVEMENTS ON BANK BALANCES FOR THE YEAR ENDED 31 DECEMBER 2003

		2003	2002
OPENING BALANCES			
ANZ bank	- ASM account	9,212	9,287
	- Access Cheque account	8,085	17,431
	- VZ Plus	92,825	89,707
		110,122	116,425
add, **RECEIPTS**		142,536	130,466
		252,658	246,891
less, **PAYMENTS**		136,179	136,769
CLOSING BALANCES			
ANZ bank	- 1998 ASM account	13,632	9,212
	- Access Cheque account	6,447	8,085
	- VZ Plus	96,400	92,825
		$116,479	$110,122

NOTE:
Receipts and Payments above may include Balance Sheet items which are not included in the Income and Expenditure statement.

Minutes of the combined Annual General Meeting of ANZHMG and D&HM SIG

Four Seasons Hotel, Sydney, Wednesday 26 May 2004

Opened: 1620 hours

1. Present
D Smart, R Wong (co-chairs), M Walker, B Spain, B Trytko, R Lloyd-Williams, S Sharkey, R Walker, R Harris, R Webb, D Griffiths, R Long, G Emerson, F Sharp, I Millar, A Gibson, M Davis, M Bennett, D Davies, M Hodgson, D Wilkinson

2. Apologies
H Oxer, M Viney, D Wright, C Acott

3. Minutes of 2003 Annual General Meeting
Minutes accepted (Davis/Bennett)

4. Business arising
None

5. MSAC report
The supporting committee for application 1054 (dealing specifically with the indications of refractory soft-tissue radiation injury and refractory wounds in non-diabetic patients) last met over 12 months ago yet their recommendations remain hidden. The only information provided by MSAC has been their announcement that the interim medicare item number for these indications has been extended to 31 October 2004. Lack of any precedent, lack of an adequately described process, lack of independent review in case of dispute, lack of transparency and ultimately lack of faith mean suspicion is an appropriate response. Contingency plans broadly discussed.

6. ANZHMG/SIG list of approved indications for HBO_2
Discussion initiated by Dr Long concerning avascular necrosis of femoral head, which is not currently part of our list. Prompted by a large case series from Israel and his own personal experience, Dr Long has proposed a study of avascular necrosis involving MRI and pain scale assessment. The study was encouraged with further discussion held over until next AGM.

Action: People who have treated AVN or who wish to contribute to the study to contact Dr Long

7. Introductory Course in Hyperbaric Medicine – March 2004
Successfully held at the Prince of Wales Hospital this year and attended by 19 candidates including international representatives from SE Asia. Course organisers are discussing a change in format, away from didactic lectures in favour of problem-based evolving clinical scenarios. The UHMS accreditation currently held by this course is up for review; as no UHMS members have attended the course it was questioned if the process of reaccreditation was warranted. Decision was left to the course organisers.

8. ANZCA-SIG Certificate
The Australian and New Zealand College of Anaesthetists has awarded foundation certificates in Diving and Hyperbaric Medicine to 17 people.

9. ANZCA-SIG exams
The certificate in Diving and Hyperbaric Medicine will now be awarded on completion of criteria described in the SPUMS Journal, including an exam. For this exam, the written paper will be held on 11 October (local to the candidate, consisting of 10 short-answer questions) and the viva on 29 October (central location, presenting to two examiners). College-approved examiners so far are Drs Bennett, Wilkinson, Smart and Wong. Dr Walker has applied and others interested in becoming involved are invited to apply to the College of Anaesthetists.

Action: Details of exam to be published in SPUMS Journal

10. ANZCA citations
Citations have been awarded and presented to Drs Carl Edmonds and Peter McCartney. A citation has also been awarded to Dr J Williamson and will be presented at a forthcoming SA CME meeting. Dr Davis to receive all citations for eventual publication in the Journal.

11. Minimum qualification to conduct AS/NZS 2299 diving medicals
Dr Davis reported that New Zealand is introducing a scheme for recertification of doctors who perform diving medical examinations – the nature of which was not clear. Discussion also noted that the standard refers readers to SPUMS for appropriate courses, leaving it to SPUMS to make this determination.

12. Minimum qualifications to direct hyperbaric treatment
This topic was discussed at last year's AGM; in essence, direction of treatment may be remote.

13. Australian Standards issues
Dr Davis suggested he would talk to Standards New Zealand about adopting AS 4774 for hyperbaric facilities.
Dr Millar suggested that there was uncertainty expressed in Standards Australia in relation to a hyperbaric chamber being used with other medical equipment. It was suggested to involve local biomedical departments in chamber operation to ensure safety.
Dr Millar also commented that the HTNA were addressing technician qualifications.

14. Hyperbaric facility accreditation
Royal Hobart Hospital, Fremantle Hospital and Prince of Wales Hospital have achieved accreditation. Royal Adelaide Hospital has applied. Other units are encouraged to apply.

15. Training positions
Training positions will need to be undertaken at accredited units.

16. SPUMS Journal
Dr Davis reported that a motion to change the name of the Journal was tabled for the upcoming SPUMS AGM, changing "South Pacific Underwater Medicine Society Journal" to "Diving and Hyperbaric Medicine: The Journal of the South Pacific Underwater Medicine Society". This was seen to better advertise the content and scope of the Journal. Following on from the efforts of Dr Knight when the Journal was indexed by PubMed but knocked back by Medline, the five-year embargo on reapplying is approaching. The change in name and revamped format were seen as positives for the chance of being accepted by Medline this time around, but this is not guaranteed. Finally, the submissions to MSAC as reviews of soft-tissue radiation injury and hypoxic wound assessment and management still need publishing – their submission to the Journal was encouraged. Credit was made to Dr Davis for the changes in the Journal.

17. Minimum data set
No new information.

18. HTNA issues
Dr Smart foresaw the need for the ANZHMG Executive to liase with the HTNA Executive to discuss common issues, perhaps over a drink (an eminently reasonable suggestion). The HTNA was recognised as sharing the current meeting with the UHMS – 70 HTNA members were registered for the meeting. Planning is well advanced for the HTNA AGM next year in Melbourne.

Action: HTNA AGM in Melbourne 18-21 August 2005

19. SIG business
Dr Wong reported that the recent call for nominations to the SIG Executive resulted in nine nominations for the nine positions and so no election was required. The two co-opted positions on the Executive remain vacant.

20. Other business
Multicentre trial meeting on Thursday 27 May at 5pm.
Dr Bennett formally thanked everyone for attending the first UHMS AGM held in the southern hemisphere. With a total of 393 registrants, it is the third largest meeting in the history of the UHMS.

Closed: 1735 hours

David Wilkinson
Honorary Secretary ANZHMG

ANZ College of Anaesthetists Certificate in Diving & Hyperbaric Medicine Examination

Applicants who did not meet the criteria for the award of the Foundation Certificate in Diving & Hyperbaric Medicine of the ANZ College of Anaesthetists by 30 June 2003 are advised that they may be eligible to present for the examination for the Certificate.

The criteria for examination are:
1 Possession of a specialist qualification registrable in Australia/New Zealand
2 Possession of DipDHM
3 Minimum of 6 months' experience in anaesthesia
4 At least 12 months' *full-time equivalent* experience in diving and hyperbaric medicine in a hyperbaric department (accredited or to be accredited by ANZCA)
5 Currently working in diving and hyperbaric medicine

Trainee registration (one-off fee): $300.00
Examination fee: $500.00
Annual fee for certificate holders: $100.00
The interim regulation expires on 31 December 2004, after which time all candidates must meet the requirement of the SIG Workbook and the requisite training time.

Intending candidates are requested to contact Ms Helen Morris at ANZCA for further information:
The Australian and New Zealand College of Anaesthetists
'Ulimaroa', 630 St Kilda Road
Melbourne, Victoria 3004, Australia
***Phone:** +61-(0)3-9510-6299*

Diving-related fatalities document resource

All the coronial documents relating to diving fatalities in Australian waters up to and including 1998 have now been deposited by Dr Douglas Walker for safe keeping in the National Library of Australia, Canberra.

These documents have been the basis for the series of reports previously printed in this Journal as Project Stickybeak.

These documents will be available free of charge to bona fide researchers attending the library in person, subject to the stipulation that the researcher signs an agreement that no identifying details are to be made public.

Accession number for the collection is: MS ACC 03/38.

It is hoped that other researchers will similarly securely deposit documents relating to diving incidents when they have no further immediate need of them. Such documents can contain data of great value for subsequent research.

The world as it is

Pathfinder for the epidemiology of Australian recreational scuba diving accidents

Peter Buzzacott

Key words
Scuba accidents, recreational divers, medical database, diving research, diving organisations, diving scholars

Abstract
The majority of research into recreational scuba accidents has been conducted overseas, with Australian studies less frequently found in scholarly journals and books. Many journals now allow access to their archives via the World Wide Web. For researchers of Australian scuba diving accidents, sources of information are presented.

Introduction

Australian research into scuba diving accidents is less frequently found in scholarly journals and books than international research. Electronic databases offer today's researchers an efficient means of conducting searches. Additionally, scholarly journals increasingly allow access to their archives via the World Wide Web. Knowing where to look for information can save researchers much time and effort.

Bibliographic databases

Medline, *Proquest*, *Embase* and *AustHealth* are the four medical databases holding the widest range of diving research. In particular decompression sickness, embolism and otological barotrauma are well represented, though there is little relating specifically to Australian diving research. All four databases allow full access to subscribers, costing per year from $250 for *Medline* to $1521 for *AustHealth*.

Citations, abstracts and, often, even full texts can be imported from each database into a bibliographic manager such as *Endnote*. *Medline* allows up to 200 citations per export while *Proquest* allows up to 50 at a time. All four databases have help files describing how to search using field identifiers (to specify, for example, the name of a journal or an author) and truncation (where symbols are substituted for letters, for example, Dive# will search for Diver and Dives).

Medline can be accessed via many portals, for example at **<medline.cos.com>**, some even free of charge such as through *PubMed*, at **<www.ncbi.nlm.nih.gov>**.

Proquest is at **<www.il.proquest.com/proquest>**.

Embase is at **<www.embase.com>**.

AustHealth (and also *Ausportmed*) can be accessed through **<www.rmitpublishing.com.au>**.

Sportdiscus, the largest physical education database, can be found at **<www.sportdiscus.com>**.

AUSPORT, an Australian sporting database, is at **<www.ausport.gov.au>**.

Australasian Legal Information Institute, a joint facility of the UTS and UNSW Faculties of Law, is freely available from **<www.austlii.edu.au>**.

Scholarly journals

By far the three most comprehensive collections of Australian diving accident research can be found within the journals of SPUMS, UHMS and DAN (contact information overleaf).

UHMS publish a quarterly peer-reviewed journal and allow access to the archive of back issues via the UHMS web site. Visit **<www.uhms.org>**.

SPUMS publish this quarterly peer-reviewed journal, which has been indexed by *EMBASE* since 2000.

DAN publishes *SE Asia-Pacific Alert Diver* quarterly, often citing recent diving morbidity and mortality statistics. The magazine is not peer-reviewed.

The *British Journal of Sports Medicine* has published diving-related original research recently. *BJSM* online archives are at **<http://bjsm.bmjjournals.com/>**.

Both *Aviation Space and Environmental Medicine* (**<www.asma.org/Publication/medicine>**) and *Wilderness and Environmental Medicine* (**<www.wemjournal.org>**) publish original research into diving accidents, though few studies are Australian.

Emergency Medicine, the journal of the *Australasian Society of Emergency Medicine*, publishes Australian diving articles. *Emergency Medicine* abstracts are available through *AustHealth.*

The *Journal of Occupational Health and Safety, Australia and New Zealand* published Australian studies in the 1990s. Visit **<www.cch.com.au>** for details of how to subscribe.

Other peer-reviewed publications to recently publish original diving-related research include: *Chest*, *Neurology*, *Stroke*, *Thorax*, and *European Heart*

Journal, all indexed by *Medline*, and *British Medical Journal*, *Emergency Medicine Journal*, and *Heart*, all indexed by *EMBASE*.

Books

Best Publishing **<www.bestpub.com>** stock a very comprehensive catalogue of hyperbaric and dive medicine titles. E-mail: <divebooks@bestpub.com>.

The *Divers Alert Network* and *JL Publications* publish and/or sell many titles related to diving accidents. Contact DAN, or John Lippmann directly, for a list.

Peter Stone at *Oceans Enterprises*, 303 Commercial Road, Yarram, Vic. 3971, **<peter@oceans.com.au>**, offers a wide range of new and second-hand titles.

The following can only be considered a taster for the range of texts available:

Diving medicine by Alfred Bove and Jefferson C. Davis (Eds). Comprehensive clinical knowledge and a 330+ page Australasian dive medicine text, costing c.$220.

Diving and sub-aquatic medicine (4th edition) by Carl Edmonds. Probably the most popular dive medicine text for physicians and hyperbaric technicians. Hardcover, 720 pages and costing c.$225.

Hyperbaric medicine practice by Eric Kindwall and Harry Whelan. The definitive work on hyperbaric practice and useful for the epidemiology of diving injuries. 950+ pages and c.$210.

Physicians guide to diving medicine by Charles Shilling (Ed). An encyclopaedic clinical reference for the researcher and physician, costing about $180.

Physiology and medicine of diving (5th edition), edited by Alf Brubakk and Tom Neuman. A 'must have' for the diving medico, costing about $310.

Underwater ear and nose care by Noel Roydhouse. If you have any change after buying the aforementioned books then pick up this paperback gem for $20. It is detailed, thorough and a second edition is due any day.

Organisations

SPUMS - *South Pacific Underwater Medicine Society*, has been publishing a diving medicine journal since May 1971. Ordinary membership costs $132 per year. A list of their published journal indexes can be accessed through the SPUMS web site found at **<www.spums.org.au>**.

UHMS - The *Undersea and Hyperbaric Medicine Society* is the foremost source of diving accident research. Based in the US, ordinary membership costs $250 per year. Visit **<www.uhms.org>**.

DAN SEAP - The *Divers Alert Network in South East Asia Pacific*, has been collecting Australian diving fatality data and publishing diving safety advice for thirty years. Ordinary membership costs $65 per year. E-mail: **<info@danseap.org>** Web: **<www.danseap.org>**

NAUI - *National Association of Underwater Instructors*, another diver training organisation active in Australia, has its HQ in the USA. E-mail: **<nauihq@nauiww.org>** Web: **<www.nauiww.org>**

PADI - *Professional Association of Diving Instructors*, the Asia Pacific headquarters of this global diver training organisation is based in Sydney. They certify the majority of Australian divers and collect incident reports for Australian PADI diver-training accidents. Web: **<www.padi.com>**

SSI - Started in 1970, *Scuba Schools International* is another diver training organisation active in Australia, with more than 1500 dive store affiliates in 86 countries. Web: **<www.ssidiving.com>**

TDI - *Technical Divers International* is another diver training organisation active in Australia, with 10,000 instructors worldwide. E-mail: **<info@tdisdi.com.au>** Web: **<www.tdisdi.com>**

Known scholars in the field of diving accidents

Dr Chris Acott, Diving Incident Monitoring Study. E-mail: **<cacott@optusnet.com.au>**

Dr Mike Bennett, Prince of Wales Hospital, University of NSW. E-mail: **<M.bennett@unsw.edu.au>**

Dr David Doolette, Former SPUMS education officer. E-mail: **<David.Doolette@adelaide.edu.au>**

John Lippmann, Director of the Divers Alert Network. E-mail: **<info@danseap.org>**

Dr Simon Mitchell, Hyperbaric Unit, Royal New Zealand Naval Hospital. E-mail: **<dr.m@xtra.co.nz>**

Dr Douglas Walker, author of the Australian diving fatality reports. E-mail: **<diverhealth@hotmail.com>**

Professor Jeffrey Wilks, University of Queensland. E-mail: **<j.wilks@mailbox.uq.edu.au>**

Dr Robert Wong, Hyperbaric Unit, Fremantle Hospital. E-mail: **<robert.wong@health.wa.gov.au>**

Government documents

The Queensland Workplace Health and Safety Industry *Code of Practice for Compressed Air Recreational Diving and Recreational Snorkelling* is available from **<www.whs.qld.gov.au/icp>**.

Recreational Diving and Snorkelling Codes for WA produced by the Western Australian Department of Sport and Recreation, are freely available to download from **<www.dsr.wa.gov.au>**.

Navigable Waters Regulations for Western Australia, including diving regulations, can be purchased for $10 from the State Law Publisher. Visit **<www.slp.wa.gov.au>**.

Similar codes of practice and boating regulations are in force in other Australian states. Contact your local dive store and they'll describe who is responsible for which regulations in your state.

Statistics

At the time of writing the third release of the 2001 Australian Census CD-ROM is awaited by regional librarians across Australia. Access is free but copies cannot be borrowed. It does not relate to diving specifically but it does offer population data such as age distribution by geographic region.

The Australian Bureau of Statistics web site provides free access to many published surveys. Publication 4177.0 describes scuba diving participation rates for each state. The 2000 version is probably more accurate than the 2002 version. Visit **<www.abs.gov.au>**.

The Bureau of Tourism coordinates national tourism surveys of visitor volumes and expenditure.

The *National Visitor Survey* (NVS) began estimating volumes of domestic travel within Australia in January 1988, specifically following Australian residents aged 15 or over, the age from which most entry-level dive courses can be undertaken. The survey method is by telephone interviews conducted continuously throughout the year.

The *International Visitor Survey* (IVS) mirrors the NVS and specifically monitors international visitor volumes by region. The survey method is by interviewing departing visitors at the airports of Perth, Sydney, Melbourne, Brisbane, Cairns, Adelaide and Darwin.

The *Domestic Tourism Monitor* was the major data source on Australian residents travelling within Australia until 31 March 1998, whereupon it was replaced by the NVS.

State tourism commissions are a font of information. In Western Australia there are regional offices around the state and the HQ, who produce a *Research on Tourism Brief* every six months, are at 16 St Georges Terrace, Perth, WA 6000, postal address GPO Box X2261, Perth, WA 6847. Free surveys and reports are available from **<www.westernaustralia.com/en/>**.

Australian standards

The Australian Standards that relate to scuba diving are available to purchase from Standards Australia by phoning 1300 654 646 or e-mailing **<sales@standards.com.au>** and they are (cost):

AS 2299.3 ($64.24)	AS 4005.2 ($47.52)
AS 2299.1 ($140.80)	AS 4005.3 ($29.92)
AS 2299.1 Supp 1 ($22.88)	AS 4005.4 ($39.16)
AS 2299.2 ($108.68)	AS 4005.5 ($39.16)
AS 4005.1 ($54.12)	

They are each described on the standards web site **<www.standards.com.au>**.

Note: All web sites and e-mail addresses were confirmed 17 August 2004.

Peter Buzzacott, BA, is a PADI Master Instructor with a Dip. Outdoor Recreation, Assoc. Deg. (Training and Development). He has closed his dive school of five years to research Western Australian scuba diving accidents, full time, for a Master of Public Health Degree at the School of Population Health, of the University of Western Australia.
E-mail: *<reefdiving@eftel.com.au>*

Why certified divers drop out of diving

Drew Richardson

Key words
Scuba diving, questionnaire, World Wide Web, PADI

Abstract
(Richardson D. Why certified divers drop out of diving. *SPUMS J*. 2004; 34: 169-71.)
In early 2003, PADI conducted an online, two-week Web survey of 190,000 individuals certified at various levels after 1 January 2000. One of the questions asked was “Are you currently continuing to dive?” Out of 12,049 total responses (6.34% response rate), approximately 25% (n = 3041) had dropped out of diving at the time of the survey. The most prevalent reasons given included lack of time, equipment, local diving opportunities or dive buddies, and expense. Eleven per cent stopped due to a bad experience, and 4% stopped for medical reasons. Many respondents gave more than one reason for ceasing to dive. This presentation looks in greater detail at some of the reasons given for why divers quit.

Introduction

Historically, the drop-out percentage or ‘decay rate’ for diving has been a subject of uncertainty and debate. Estimates have been made in a number of reports but with no reliability. As part of a survey of its customers, the Professional Association of Diving Instructors (PADI) have attempted to provide some information in this area.

Methods

In early 2003, PADI conducted an online, two-week Web survey of 190,000 PADI-certified scuba divers, asking a variety of questions. One of the questions was “Are you currently continuing to dive?”

Results

Responses were received from 12,049 divers (a 6.34% response rate), approximately 25% (n = 3041) of whom had dropped out of diving at the time of the survey.

DEMOGRAPHICS OF RESPONDENTS

Of the respondents, 62% were male and 38% female, with about two thirds having a college or tertiary degree. Over 80% were Open Water or Advanced Diver certified. The drop-out rate for women was higher (32%) than for men (21%). The data also suggested that the higher the certification level, the more likely divers were to continue to scuba dive.

WHY CERTIFIED DIVERS ARE NOT DIVING

Many respondents gave more than one reason for ceasing to dive (Table 1). The top five reasons why divers were not diving were: no time (50%); they did not own their own diving equipment (48%); local diving was not available (47%); they had no buddy (32%); and diving was too expensive (31%). Of interest were the 18% who indicated they were not currently travelling, a reflection of the caution and fear of travel that was prevalent at the time of the survey. A bad experience was identified by 11%. 'Medical' reasons were given by 111 (4%) of the respondents, but no additional information was presented. Approximately 4% of women had stopped because of a pregnancy or a baby.

DIVERS WHO DROP OUT DUE TO A BAD EXPERIENCE

Three hundred and thirty four divers (11%) indicated that they had had a bad experience. Of these, 121 provided more detailed explanations. Thirty eight had experienced a lack of professionalism exhibited by dive industry personnel they encountered. A wide range of complaints were noted in this most common factor listed.

Twenty seven of the write-in respondents described an episode of anxiety, near panic or panic underwater, which caused them to stop diving. Contributing episodes included running out of air at the beginning of a deep dive, becoming lost or separated from a group, difficulty with mask flooding or clearing, ascent problems (including an inverted ascent in a dry suit) and other stressors. Buddy abandonment or poor buddy pairing by a dive master, or being paired with an unfamiliar person also led to anxiety and stress.

Eighteen respondents attributed the bad experience to poor diving conditions that caused them to stop scuba diving. Examples cited included rough water, strong currents, high seas, seasickness, cold water, dark water, the dive not meeting personal expectations, and discomfort from cold. Fifteen respondents reported a diving injury or accident, including pulmonary barotrauma, decompression sickness and immersion pulmonary oedema; whilst fourteen listed a malfunction and/or faulty equipment maintenance as the causative factor. Problems with equalisation or other ear problems were reported by only nine divers.

Discussion

Historically, the drop-out percentage or 'decay rate' for diving has been a subject of uncertainty and debate. This representative sample of divers, who had received certification or an upgrade to certification within the past two years and responded to this online survey, indicated a drop-out percentage of 25%. Further study and analysis of divers over a longer period would be of interest. Of note is the declining percentage of female participation in PADI continuing education as compared with males, and the fact that female divers are more likely to stop diving than male divers.

The lack of time in today's busy world came out as the most cited reason for not continuing to dive in this survey. This has important implications for the diving industry, which would need to create attractive experiences to invite divers back into diving without having to commit a large amount of time in order to do so. It seems more likely that an individual will purchase diving equipment after continuing their diving education to more advanced levels of certification rather than at the time of their initial course. The time-proven advantages of offering attractive, convenient, continuing education programmes are clear.

The lack of someone to dive with was noteworthy. This is an opportunity for dive centres to design and promote social events and dive clubs to encourage participation. Diving is a lifestyle in which people enjoy socialising and sharing the experience.

The most common reason that a diver had had a bad experience was an unprofessional attitude by members of the recreational dive industry. Striving to reduce and

Table 1
Responses by divers who were not diving at the time of a PADI Web-based survey (Total n = 3041)
(Multiple responses accepted; total over 100%)

Number of responses	n	%
No time	1517	50
Don't own equipment	1447	48
No local diving	1423	47
No dive buddy	958	32
Too expensive	928	31
Don't like local diving	675	22
Won't travel now	540	18
Had bad experience	334	11
Other	139	5
Took up another hobby	121	4
Medical reasons	111	4

eliminate such attitudes and behaviour is in the best interest of every stakeholder and consumer involved in diving. Finally, 'word of mouth' has proven to be the number one source of new diver acquisition in the dive industry. If the best possible goods and services are provided for clients, and they derive value and satisfaction from these, then they will recruit new consumers into recreational diving.

This synopsis by the Editor is based on a talk given by Dr Richardson at the SPUMS Annual Scientific Meeting 2003 in Palau, and was published previously as:

Richardson D. Why certified divers drop out of diving. *The Undersea Journal*. 2003; third quarter: 88-92.

Drew Richardson, AS, BSc, MBA, EdD, is President and Chief Operating Officer, PADI Worldwide.
PADI, 30151 Tomas Street,
Rancho Santa Margarita, Ca 92688-2125, USA
***Phone:** +1-949-858-7234; ext. 2269*
***Fax:** +1-949-858-9220*
***E-mail:** <drewr@padi.com>*

Book review

Wound care practice

Paul J Sheffield, Adrianne PS Smith, Caroline E Fife (eds)

848 pages, hardback
ISBN 1-930536-16-X
Flagstaff, Arizona: Best Publishing Company; 2004
Available from Best Publishing Company, P O Box 30100, Flagstaff, Arizona 86003-0100, USA.
Ph: (+1)-928-527-1055; Fax: (+1)-928-526-0370
E-mail: <divebooks@bestpub.com>
Copies can be ordered online at <www.bestpub.com>
Price US$158.00, postage and packing extra

This excellent publication is dedicated to the late Jefferson C Davis, MD, and to Thomas K Hunt, MD. It aims to cross specialty boundaries, which it has done exceedingly well, giving the clinician insight from multiple perspectives. It describes medical conditions relating to wounds, their underlying pathology, latest hypotheses and treatment modalities. It is very strong on assessment, and clear on which specialties to involve in the patient's care.

The editors have sourced clinicians who are well respected in their field, and who are able to bring their specialty across in a clear, informative way. This text is aimed at clinicians across all disciplines, and who already have the skills in basic wound management, as it focuses more on the medical management dealing with the underlying cause(s) of the problem wound.

The book is well bound, the paper is shiny and was reflective under the chamber lights. Print quality is good, all photos, tables and diagrams are clear and appropriate. There are helpful algorithms and scoring systems throughout. Referencing is at the end of each chapter, and organised under subject headings, which is particularly helpful. Layout is in five clear, logical sections with one exception. The chapter on Hyperbaric Oxygen Applications in Wound Care is wedged in between Modern Wound Dressings and Biochemistry and Biophysical Basis of Wound Products. My only concern is that this text leaves out patient participation. Wound care must be planned with the patient in a partnership. Outcomes need to be patient centred.

Section 1 defines the problem wound discussing at an advanced level the aetiology and normal biochemistry in wound healing. Section 2 is a thorough look at problem wound assessment covering a comprehensive array of available assessment tools, thus enabling the clinician to order appropriate investigations and feel confident in understanding their meanings, leading to a logical rationale for treatment and best outcome. Section 3 gives a comprehensive view of wound care, medical and surgical wound management, and includes a chapter on wound care in paediatric patients. I would have liked to see more in-depth coverage of the altered patho-physiology of the diabetic foot. Section 4 starts with a chapter on nutrition and hydration that provides the clinician with a powerful armamentarium for their wound care practice. This is followed by glycaemic control, infective conditions, and acute and chronic pain management. There are three chapters dealing with adjunctive wound care therapies, finishing off with the biochemical and biophysical basis of wound care products. Section 5 focuses on healthcare delivery, with a helpful framework for setting up a multi-disciplinary wound care centre.

In summary, this book should be on the shelf and on the desk of every clinician who practises wound care. It will help them make rational choices with the patient and request appropriate consultations with confidence. Looking at the patient with a problem wound from many perspectives is essential in modern wound care practice. As clinicians we must practise in this way, not just paying lip service to the multi-disciplinary approach, which includes the patient. We cannot afford to be territorial if we want the best outcome for our patients. Our medical and surgical colleagues might not always agree but only experience and open dialogue will lead us in the right direction.

Marj van der Linden, RGN, BN
Clinical Charge Nurse, Christchurch Hospital

Key words
Book reviews, treatment, wounds

Letters to the Editor

An additional mechanism for aural injury

Dear Editor,

We read with interest the suite of articles relating to the ear and diving that was recently published in the SPUMS Journal.[1-4] These articles provide a useful description of the array of injury that may affect both the middle and the inner ear. It is notable that the authors, especially those of the two case series,[2,3] report aural injuries as having considerable symptomatology and a clear temporal relationship to a diving event. As reported, the diagnosis may initially be difficult to determine but the injuries may be associated with significant long-term morbidity.

We would like to propose an additional mechanism for aural injury while diving. This involves the cumulative effect, over a long diving career, of relatively minor aural injury that may be either symptomless or not requiring of medical attention. It is conceivable that these injuries result from repeated minor barotrauma with subsequent fibrosis and scarring or subclinical decompression sickness (DCS). Indeed, it is well recognised that minor aural barotrauma is common. Bubble formation upon ascent is also common and, while benign in most cases, has been demonstrated to cause pathological lesions in the central nervous system (CNS) in the absence of clinical signs or symptoms.[5] There is no reason to expect that the inner ear or CNS pathways that serve the sense of hearing are exempt from cumulative subclinical bubble injury.

A recent report of diving injuries sustained by experienced Australian and American divers tends to support the above hypothesis.[6] This study found that aural symptoms (deafness and tinnitus) were common among respondents and could not be adequately explained by the relatively rare events of significant aural barotrauma or DCS. To further investigate these findings, we are undertaking a retrospective cohort study that compares the hearing of experienced scuba divers with that of matched non-divers (controls). This involves pure tone audiometric testing utilising both air- and bone-conduction techniques. We hope to determine if subtle hearing loss is a real phenomenon among experienced divers and, if so, whether this loss is conductive (likely barotrauma related) or neural (likely DCS related) in nature.

Associate Professor David McD Taylor
Director of Emergency Medicine Research
Royal Melbourne Hospital.
E-mail: *<David.Taylor@mh.org.au>*

John Lippman
Executive Director, Diver Alert Network (SE Asia Pacific)
E-mail: *<johnl@danseap.org>*

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Reply:

There is absolutely no reason why the correspondents should not investigate the possibility of multiple subclinical pathology producing a clinical entity after multiple diving exposures. Indeed, such a proposal has been conjectured in many of the previous surveys of hearing damage in divers and submariners. The reason why such a pathogenesis was not referred to in the SPUMS articles is probably that there is no evidence for it, as opposed to the aetiologies that were mentioned.

There have been extensive surveys of navy divers, ranging back to 1942, as well as of professional diving groups over the last three decades. There have been fewer observations on amateur divers, possibly because they did not have pre-diving pure tone audiograms performed. This excuse is no longer relevant in Australia, as pre-diving medicals include this investigation, so that Taylor and Lippmann have an opportunity to correct this omission.

As well as hearing loss and tinnitus, a history of disorientation episodes needs to be included for an otological assessment, as does a competent otologist's examination in clinically significant cases. We found this out the hard way in our Abalone Diver Survey.

There are some qualifications. Firstly, I cannot understand why common aural symptoms could not be explained by aural barotrauma, which the authors previously admitted was common! Next, the problem with retrospective studies is that much information is missing (forgotten or not asked). Thus, conclusions based on the absence of evidence are not valid in these studies. The inadequate investigation is then often used to support a conclusion of 'no other cause being detected'. Why do a retrospective survey when a prospective one is possible?

Other causes of hearing loss are related to the diving population, without necessarily being due to diving per se. Thus, the various 'cohort groups' need to be carefully controlled for these factors, and a dose–response relationship between the diving exposures and the pathology being claimed needs to be evident before any conclusions can reasonably be drawn.

Another problem is that arguing by analogy is especially inadequate when the analogy is not accurate. There has been no consensus on multiple subclinical injuries leading to clinical entities in the proposed neurological or psychological complications of diving. The reference quoted is probably the worst scientific study on this subject since that of Roszahegyi in 1959.[1,2] There have been at least three international conferences on this topic and in none has there been any substantial agreement that such a subclinical cumulative effect has been demonstrated, despite many attempts. Indeed, the opposite has been concluded. With these provisos, I wish the researchers well, offer any assistance that I can, and look forward to their results.

Carl Edmonds
E-mail: *<puddle@bigpond.net.au>*

References

1 Reul J, Weis J, Jung A, Willmes K, Thron A. Central nervous system lesions and cervical disc herniations in amateur divers. *Lancet*. 1995; 345: 1403-5.
2 Roszahegyi I. The late consequences of the neurological forms of decompression sickness. *Br J Ind Med*. 1959; 16: 311-7.

Key words
Letters (to the Editor), ear barotrauma, decompression illness

Funding of recompression chambers in the Pacific

Dear Editor,

Thank you for highlighting some of the challenges we face. I would like to correct some points in your editorial.[1] With reference to paragraph 3, DAN has not set up any chambers in the South-East Asia Pacific region. Hyperbaric Health Pty. Ltd., an Australian-based company, manages 15 chambers operating in this region. These include Melbourne (Berwick), Hong Kong, Singapore, Kuala Lumpur, Ipoh-Malaysia, Philippines, Papua New Guinea, Vanuatu, Fiji, Pohnpei, Chuuk, Palau, Yap, Nauru and soon the Solomon Islands. Subaquatic Safety Services have set up three.

With regards to the costs of treating tourist divers, none of the local communities we are associated with is required to fund the upkeep or any ongoing costs or maintenance of the systems; we do that at our cost.

You mention that you suspect the majority of tourist cases to be uninsured but I can confirm that the reverse is true. The majority of tourist cases are in fact insured and only a small number elect to be "self insured" (uninsured). We refer to them as self insured as they choose not to buy insurance but rather retain the premium they would otherwise pay and therefore carry the risk themselves. Even when a self-insured tourist diver presents for treatment at one of our chambers the charges are borne by ourselves and not the local community.

We are yet to be paid for any self-insured diver whom we have treated and who promised to pay us. Not a one. (We have never withheld a treatment for any diver due to lack of insurance or inability to pay.) Local (indigenous) divers are usually treated for no charge. We do request a contribution towards oxygen but seldom receive it.

I would also like to point out a correction to Dr Rob Grace's review of diving medicine in Vanuatu in the same issue.[2] In the first paragraph Rob states "...a chamber was procured, funded by subscriptions levied on the dive operators." In fact, the chamber was funded by Hyperbaric Health Pty. Ltd. Initially, there were some small levies collected by the local dive operators, which were contributions towards the ongoing upkeep of the system, but these contributions amounted to very little. The practice of collecting levies in Vanuatu was then abandoned by us and we have never applied it at any other location.

Tim Snowden
CEO, Hyperbaric Health Pty. Ltd.
Unit 5, Sandlake Estate
25–41 Redwood Drive, Dingley 3172
Victoria, Australia
E-mail: *<tim@hyperbarichealth.com>*
Web address: <www.hyperbarichealth.com>

References

1 Davis FM. The Editor's offering. *SPUMS J*. 2004; 34: 1.
2 Grace RF. A review of diving and hyperbaric medicine in Vanuatu. *SPUMS J*. 2004; 34: 23-6.

Key words
Letters (to the Editor), hyperbaric facilities, tourism, insurance

Proceedings of the 14th International Congress on Hyperbaric Medicine

Dear Editor,

Thank you for the opportunity to write in regard to the review by Martin Hodgson of the Proceedings of the Fourteenth International Congress on Hyperbaric Medicine

(ICHM).[1] As (I think) the only hyperbaric practitioner from Australia and New Zealand who was present at the meeting, I hope I can add some useful comments to Martin's review.

Firstly, I wholeheartedly agree with him that these meetings are highly inclusive. Anyone interested in the field should attend one or two to get a renewed sense of the scope of world practice in hyperbarics. This is the only meeting where one meets with lay pressure groups or non-medical practitioners in an environment with plenty of opportunity to discuss alternative views in some depth. The ICHM is refreshing because it is packed with fundamentally opposing views on hyperbarics, medicine and the human condition. The loss of the more usual self-reinforcing view of our practice can be quite liberating.

However, it behoves us to maintain our scepticism in the face of all the hope and emotion. Martin is quite right to draw a parallel between the Japanese use of hyperbaric oxygen (HBOT) for stroke and the use of antibiotics for otitis media closer to home. The difference, however, is this. Dissemination of the results of explicit systematic reviews of the evidence is changing practice in the latter case, while in many hyperbaric centres physicians continue to press ahead with the treatment of stroke, cerebral palsy and multiple sclerosis despite the evidence we have to show that HBOT is not efficacious in these conditions.

Certainly, much of the material in these proceedings has scientific merit, and much besides is thought provoking. Some is of more dubious merit. Martin correctly describes some of the science as "dreadful" and his examples are well made. But a word of warning, it may be worse than you think – some of this material is not what it may at first appear. Martin mentions a report by Barboza, for example, concerning the administration of sheep-derived embryonic cells to children with cerebral palsy and spinal injury.[2] Hard as it is for me to comprehend, this 'trial' apparently involves the intra-spinal and intra-cerebral administration of foreign genetic material to children, in the belief that this material will grow into mature human neurones under the influence of HBOT. It is hard to imagine this procedure passing an ethical review in the United States, and indeed when questioned, the authors conceded they had not been required to satisfy a formal ethical review process. Further, the great majority of patients enrolled were from the USA and paid for their treatment. It is hard to see this paper as 'research'; rather, it is an audit of a highly unusual practice and the results should be interpreted very carefully.

I must take issue with Martin when he exhorts us to "approach this publication with an open mind and the evidence-based filter switched off".[1] This is precisely what we *must not* do. I have no problem with approaching this material with an open mind, but I implore colleagues not to open their minds so far their brains fall out! Never, ever switch off the EBM filter for professional material. I look forward to seeing a good contingent from SPUMS at the next meeting in Barcelona in 2005. Now, there is a town worth visiting, and you will never have a better reason.

Mike Bennett
Department of Diving and Hyperbaric Medicine, Prince of Wales Hospital, Randwick, NSW 2031, Australia
E-mail: *<m.bennett@unsw.edu.au>*

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1 Hodgson M. Book review: Proceedings of the Fourteenth International Congress on Hyperbaric Medicine. *SPUMS J*. 2004; 34: 110.
2 Barboza JLD, Morales FJ. Hyperbaric oxygen for cerebral palsy and brain-injured children: a continuing study. In: Cramer FS, Sheffield PJ (eds). Proceedings of the 14th International Congress on Hyperbaric Medicine. Flagstaff, Arizona: Best Publishing; 2003. p. 70-3.

Key words
Letters (to the Editor), book reviews, meetings, ethics, evidence

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Maintenance of Professional Standards

Dear Editor,

Here are the details of the ANZCA MOPS points that have been approved for our recent activities. I have not applied for QA points as the only presentation that is really relevant for this was the Diving Incident Monitoring Study presentation.

1. The Undersea and Hyperbaric Medical Society (UHMS) Annual Scientific Meeting (ASM) has been approved as a Major CME Meeting under the ANZCA MOPS Programme. Participants can claim 3 CME points per hour under Code 111. The approval number for this activity is 0485.

2. SPUMS 2004 ASM has been approved as a Major CME Meeting under the ANZCA MOPS Programme. Participants can claim 3 CME points per hour under Code 111. The approval number for this activity is 0492.

3. The diving and hyperbaric medicine Introductory Course (UHMS) has been approved as a Learning Project under the ANZCA MOPS Programme. Participants can claim 100 CME points under category 4 of code 161. The approval number for this activity is 0151.

Jan P Lehm,
Department of Diving & Hyperbaric Medicine
Prince of Wales Hospital
Randwick, NSW 2031, Australia
E-mail: *<lehmj@sesahs.nsw.gov.au>*

THE UNIVERSITY OF AUCKLAND
FACULTY OF MEDICAL AND HEALTH SCIENCES

Postgraduate Diploma Medical Science – Diving and Hyperbaric Medicine

Applications are now being accepted from registered medical practitioners for this one-year Postgraduate Diploma Medical Course. The Diploma can be spread over two years part time.

Staff: Professor D Gorman, Associate Professor M Davis and other faculty of the Occupational Medicine Unit.

Overview: The Diploma is a distance learning programme, available internationally without a resident component in Auckland. However, special conditions apply for some courses. Graduates will be able to practise effective clinical diving medicine in a primary care setting or to embark on clinical practice within a hyperbaric medicine environment.

The course titles are:

- Physiology and medicine of diving (2 papers in 2005)
- Health surveillance of divers and hyperbaric workers
- Hyperbaric medicine
- Clinical diving and hyperbaric practice
- Research essay in diving or hyperbaric medicine
- Research project in diving or hyperbaric medicine

For further information, including fees, please contact the Course Coordinator: Jessica Rorich
Phone: +64-(0)9-373-7599, extn 88489
Fax: +64-(0)9-308-2379
E-mail: <occmed@auckland.ac.nz>
Full information on courses and admission regulations is available in the University of Auckland Calendar or at <http://www.auckland.ac.nz>

ROYAL ADELAIDE HOSPITAL HYPERBARIC MEDICINE COURSES 2004

Medical Officers Course

November 2004

Basic	8/11/04	to	12/11/04
Advanced	15/11/04	to	19/11/04

DMT Full Course

October/November 2004 3 weeks, 25/10/04 to 12/11/04

DMT Refresher Course

November 2004 1 week (Wk 2), 1/11/04 to 5/11/04

For further information or to enrol contact:
The Director, Hyperbaric Medicine Unit,
Royal Adelaide Hospital, North Terrace,
South Australia 5000.
Phone: +61-(0)8-8222-5116
Fax: +61-(0)8-8232-4207

JAMES COOK UNIVERSITY AND ANTON BREINL CENTRE FOR PUBLIC HEALTH AND TROPICAL MEDICINE

Tropical marine and diving medicine (TM5508:03)

Location: Townsville
Availability: Semester 2, external subject with compulsory limited attendance residential
Dates: 18 - 22 October 2004
Staff: Associate Professors G Gordon and P Leggat
Cost: $Aust 1,260.00
Overview: This subject, conducted in association with the Townsville Hospital, presents the basic principles of underwater and hyperbaric medicine over a five-day residential programme. A series of lectures, demonstrations and practical sessions highlight the taking of a diving history, performing a diving medical examination, decompression sickness, management of near drowning, hypothermia, sinus and ear barotrauma, diving equipment, gases, physiology, diving hazards and diving techniques. A hyperbaric unit is located at the Townsville Hospital. Optional dives may be conducted.

For further information or to enrol contact:
Marcia Croucher, Senior Student Officer,
Anton Breinl Centre for Public Health and Tropical Medicine,
James Cook University,
Townsville, Queensland 4811, Australia
Phone: +61-(0)7-4781-6107
E-mail: <sphtm-studentofficer@jcu.edu.au>

ROYAL AUSTRALIAN NAVY MEDICAL OFFICERS' UNDERWATER MEDICINE COURSE 2004

Dates: 22 November to 3 December, 2004
Venue: HMAS Penguin
The Medical Officers' Underwater Medicine Course seeks to provide the medical practitioner with an understanding of the range of potential medical problems faced by divers. Considerable emphasis is placed on the contraindications to diving and the diving medical, together with the pathophysiology, diagnosis and management of the more common diving-related illnesses.
Cost: $Aus1833.00 (tbc)

For information and application forms contact:
The Officer in Charge, Submarine & Underwater Medicine Unit, HMAS PENGUIN,
Middle Head Rd, Mosman, 2088 NSW, Australia
Phone: +61-(0)2-9960-0572
Fax: +61-(0)2-9960-4435
E-mail: <Sarah.Sharkey@defence.gov.au>

Instructions to authors

(Revised March 2004)

The *SPUMS Journal* welcomes contributions (including letters to the Editor) on all aspects of diving and hyperbaric medicine. Manuscripts must be offered exclusively to the *SPUMS Journal*, unless clearly authenticated copyright exemption accompanies the manuscript. All manuscripts, including SPUMS Diploma theses, will be subject to peer review. Accepted contributions will be subject to editing.

Contributions should be sent to:
The Editor, SPUMS Journal,
C/o Office 137, 2nd Floor, Christchurch Hospital,
Private Bag 4710, Christchurch, New Zealand.
E-mail: <spumsj@cdhb.govt.nz>

Requirements for manuscripts

Documents should be submitted electronically on disk or as attachments to e-mail. The preferred format is Word 97 for Windows. If submitted as a paper version, two printed copies of all text, tables and illustrations should also be mailed. All articles should include a title page, giving the title of the paper and the full names and qualifications of the authors, and the positions they held when doing the work being reported. Identify one author as correspondent, with their full postal address, telephone and fax numbers, and e-mail address supplied. The text should be subdivided into the following sections: an Abstract of no more than 250 words, Introduction, Methods, Results, Discussion, Acknowledgements and References. Acknowledgments should be brief. References should be in the format shown below. Legends for tables and figures should appear at the end of the text file after the references.

Paper versions and electronic files should be double-spaced, using both upper and lower case, on one side only of A4 paper. Headings should conform to the current format in the *SPUMS Journal*. All pages should be numbered. Underlining should not be used. Measurements are to be in SI units (mm Hg are acceptable for blood pressure measurements) and normal ranges should be included.

The preferred length for original articles is 3,000 words or less. Inclusion of more than five authors requires justification as does more than 30 references per major article. Case reports should not exceed 1,500 words, with a maximum of 10 references. Abstracts are also required for all case reports and reviews. Letters to the Editor should not exceed 500 words (including references, which should be limited to five per letter). Legends for figures and tables should be less than 40 words in length.

Illustrations, figures and tables should not be embedded in the wordprocessor document, only their position indicated. All tables are to be in Word for Windows, tab-separated text rather than using the columns/tables option or other software and each saved as a separate file. They should be double-spaced on separate sheets of paper. No vertical or horizontal borders are to be used. Illustrations and figures should be separate documents in JPEG or GIFF format. Please note that our firewall has a maximum size of 5Mbytes for incoming files or messages with attachments.

Photographs should be glossy, black-and-white or colour. Slides should be converted to photographs before being sent. Colour reproduction is available only when it is essential for clinical purposes and may be at the authors' expense. Indicate magnification for photomicrographs.

Abbreviations should only be used in brackets after the complete expression, e.g., decompression illness (DCI) can thereafter be referred to as DCI.

References

The Journal reference style is the 'Vancouver' style *(Uniform requirements for manuscripts submitted to biomedical journals*, updated July 2003. Web site for details: <http://www.icmje.org/index.html>).
In this system 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 (<http://www.nlm.nih.gov/tsd/serials/lji.html>). Examples of the format for quoting journals and books are given below.

1 Freeman P, Edmonds C. Inner ear barotrauma. *Arch Otolaryngol.* 1972; 95: 556-63.
2 Hunter SE, Farmer JC. Ear and sinus problems in diving. In: Bove AA, editor. *Bove and Davis' Diving Medicine, 4th ed.* Philadelphia: Saunders; 2003. p. 431-59.

There should be a space after the semi-colon and after the colon, and a full stop after the journal and the page numbers. Titles of quoted books and journals should be in italics. Accuracy of the references is the responsibility of authors.

Consent

Studies on human subjects must comply with the Helsinki Declaration of 1975 and those using animals must comply with National Health and Medical Research Council Guidelines or their equivalent. A statement affirming Ethics Committee (Institutional Review Board) approval should be included in the text. A copy of that approval should be available if requested.

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The toll-free number 1-800-088-200 can only be used in Australia

NEW ZEALAND
0800-4-DES111 or 09-445-8454 (in New Zealand)
+64-9-445-8454 (International)
The toll-free number 0800-4-DES111 can only be used in New Zealand

The DES numbers are generously supported by DAN-SEAP

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
PO Box 120, Narrabeen, NSW 2101, Australia.

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 anonymously any incident occurring in your dive party. Most incidents cause no harm but reporting them will give valuable information about which incidents are common and which tend to lead to diver injury. Using this information to alter diver behaviour will make diving safer.

Diving Incident Report forms (Recreational or Cave and Technical)
can be downloaded from the DAN-SEAP web site: <www.danseap.org>
They should be returned to:
DIMS, 30 Park Ave, Rosslyn Park, South Australia 5072, Australia.

PROJECT PROTEUS

The aim of this investigation is to establish a database of divers who dive or have dived with any medical contraindications to diving. At present it is known that some asthmatics dive and that some insulin-dependent diabetics dive. What is not known is how many. How many with these conditions die is known. But how many dive safely with these conditions is not. Nor is the incidence of diving accidents in these groups known.
This project is under the direction of Dr Douglas Walker and Dr Mike Bennett. The investigation has been approved by the Ethics Committee of the Prince of Wales Hospital, Randwick, approval number 01/047.

If you are in such a group please make contact. All information will be treated as CONFIDENTIAL.
No identifying details will appear in any report derived from the database.

Write to: Project Proteus
PO Box 120, Narrabeen, NSW 2101, Australia.
E-mail: <diverhealth@hotmail.com>

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