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Illicit drug use in divers

Selection of Navy divers using mental health measures

Traditional apnea divers of Asia – the Ama and Bajua

Peripheral muscle modulation of respiration

A paediatric diving death

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PURPOSES OF THE SOCIETIES

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 and to convene members of each Society annually at a scientific conference

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Editor and Publisher:
Michael Davis <editor@dhmjournal.com>
c/- Hyperbaric Medicine Unit
Christchurch Hospital, Private Bag 4710
Christchurch, New Zealand
Phone: +64-(0)3-364-0045 or (0)3-329-6857
Fax: +64-(0)3-364-0817 or (0)3-329-6810
European Editor:
Peter Müller <peter.mueller@eubs.org>

The Editor's offering

MEDLINE indexation for DHM

In June 2009, the Editorial Board of *Diving and Hyperbaric Medicine* (DHM) submitted an application to the National Library of Medicine (NLM) in the USA for the Journal to be indexed on MEDLINE. This was the third time that this journal has applied for listing, most recently in 1998. Both the previous applications were unsuccessful. Our application was considered by their Literature Selection Technical Review Committee (LSTRC) in early 2010 and again DHM was declined, but by only a narrow margin, based on the journal review summary that we received. There were some aspects of this report that we considered were incorrect factually and that parts of our application had been misinterpreted by the Committee.

The Presidents of EUBS (Professor Alf Brubakk) and SPUMS (Associate Professor Mike Bennett) and I submitted a letter to NLM putting our case and requesting a further review. This request was granted, but rather than our having to resubmit through the formal channels to the LSTRC, we were given the opportunity to have an internal reassessment by the NLM, including 'experts' in the fields of diving and hyperbaric medicine. The reason given for providing this opportunity so soon after an unsuccessful application was the unusual nature of our fields of medicine. In January this year, I received a letter from the Associate Director for Library Operations notifying us that our re-application, based on the 2009 and 2010 issues had been successful.

From this issue, DHM will be MEDLINE-indexed.

As you will appreciate, this is a momentous decision for our journal. Those authors whose papers appeared during this period should be proud of their efforts and the Editorial Board thanks them sincerely, as only by the content is a journal judged. This will no doubt bring a wry smile to some faces who know all too well that the members of the Editorial Board and I have been hard task masters! That said, we take a positive approach to submissions, a majority of which are potentially publishable in some form, but may take a lot of hard work to reach that point. Sadly some authors give up on this intellectual challenge, which is a pity. Doing research, basic or applied or clinical, and writing papers was never easy, but to see something through to completion is immensely satisfying. At the same time, my role as Editor is to ensure that what is publishable is readable and that there is something for everyone from our very diverse readership. We hope that, with MEDLINE listing, greater consideration will be given to submitting your work to DHM.

There is work to do in reformatting the way in which the Journal is prepared for publication before the abstracts of articles start to appear in PubMed, but we hope to complete this by the middle of the year, and certainly before 2012. Whilst this will not change the appearance of the printed copy, it paves the way for DHM to become an electronic publication if, in the future, members of SPUMS and EUBS wish this. With rapidly improving technology, this is becoming more and more a realistic option; one about which, sometime over the next year or so, members' opinions will likely be canvassed by your executives.

There is also work to be done by all members. The membership of both societies has been steadily falling in recent years, a phenomenon experienced widely by medical societies in recent times. We need you to encourage colleagues with involvement or an interest in diving and/or hyperbaric medicine to join and subscribe to this journal. Let 2011 be a year in which every one of you plays a part in this. Publishing DHM uses up about 70–80% of your dues, and this is too high a proportion to sustain over a long period. About half of these costs are simply for printing and postage, which is why the possibility of going digital in the future is to be explored, as in the longer term it will save money.

Whilst it may be seen by some as inappropriate to single out individuals, I would particularly like to thank Mike Bennett, whose support has been immense and unflagging since I took over as Editor from John Knight in 2002.

As you read this, the SPUMS ASM in Guam is only a couple of months away. We urge everyone to consider attending what will be an excellent meeting with outstanding principal speakers, and there is still time to take that leave and book your passage. Being in the northern hemisphere and in a United States Territory makes it an especially attractive option for American colleagues, and relatively easy to travel to from Europe. Unfortunately because of the earthquakes that have hit my city, your Editor cannot attend this or the EUBS meeting in August in Gdansk, a city of immense importance in late-twentieth century European history. I wish you two successful and professionally fulfilling events.

The news about MEDLINE has left little space to comment on the interesting papers in this issue, from the physiology of respiratory control to the tragic death of a young diver. This latter case has many take-home messages, but for those of you travelling to and diving in Guam, proper diving travel insurance is essential.

As we go to press, alarm has arisen in Australia at moves by SafeWork Australia to introduce new government regulations that will lower the standards of commercial diver training and supervision, including medical clearance. No doubt we will hear more on this soon.

Mike Davis

Front page photo: A diver uses artificial media to assess how habitat complexity relates to ecosystem function. Photo taken in Dunstaffnage Bay, near Oban, in Scotland, by Hugh Brown of the UK National Facility for Scientific Diving.

The President's page

Peter Germonpré
President, EUBS

Dear friends,

As I sat, some weeks ago, in the cosiness of my home, sipping a glass of sparkling grape juice to celebrate the end of the previous year and the start of a new one, little did I think about the wonders that happened beneath the surface. Savouring the aromas as my face neared the rim of the glass, my mind was focused on wordly considerations, such as how to survive the next day without a headache rather than on scientific matters.

A few days later, a good friend of mine handed me a small booklet, entitled "*Effervescence*", and my interest turned from gustatory and olfactory towards science. Starting with a chapter on the history of champagne (actually a consequence of global climate change back in the fifteenth century, ruining the 'ideal' wine fermentation process by a second fermentation in the casks; sparkling wine was not appreciated until 150 years later – by the English, of all people!), the author describes his own fascination with bubbles ever since his youth, and his quest to study, clarify and optimise the process. His choice of work – master engineer oenologist at one of the most famous champagne houses in France – provided him with unlimited study material, and a regular stream of scientific publications in reputed oenologic and chemistry journals undoubtedly helped him to secure his position in the lab. How lucky can you get to turn your hobby or passion into a paid occupation?

A bubble, it seems, is not just a bubble. There are small bubbles and large bubbles, stable bubbles and unstable bubbles, round bubbles, bubbles with or without a protein coating, stationary bubbles and free-moving bubbles. In the end, they all disappear upon contact with the free air at the surface. In a perfectly clear glass, without impurities and with a perfect hydrophobic surface, no bubbles can be seen. Too dirty a glass and the bubbles stick to the walls and, of course, also spoil the experience for the drinker. All bubbles originate when the partial pressure of carbon dioxide above the wine is suddenly decreased, and the quantity of bubbles liberated is proportional to the carbon dioxide content of the wine (in a typical champagne bottle the pressure under the cork is as high as 608 kPa) and the turbulence in the wine when poured into the glass. The site of origin is, as said, impurity: microscopic cellulose fibres act as 'gas traps' where molecules of carbon dioxide collect and, when large enough, ;spill out' of the microtube into the liquid. While rising in the fluid, the bubbles grow by absorbing more carbon dioxide, and surface tension keeps them in a bubble state until they 'explode' in a fountain of droplets. These disperse the aromas and tickle the nostrils. Ultra-fast microscopic photography documents the hidden secrets of decompression bubbles, as they are born, as they rise to fame and as they perish.

Did you know the difference between bubbles in beer and in champagne? I thought I did, now I know better. This little book has truly opened perspectives for 'conference-oriented research', and I offer it to you all, free of charge, as another excellent excuse to attend the EUBS Annual Scientific Meeting in Gdansk, Poland, next August. Our SPUMS colleagues are, of course, invited to participate as well.

In the eye of the creative beholder, science is everywhere...

The attraction of combining clinical work with research has become evident, once again, to me while lecturing recently to a group of hyperbaric nurses. Of course, giving a class in anatomy and physiology to already experienced emergency and intensive care nurses does not need to focus on the basics, so in our course curriculum, we emphasise mainly those items that are of interest to the hyperbaric field. As the course progresses, it is most satisfying to see their minds getting to work, combining newly gathered knowledge with previous experiences, with new or renewed enthusiasm bubbling up to participate actively, often in their free time, in diving or hyperbaric research projects. At first, it may seem a good idea to focus on one single occupation in order to 'be good at it', but I find that combining different interests helps a lot to keep one's eye and mind fresh and focused; not forgetting the social satisfaction of off-topic meetings, as above.

This being said, if you take the time to visit the EUBS website <www.eubs.org>, log into your member account and browse in the membership database, you will soon find, perhaps to your surprise, that the number of EUBS members in your country is much lower than you would have expected. Imagine, all those scientists interested in diving, hyperbarics or just bubbles and not knowing that the EUBS exists? Not knowing that this journal is specifically there for their education on the topics that they need in their practice? Remember, this is one of the very few international scientific journals on diving and hyperbaric medicine. Our editors get grey hairs ensuring the highest standards are met issue after issue, so it is something we should all be proud of! So, I call upon you all, EUBS and SPUMS members alike, to spread your enthusiasm and ask your friends to become society members.

Enjoy this copy of your journal, and then spread the word!

Key words
Medical society, general interest

Original articles

Respiratory rate can be modulated by long-loop muscular reflexes, a possible factor in involuntary cessation of apnea

Costantino Balestra, Morgan Levenez, Pierre Lafère, Bernard Dachy, Mikel Ezquer and Peter Germonpré

Key words
Musculoskeletal, metabolism, breath-hold diving, respiratory, physiology, research

Abstract
(Balestra C, Levenez M, Lafère P, Dachy B, Ezquer M, Germonpré P. Respiratory rate can be modulated by long-loop muscular reflexes, a possible factor in involuntary cessation of apnea. *Diving and Hyperbaric Medicine*. 2011;41(1):3-8.)
Introduction: The main limiting factors determining apnea time are generally considered to be related to blood and cerebrospinal fluid chemistry. Several physiological (adaptive) mechanisms and some psychologic parameters, such as motivation, are also known to increase apnea time.
Aim: We wished to study the link between peripheral muscle fatigue, the concomitant alteration of long latency (transcortical) reflexes and respiratory control.
Methods: Fatigue was induced in a small hand muscle (abductor pollicis brevis) (n = 11). This muscle is sufficiently small that its fatigue and the resulting production of metabolites are unlikely to alter whole-blood biochemistry. The Hoffmann reflex, an involuntary reaction to electrical stimulation of muscle afferent sensory fibreswas studied, as was the long latency reflex (LLR) using the Dueschl method in which electrical stimulation is superimposed on a slight voluntary contraction, Different fatiguing protocols were performed, and respiratory rate continuously recorded.
Results: The 'muscular metabolites increasing protocol' (at 50% maximum voluntary contraction, MVC) showed a significant dissociation between the decreases in the H-reflex and the LLR, compared to contraction at 25% MVC. This was associated with an increase in the respiratory rate to 148.25 (SD 11.37)% of control at 3 min (the maximum time the contraction could be sustained), whereas at 25% MVC, respiratory rate did not change during the contraction.
Conclusions: This suggests a peripherally mediated, central input to the respiratory centres, triggering a powerful stimulus when metabolites accumulate in muscles. We believe this to be a possible mechanism terminating extreme breath holds.

Introduction

As part of the neural control of respiration, it is believed from animal studies that muscular afferent signals of some type may be responsible for respiratory rate modulation, especially during muscular effort.[1,2] Human studies have shown that group III and IV polymodal afferents (small diameter chemosensitive fibres located in the muscle aponeurosis and perimysia) can affect respiratory rate, but the exact mechanism has not been clarified.[3–5] During a breath-hold experiment after oxygen breathing (100% oxygen for 30 minutes), one of our subjects maintained an apnea for 13 min 54 s (in water of 1.5 metre depth). We measured alveolar gas composition at the breaking point and concluded that, since the oxygen percentage was 93.7% and carbon dioxide (CO_2) 5.9% at the end of the breath hold, these levels could not be the full trigger for its termination. In our experience, this percentage of CO_2 at end-apnea is not exceptional in arterial blood gas measurements of elite apnea divers.[6]

To understand better the reasons why our subject terminated his apnea, we considered the possible factors that might contribute to the cessation of apnea in humans: psychological factors, hypercarbia, acidosis, hypoxia and muscular afferent neurological signals. We excluded the first two factors, and considered the third and fourth as unlikely because this was a resting apnea and thus the diver was not voluntarily contracting any muscle. We hypothesised that the 'muscular afferents theory' could well fit the profile.

To investigate this hypothesis, an experiment was designed in which we studied EMG recordings from a small hand muscle whilst recording respiratory rate. The abductor pollicis brevis (APB) was chosen at two different contraction levels, 25% and 50% of maximal voluntary contraction (MVC). This muscle is small enough for its contraction not to interfere with global oxygen consumption but large enough to allow the Deuschl method for H-reflex and long latency reflexes (LLR) measurement.

Methods

SUBJECTS

Eleven healthy volunteers (8 males and 3 females; aged 22–40 years, mean 28.8 SD 5.6) took part in this investigation. All subjects were part of the Physical Education Department of

Figure 1
Pathways involved in the mechanism. During fatigue, metabolites accumulate in the contracting muscle, increasing presynaptic inhibition at the spinal level, via afferent fibres III-IV, reducing the spinal level input. In parallel, the supraspinal level will increase its input towards available synergistic neurons to overcome force reduction. This descending input will in turn down-stimulate the pneumotaxic centre, and increase respiratory rate. (HR – Hoffmann reflex, LLR – long latency reflex)

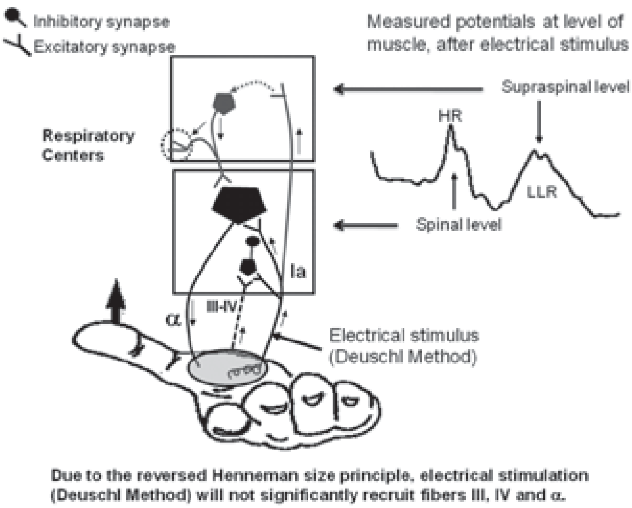
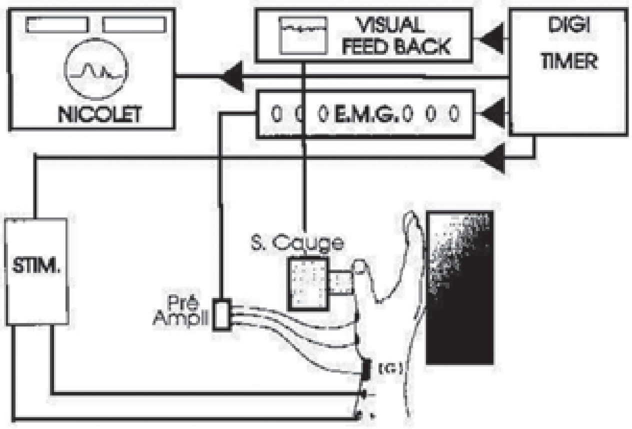


Figure 2
The experimental set-up when recording the EMG and force in the abductor pollicis brevis



the Université Libre de Bruxelles. This study was approved by the University Ethics Committee, and the subjects gave their informed consent to participate in the investigation.

STIMULATION

The Hoffmann reflex (H-reflex) is an involuntary reaction of muscles after electrical stimulation of their afferent sensory fibres (Ia afferent fibres, arising from muscle spindles). The reflex loop transits in the spinal cord. The H-reflex test is elicited using an electrical stimulator, which gives a square-wave current of short duration and small amplitude, and an electnomyelogram (EMG) set to record the muscle response. This response is called the H-wave, 28–35 ms after the stimulus (Figure 1).

In the Deuschl method, a slight voluntary contraction (10–25% of MVC) is used, which permits the elicitation of another component of the EMG during electrical stimulation superimposed on the voluntary contraction called the long latency reflex (LLR, Figure 1).[7,8] This reflex is a compound muscular reaction composed of the medium latency reflex (MLR, ±40 ms), mediated via large fibres from muscle to cortex and back to the muscle via alpha motor fibres, and the long latency reflex (LLR, ±60 ms). This signal has the same pathway as the previous one, adding some slower cutaneous afferents. These two components are better seen during rapid stretching of the muscle. Electrical stimulation does not allow separation of the two components and shows a single signal, the LLR (Figure 1). The general pathway of the LLR is described as follows: the afferent signal starts from the muscle spindle, moves toward the spinal chord via Ia large afferents, then reaches the medulla oblongata, finds a relay in the cuneatus or gracilis nuclei (gracilis for lower body afferents, cuneatus for the upper body), another relay via the lemniscus medialis with the thalamus (ventroposterolateralis nucleus), then reaches the Brodmann 3 area (somatosensory area) and finally transits to the motor cortex (Brodmann 4 area) to reach the alpha motor neuron of the anterior horn of the spinal grey matter.

Muscular contraction, when sufficiently intense to impair local microcirculatory blood flow, induces local metabolite build-up, which stimulates III-IV fibres originating from the muscle membrane. These fibres exert an inhibition at the level of the spinal cord and thus reduce the amplitude of the H-reflex, as well as the LLR at the level of the alpha motor neuron in the anterior horn.

The H-reflex and LLR evoked by electrical stimulation were recorded during a weak sustained contraction (25% of MVC) of the APB.[8,9] Using two silver surface electrodes, the median nerve was electrically stimulated at the wrist at a frequency of 3 Hz. The stimuli were rectangular pulses of 1 ms duration, with the intensity of the stimulation set near the threshold response of the motor fibres. In order to normalise the H-reflex changes during fatigue (c.f., below), the maximal muscle compound action potential (M_{max}) (direct stimulating effect of alpha neurons on muscle, elicited by electrical stimulation) was evoked by a supramaximal stimulation of the nerve at each measuring point. Pulses were delivered from a custom-made, two-channel stimulator triggered by a digitimer (model 4030, Digitimer Ltd, Welwyn Garden City, UK). The muscle reflex responses and the M_{max} were evoked through the same electrodes.

EMG AND FORCE RECORDING

The EMG recordings (H-reflex, LLR and M_{max}) were obtained by means of a pair of silver disc electrodes (8 mm in diameter), one fixed over the muscle motor point and the other over its distal tendon (belly tendon derivation). The ground electrode was attached to the skin between the stimulating and recording electrodes. The signal was AC -amplified (1000 x), filtered (bandpass, 10 Hz to 5 kHz), and full-wave rectified. The reflex responses were averaged (64–128 sweeps).

The recordings of the APB were made with the subject's arm placed on a horizontal board in a semi-supine position, with the back of the hand fixed against a vertical restraint (Figure 2). The abduction force was recorded by pushing with the middle of the thumb against a strain gauge transducer (TC 100, Kulite, Ridgefield, *NTJ,* USA). The subjects were provided with visual feedback of the force and EMG signals in order to maintain a steady level of contraction.

The force of contraction was continuously recorded on a paper chart (Graphtech, WX2400, USA) and the EMG data were recorded and averaged by a digital oscilloscope (Nicolet 4094c, USA) then stored on disk. For each reflex component we measured the peak amplitude. The size of each reflex was defined as the distance between the peak amplitude and the mean background level computed during the 15–20 ms following the stimulus. In order to exclude fatigue-induced changes in the muscle fibre membrane response, each EMG component was normalised as a function of the peak size of the same subject's M-wave (M_{max}).

MUSCLE FATIGUE AND TESTING PROCEDURE

Muscle fatigue was induced by a sustained contraction at 25% or 50% of MVC of the APB. The experiment was terminated in both fatigue tests when the applied force fell to under the target value and the subject could not reach it again even with strong encouragements. The H-reflex and LLR responses were recorded every minute during the test. During the 50% fatigue test, the subject was instructed to reduce contraction to 25% of MVC before each measurement, and recover the 50% contraction level immediately after the measurement. To avoid any recovery from anaerobic metabolites during the recordings, a blood pressure cuff wrapped around the arm was inflated to 250 mmHg just before reducing the contraction and was maintained inflated during the entire EMG averaging time period (not more than 40 s). During this period, first a M_{max} was elicited and then the different reflex responses were averaged. In all the experiments, the temperature of the skin overlying the muscle was continuously maintained at about $35^{O}C$ by means of an infrared lamp.

RESPIRATORY RATE MEASUREMENTS

Respiratory rate was measured with a spirometer (SP-304) connected to an analogue-to-digital converting board (IW-214, iWorx Systems, USA). Sampling speed was set at 100 per second and the data were stored on a personal computer for further analysis. No visual or auditory feedback was given to the subject. Measurement of respiratory rate was performed by calculating the time between respiratory peaks and averaged every 5 s.

STATISTICAL ANALYSIS

The data recorded during muscle fatigue and recovery were tested by means of an analysis of variance (ANOVA) with repeated measures on one factor and Dunnet or Tukey-Kramer post-test when appropriate (Graphpad Prism v.3.0). The level of significance was taken at $P < 0.05$.

Results

During 50% MVC, the H-reflex and the LLR amplitude, normalised to the M_{max} amplitude, decreased significantly during the fatigue tests from the first minute onwards ($P < 0.05$) (Figure 3), but the LLR decreased significantly less than the H-reflex to a mean of 71.37 (SD 6.17)% versus a mean of 54.06 (SD 5.93)% at the end of the third minute. No subject was able to keep the 50% of MVC target force beyond 3 min of contraction time. This dissociation between the two components of the reflex was significant ($P < 0.05$) from the 2-minute time point, the same time range as the increase in the respiratory rate.

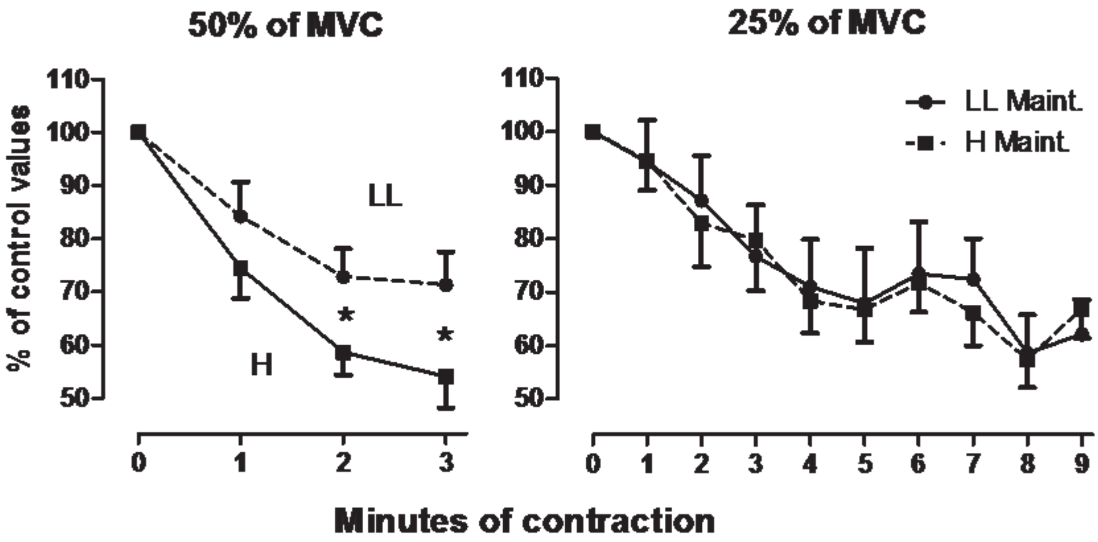
During 25% MVC, both the LLR and the H-reflex decreased concomitantly ($P = 0.05$), but there was no statistical difference between the two components throughout the test. The reduction in amplitude reached a mean of 66.9 (SD 5.48)% for the LLR and 62.14 (SD 6.43)% for the H-reflex after 9 min of contraction.

Respiratory frequency rose during the 50% MVC test only, reaching 148.25 (SD 11.37)% of control at 3 min (the maximum time the contraction could be sustained) (Figure 4). A significant ($P < 0.05$) dissociation between respiratory rates at 25% and 50% MVC appears after 110 sec of contraction and increases from then on.

Discussion

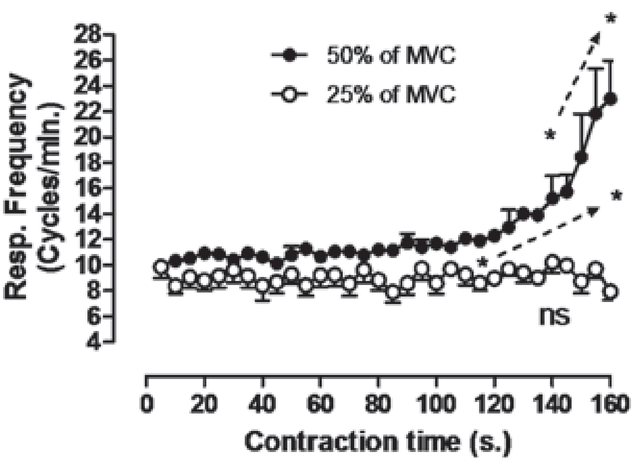
In the present investigation, the major finding is that fatigue during sustained contractions at 50% of MVC induces a decrease of the normalized H-reflex amplitude but lesser changes in the LLR, concomitant with an involuntary increase of breathing rate. This dissociation has previously been described during 100% contractions on the first dorsal interosseus muscle and the APB; however, respiratory rate was not measured.[8] During the decrease of the H-reflex, LLR was even enhanced in a neighbouring muscle which remained at rest, while the H-reflex was not changed in that muscle.[8] This suggested a central, non-specific stimulus to the LLR amplitude.

Figure 3
Normalised reflex amplitude (long latency reflex – LL, Hoffmann reflex – H) during 50% of maximum voluntary contraction (MVC) (left) and 25% MVC (right) (mean and SEM , *n* = 11; * *P* < 0.05). Subjects were instructed to maintain the contraction as long as possible; at 50% MVC they were unable to do so beyond 3 min.



In our experiment, the H-reflex decreased during fatigue-inducing contractions at both 25% and 50% MVC. Mechanisms for this may be related to (1) motor neuron adaptation processes, (2) reduced muscle spindle output or (3) increased presynaptic inhibition of Ia terminals and/or inhibition of interneurons in the oligosynaptic pathway. Adaptation of motor neuron properties to constant excitatory drive as observed in anesthetised cats,[9] does not appear to be preponderant with respect to the H-reflex decrease recorded in our experiments because the time course of the phenomenon that we observed was slower and there was no recovery if the pressure cuff was maintained after the fatiguing contraction. The adaptation of motor neuron properties is not present during voluntary contractions.[10]

Figure 4
Respiratory frequency (breaths per min) after the two fatigue tests (mean and SEM, *n* = 11, * *P* < 0.05)



The mono- and oligosynaptic pathway contributions to the short latency reflex evoked by stretch or electrical stimulation (H-reflex) differ slightly, but the main difference is that the H-reflex bypasses the spindle.[11,12] The comparison of the normalised H-reflex with previously reported reductions of stretch latency shows a very similar decrease of both signals under comparable conditions.[13,14] This suggests that the decrease in muscle spindle sensitivity should not play a key role in the mechanism.

In our experiment, the significant reduction (see Figure 2) of the H-reflex could be explained by a decline in transmission along neural elements between the nerve stimulation point and the H-responding motor neurons as a result of the activation of the muscle afferents (III-IV fibres), causing presynaptic inhibition of the Ia terminals and/or inhibition of interneurons of the oligosynaptic pathways at the level of the spinal cord. Because of the slow time course of the H-reflex decrease during fatigue, it is suggested that this is induced by chemical processes or metabolite accumulation in the muscle that trigger the small afferents from the fatigued muscle.[14,15] This conclusion is supported by the fact that no recovery was seen if ischaemia was maintained.[16,17]

The H-reflex and LLR evoked by electrical stimulation of the median nerve at the wrist have the same origin and are both transmitted by Ia fibres, but the LLR is routed transcortically.[7,18] The different behaviour of the LLR compared to the H-reflex in the sustained contraction at 50%

of MVC can thus be understood by the fact that metabolite-induced afferent input from type III or IV polymodal fibres will increase presynaptic inhibition, which in turn will decrease the segmental reflex (H-reflex) without influencing the transcortical pathways (LLR). In order to detect this central 'drive', a sufficient level of metabolites needs to be generated, explaining why the two signals show a parallel behaviour during weaker contraction (25% of MVC).

Thus, it seems that, in static contracting muscles (approaching 50% of MVC), fatigue induces afferent feedback, which provides the motor neurons with less excitation and, as a reflex compensation, a stronger descending supraspinal drive. This conclusion is strongly supported by the significant increase in respiratory rate, which is by definition a central mechanism, in subjects contracting the APB at 50% of MVC and no significant change at 25% of MVC. Our results are consistent with the presence of a long-loop mechanism underlying respiratory rate control in humans, with an accumulation of metabolites in contracting muscles as the trigger. Even small muscles can build up sufficient metabolites to induce this neural response. In respiratory physiology, such reflexes have long been proposed for respiratory control but until now the mechanisms involved remained unexplained. Previously published reports on phrenic afferents agree with our findings.[19] Whereas most of the studies on muscle afferents and respiratory drive have been performed on anesthetised dogs, our findings in awake, healthy humans confirm that these can also play a role in real-life situations. Recent studies utilising other approaches confirm this phenomenon in humans.[20–22]

Our results could offer an explanation for the termination of prolonged apneas, where hypercapnia and/or hypoxia are an insufficient explanation, even if these apneas are performed in a totally relaxed state. In this situation, diaphragmatic and/or intercostal muscle spasms can, with time, build up enough metabolites to trigger the system and induce the cessation of apnea.[20] This mechanism is probably relevant and deserves to be considered when discussing the limitations of extreme apnea.[23,24]

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Costantino Balestra, PhD, is Professor and Director of the Environmental & Occupational Physiology Laboratory, Haute Ecole Paul Henri Spaak , Brussels, Vice-President for Research & Education of DAN Europe and Vice President of the EUBS.
Morgan Levenez, MSc, DO, is a postgraduate student at the Université Libre de Bruxelles Institut des Sciences de la Motricité, Brussels and Assistant Professor at the Haute Ecole Paul Henri Spaak.
Pierre Lafère, MD, is a specialist at the Center for Hyperbaric Oxygen Therapy, Military Hospital Queen Astrid, Brussels.
Bernard Dachy, MD, is a neurologist, University Hospital Brugmann, and Assistant Professor at the Haute Ecole Paul Henri Spaak.
Mikel Ezquer, MSc, is Assistant Professor in Respiratory Physiology at the Haute Ecole Paul Henri Spaak.
Peter Germonpré, MD, is Director of the Center for Hyperbaric Oxygen Therapy, Military Hospital Queen Astrid, Medical Director of DAN Europe Benelux and President of the EUBS.

Address for correspondence:
Costantino Balestra
Environmental & Occupational Physiology Laboratory
Haute Ecole Paul Henri Spaak
Pôle Universitaire Bruxelles-Wallonie
91, Avenue Charles Schaller
1160 Auderghem (Brussels)
Belgium
Phone: *+32-(0)2-387-3714*
Fax: *+32-(0)2-387-3714*
E-mail: *<balestra@daneurope.org>*

The use of drugs by UK recreational divers: illicit drugs

Marguerite St Leger Dowse, Steve Shaw, Christine Cridge and Gary Smerdon

Key words
Recreational divers, drugs, risk factors, health survey, questionnaire, epidemiology

Abstract
(St Leger Dowse M, Shaw S, Cridge C, Smerdon G. The use of drugs by UK recreational divers: illicit drugs. *Diving and Hyperbaric Medicine*. 2011;41(1):9-15.)
Aims: Anecdotal observations suggest the use of illicit drugs takes place amongst recreational divers but, to date, there has been little open debate within the diving community concerning possible prevalence. This study investigated the prevalence and type of illicit drugs used by recreational divers in the United Kingdom (UK).
Methods: Anonymous questionnaires were circulated via UK dive clubs, dive schools, dive shows and conferences. Questions incorporated diver and diving demographics and general health, which included anxiety, depression and panic attacks, alcohol use, smoking and illicit drug use since learning to dive and closest time to a dive. Questions pertaining to over-the-counter and prescription drug use were also asked.
Results: 479 divers responded (66% males and 34% females) in the age range 16 to 59 years. Of the respondents, 22% had used one or more illicit drug since learning to dive, reporting benzodiazepines, amphetamines, cocaine, ecstasy, LSD, cannabis, heroin, and 'magic mushrooms'. Illicit drugs had been used by 3.5% of respondents in the last 12 months, and 3% in the last month. Cannabis, cocaine and ecstasy use was reported within 6 hours of a dive. Logistic regression confirmed a relationship between illicit drug use and depression (P = 0.014), and also between illicit drug use and anxiety (P = 0.024).
Conclusion: These data support anecdotal reports that recreational divers use a range of illicit drugs. The significant relationship between illicit drug use and depression and anxiety supports the literature in non-diving populations.

Introduction

Illicit drugs may be defined as those that are unlawful to possess, manufacture, sell or use. In the United Kingdom (UK), illicit drugs are divided into three classes depending on the degree of harm deemed attributable to each drug. The use of illicit drugs within the diving community is a subject overdue for open debate. The estimated prevalence is largely based on anecdotal evidence, which suggests that illicit drug use and scuba diving activities may be widespread in the diving community and that drug use may be closely linked temporally with scuba diving. In divers participating in such activities, the residual effect of illicit drugs, the risks of illicit drug use, and how these factors may interact with the diving environment need to be considered by both diver and diving physician.

The effects of illicit drugs in non-diving populations are well documented, and the types, classification (USA and UK), duration of effects and detection times of the most common recreational drugs are summarised in Table 1.[1–8] Class A drugs are considered most harmful, whilst those deemed least harmful are in class C. The issue of illicit drug use in divers has been addressed sporadically through presentations, articles and internet debate.[9,10] The regular use of cannabis has been observed in native-fishing diver populations, and animal studies have investigated the effect of cannabis under increased pressure.[11–13] To our knowledge, no definitive data have been prospectively gathered in an attempt to establish the prevalence of illicit drug use within the UK diving community, although previously collected data have shown possible use of illicit drugs.[14] Even in the general population, reliable data regarding illicit drug use are not easy to obtain, with users covert and reticent with regard to reporting their illegal behaviours and addictions. The British Crime Survey (BCS), published annually, is regarded as the primary source in assessing general illicit drug use in the UK.[15,16]

Concern regarding the use of illicit drugs in diving is principally around the onset, type and residual effects, and how any psychological or physiological changes may affect a diver's ability to dive safely.[10,17–23] The aim of this study was to investigate the prevalence of illicit drug use amongst sport divers in the UK. The class and type of illicit drug used, and temporal proximity to diving were also recorded. The relationship between anxiety and depression as dependent variables with illicit drug use was considered.

Methods

Confirmation in writing was received from the Chair of the Cornwall and Plymouth Research Ethics Committee that ethics approval was not required for this study. A questionnaire entitled *Health of divers* was compiled using diver and diving demographic questions designed and used in previous field data studies, which included the number of years' diving experience, number of dives since learning to dive, number of dives in the last twelve months, and maximum depth ever dived.[14] General health,

Table 1
Type, class, duration, detection times and side effects of illicit drugs [1,7,8]

Stimulants	**Onset/duration of effects** ***Detection time in urine****	**Side effects** ***Impact on diving***
Amphetamine Class A/B* Schedule 2*	Rapid effect with intravenous and smoking use, slower orally, overall effect 4–8 hours (h), residual up to 12 h *Urine: 1–4 days*	CNS stimulation, increased heart rate, elevated BP, anxiety, delusions, light sensitivity, insomnia, irrational behaviour, headache, hallucinations, can cause convulsions. *May affect judgement and problem-solving ability, and increase hypothermia susceptibility underwater.*
Cocaine Class A Schedule 2	Within 5 minutes (min), with high lasting 15–30 min, general effects 1–2 h, up to several days for late phase following a binge *Urine: 2–4 days*	CNS stimulation, increased heart rate, elevated BP, increased body temperature, disorientated behaviour, euphoria, improved performance in simple tasks, dizziness, nausea and vomiting, increased light sensitivity, feelings of well-being, can cause convulsions. *May impair judgement and ability to respond appropriately whilst diving.*
Ecstasy (MDMA) Class A Schedule 1	Within 20–30 min, desired effect one h general effect 2–3 h *Urine: up to 4 days*	CNS stimulation, relaxation, euphoria, changes in perception, impaired performance, panic attacks, visual disturbance, anxiety, dry mouth, sweating, can cause convulsions. *May impair judgement and ability to respond appropriately whilst diving.*
Hallucinogens		
Cannabis/ Marijuana Class B Schedule 1	Within 10 min, high may last up to 2 h, behavioural and physiological effects return to baseline within 3–5 h, residual effects in specific behaviours up to 24 h *Urine: 1–3 days but may be 20 days or longer*	Increased cardiac output, vasodilatation, dry mouth, decreased coordination, impaired learning and memory, euphoria, relaxed inhibitions, subjective slowing of time, apathy, alterations in thought formation and expression, impaired motor performance. *May impair judgement and ability to respond appropriately whilst diving.*
LSD Class A Schedule 1	Intravenous 10 min, oral 20–30 min with high at 2–4 h and diminishing over 6–8 h, flashbacks may occur within a few days or more than one year after use *Urine: 2–5 days*	Changes in perception and mood, decreased coordination, subjective slowing of time, hypertension, increased heart rate, panic attacks, loss of personal boundaries, tachycardia, hypertension, sense of dissociation. *May impair judgement and ability to respond appropriately whilst diving.*
Magic mushrooms (*Psilocybe* *& Amanita* *Muscaria*) Class A Schedule 1	Within 30 min–2 h, high at about 4–10 h, after effects a further 2–6 h *Urine: approx 8 h*	Increased confidence, distortion of colour, sound and objects, changes in sense of time and movement. *May impair judgement and ability to respond appropriately whilst diving.*
Opiates		
Heroin Class A Schedule 1	Dependent on route and dosage, from 45 sec to several min, peak effects 1–2 h, overall effect 3–5 h *Urine: 2–3 days*	CNS depression, light-headedness, reduced respiratory rate, dizziness, euphoria, nausea and vomiting, sedation, intense euphoria, mental clouding. *May impair judgement and ability to respond appropriately whilst diving.*
Depressants, sedatives, hypnotics		
Barbiturates Class B Schedule 3	Long-acting effect within 1–2 h, total effect 12 h or longer *Urine: short-acting 1 day, long-acting 2–3 weeks*	CNS depression, cardiovascular system depression, decreased mental acuity, euphoria, depressed respiratory function, anxiety suppression. *May impair judgement and ability to respond appropriately whilst diving.*

*Detection times of a drug in urine are often expressed in lower and upper limits because the times are dependent on a number of variables such as the amount and frequency of use, which is then related to drug tolerance, body mass index, overall health, age, metabolic rate, and urine pH. The times of detection and duration of effect in Table 1 are therefore approximate. Drugs are classified by different countries according to their approved medical use, abuse liability, or level of penalty for illegal possession and dealing. The United Nations 1971 Convention on Psychotropic Substances is the pivotal recommendation and is a treaty signed by more than 150 nations. Class and Schedule given in this table are UK and USA respectively.

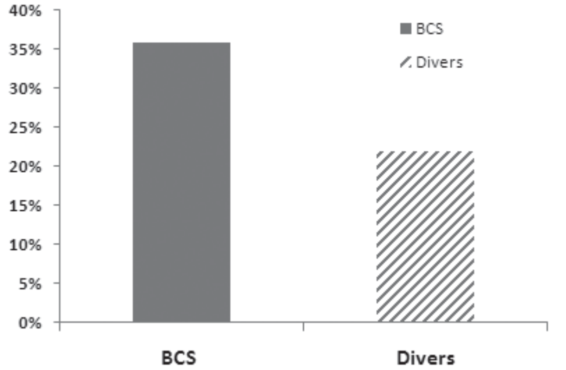
fixed-option questions based on the UK Sport Diving Medical Committee (UKSDMC) self-certification form were included.[24] Fixed-option yes/no questions were also asked concerning anxiety, depression, or panic attacks since learning to dive. Information regarding smoking and alcohol consumption was also requested. To detract from the primary focus of the study, respondents were asked to list current prescribed medication, and if appropriate any over-the-counter medication they had ever taken within six hours of diving.

Illicit drug questions to allow BCS comparison were included, detailing type of drug and when last used since learning to dive, with the following time increments: more than twelve months, in the last twelve months, in the last month.[15,16] Illicit drug type and temporal proximity to a dive were also recorded if appropriate as follows: 1 hour, 6 hours, 12 hours, 24 hours, 36 hours, 48 hours, 72 hours, 1 week, 2 weeks, 3 weeks. There was also a facility for free text. The age criteria (16 to 59 years) allowed some comparison between the study group and the BCS UK population. The illicit drug questions were unobtrusively placed in the main body of the questionnaire following questions regarding cigarette smoking.

The anonymous questionnaires (1,950), supplied with unstamped, addressed (Diving Diseases Research Centre), self-sealing envelopes were distributed randomly to divers between October 2007 and December 2009 via UK dive clubs/schools and national dive shows/conferences. The questionnaires were also available for download on the internet to complete and mail back, but questionnaires could not be returned electronically.

Data gathered focused on the prevalence, type and class of illicit drug used since learning to dive. There was no attempt to assess repetitive use, adverse outcomes, divers' knowledge of interactions of drugs with the diving environment or any increased risk of DCI.

Figure 1
British Crime Survey (BCS)[15] drug use "*in your lifetime*" compared with divers' drug use "*since you learnt to dive*"



STATISTICAL METHODS

Quantitative data are reported as range (median). Univariate analyses, including chi-square tests, were used to look at the relationships between the categorical variables drug usage (yes or no), anxiety, panic, depression and gender. An independent samples t-test was used to investigate any relationship between age and drug usage. Binary logistic regressions were used with anxiety and depression as dependent variables and drug usage, age and gender as independent variables. A significance level of $P = 0.05$ was used throughout. SPSS version 17 was used for statistical analysis.

Results

Completed questionnaires were received from 531 respondents with a response rate of 26% from hard copy questionnaires, and 2.4% from the world-wide web. A total of 479 (66% male, 34% female) records fulfilled the BCS age criteria of 16 to 59 (median 42) years and were suitable for analysis. Proportionately, there were more females than males in the younger 16 to 34 age groups, and more males than females in the older age groups. The 467 respondents (12 did not give their lifetime total dives) reported a total diving experience of 324,417 dives with a range of 2 to 9,000 (median 350) with 479 reporting a total of 27,741 dives with a range of 0 to 800 (median 40) in the last 12 months, and a depth-range experience of 4 metres' sea water (msw) to 100 msw. The number of years' diving experience ranged from 1 to 40 years.

ILLICIT DRUG USE

The BCS 2007/08 survey found that 35.8% of 16–59-year-olds had admitted to ever having used recreational drugs in their lifetime. An illicit drug had been used by 9.3% of the population in the previous 12 months, and 5.3% in the last month. A total of 105 divers (22%, 65 males, 40 females) had used one or more illicit drug since learning to dive, with 17 (3.5%) in the last 12 months, and 16 (3.3%) in the last month. These prevalences are compared in Figures 1 and 2.

Figure 2
British Crime Survey[15] and divers: drug use in the last 12 months and in the last month

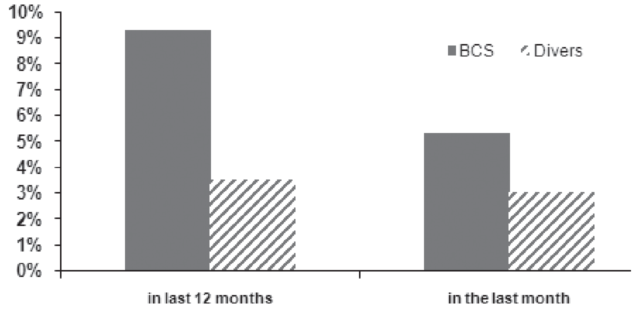


Figure 3
Type of drugs used in the last 12 months: British Crime Survey[15] versus divers

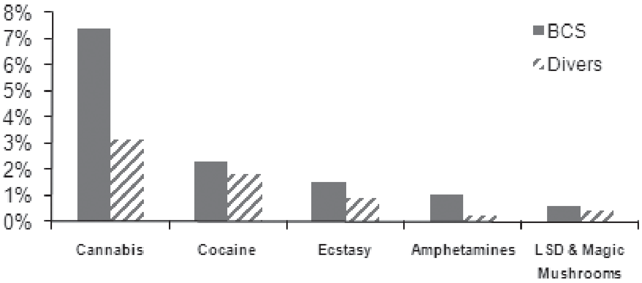


Table 2
Drug use by type; * some of the 105 illicit drug users reported using more than one type of drug

Drug	Number of reports	%
Cannabis	99	45.6
Cocaine	30	13.8
Magic mushrooms	21	9.7
Ecstasy	19	8.8
Amphetamines	19	8.8
LSD	17	7.8
Tranquillisers	7	3.2
Barbiturates	3	1.4
Heroin	2	0.9
Total	217*	100

Cannabis was cited as the most frequently used illicit drug. The types of drugs used by divers compared with the BCS in the last 12 months show similar trends, although the use of cannabis is less in the divers (Figure 3). The use of Class A drugs in the BCS data and divers is shown in Figures 4 and 5.

Within those respondents who confirmed illicit drug use (n = 105) benzodiazepines, amphetamines, cocaine, ecstasy, LSD, cannabis, heroin, and hallucinogenic mushrooms were all reported. Table 2 shows the percentages of the total 217 reports of drugs by the 105 respondents; some divers reporting the use of more than one type of drug. Additionally, of the 105 respondents, 40% admitted to using a class A drug since learning to dive. A class A or B drug had been used by 22 divers (21%) between 5 minutes (free-text response) and 24 hours before diving, with the use of cannabis, cocaine, and ecstasy reported between 5 minutes (free-text response) and 6 hours before diving. Use of hallucinogens was reported by 67% of the illicit drug group, with 25% reporting having used both hallucinogens and stimulants since learning to dive. In the last month, 10% of the illicit drug group had used both hallucinogens and stimulants.

ANXIETY, PANIC AND DEPRESSION WITH ILLICIT DRUG USE

Fixed-option data related to the general health of the divers allowed investigation regarding reports of anxiety, panic attacks and depression and any relationship with illicit drug use. A higher proportion of illicit drug users were anxious (7.6% compared to 2.7% for non-users) and a greater proportion were depressed (15.2% compared to 7.0%) (Table 3). There was evidence of a relationship between illicit drug usage by the divers in this study and both anxiety (P = 0.039) and depression (P = 0.014) but not panic (P = 0.66), based on chi-square tests. Logistic regression confirmed the relationship between anxiety and illicit drug use (odds ratio (OR) = 3.00, P = 0.024, 95% confidence intervals (CI) 1.15, 7.81). Neither gender nor age was significant.

Figure 4
British Crime Survey[15] class A drug use "*in your life time*" compared with divers' class A drug use "*since you learnt to dive*".

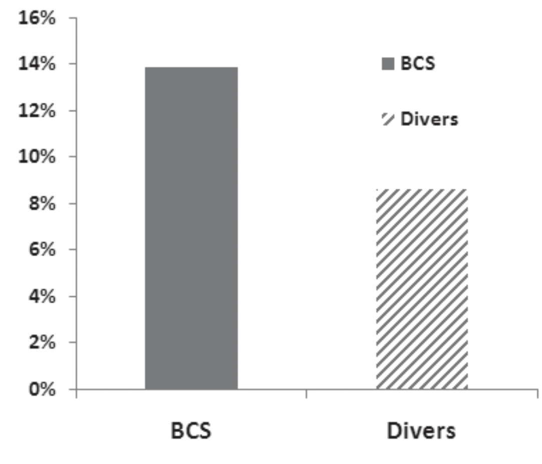


Figure 5
British Crime Survey[15] and divers: class A drug use in the last 12 months, and in the last month

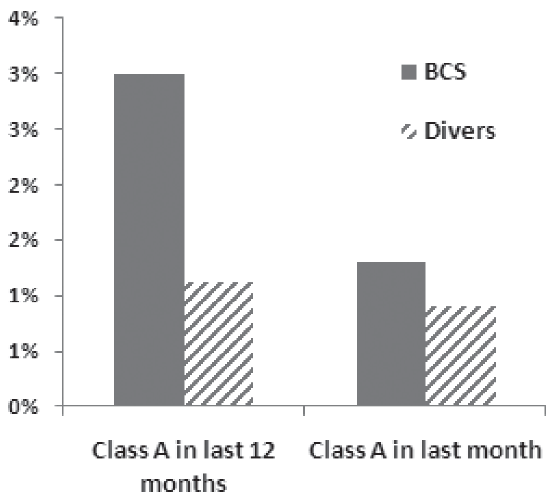


Table 3
Anxiety and depression with illicit drug use (%)

	Anxiety	Depression
Illicit drugs – Yes (n = 105)	8 (7.6)	16 (15.2)
Illicit drugs – No (n = 374)	10 (2.7)	26 (7.0)
Totals (n = 479)	18 (3.8)	42 (8.8)

Logistic regression also confirmed the relationship between depression and illicit drug usage (OR = 2.34, P = 0.014, 95% CI 1.19, 4.59). In this case, gender was significant (OR = 0.37, P = 0.002, 95% CI 0.19, 0.70), with females more likely to be depressed. Age was not a significant comparator.

Overall there was no relationship between illicit drug usage and gender (P = 0.44), but age was related to illicit drug use (P < 0.001, t-test), with illicit drug users tending to be younger (mean 38.0 years compared to 41.7 years for non-users).

Discussion

Recreational drugs change metabolic functions and perception of reality, distance and time and, therefore, can be considered to increase the risk of incidents whilst diving. These data demonstrate that some divers are using illicit drugs around the time of their diving activities and ignoring the limited advice given during dive training but widely available through public health campaigns. To date, there have been few specific studies designed to observe the use of illicit drugs in the recreational diving community, due in part to the difficulties in gathering credible data from a covert population.[8] This study cohort may suffer from potential selection bias in as much that divers who take drugs may be more willing to complete the questionnaire. Conversely, they may be less willing to participate in the event of respondents suspecting the primary aim of the study. The respondents in this study were not made aware of the primary subject matter of the project, with the title of the project and much of the data collected focusing on general health questions with which the divers would be familiar already,[24] and the diver, and diving demographics and basic health data gathered with other studies.[14,15]

The disadvantages of anonymous data collection from covert populations, such as illicit drugs users, are recognised and acknowledged.[8] However, the advantage of anonymous data gathering from covert groups is that respondents will often be considerably more overt in their willingness to provide sensitive data where they are confident that no traceable contact is likely. It was for this reason that divers could not up-load completed questionnaires on the internet, which may account for the high access to the questionnaire but low response rate from the internet. Repetitive illicit drug use, any adverse experiences, the divers' understanding of how a specific drug may interact with the diving environment or any associated DCI risks were not evaluated in this study, which could be deemed to be a weakness in the analysis of these data.

Although the proportion of divers in this study (22%) who admitted using illicit drugs since learning to dive is smaller than that of the general population in their lifetime (35.8%), and fewer divers (3%) had used recreational drugs in the last month than in the BCS (5.3%), these data still represent a sizeable minority.[15] In the main, the respondent population of divers were experienced divers. Whilst it is difficult to state whether the data gathered can be extrapolated to the larger diving community, it would be reasonable to consider that experienced divers would be more able to deal with the effects of illicit drugs underwater than a novice.

Divers were asked to record the closest time to diving that they had ever used an illicit drug. The fixed-option response for time of illicit drug use to time of dive was from one hour upwards, with space provided for additional information and this resulted in times as short as 5 minutes being recorded. Although a longer interval between the use of an illicit drug and diving should, in theory, diminish any potential risk, the timings before diving of some drug use should be of concern. With the effects of cannabis, for example, starting at 10 minutes or less depending on method of use, lasting up to 2 hours, and residual influence in specific behaviours evident up to 24 hours, these divers potentially place themselves at increased risk of a diving incident, though this cannot be substantiated. It might also be argued that divers are not exercising a responsible duty of care to their diving companions, given the psychological and physiological implications of illicit drug use.

Hallucinogens were the drugs most widely used by the divers, with cannabis/marijuana the most common. In theory, the psychological effects, such as alterations in thought formation and expression, altered time and space perception, and dulling of attention could affect a diver's ability to track depth and air, or manage a diving incident both below and above the water. Physiological changes of tachycardia and vasodilatation have a potential to impair in-water performance through effects on the cardiovascular system or by contributing to hypothermia.

Although the pharmacodynamics of drugs at surface pressure are well documented, as yet there is not a complete and thorough understanding of the pharmacodynamics of drugs under increased pressure. The question of the theoretical impact of illicit drug use on the recreational diver and safe diving practices may be an issue that researchers cannot conclusively address. Anecdotally it is known that, when questioned, divers do not always admit to illicit drug or even alcohol use when presenting at a hyperbaric chamber for a diving incident, or completing an incident report to a diving officer. Specific history of illicit drug use in the context of a diving accident should be routinely sought to gain further insight into the importance of illicit drugs as a contributing factor to dive accidents. Whilst it remains unlawful to possess or use these drugs, it is unlikely that data from recompression chambers or diving officers would be of any tangible use. Additionally, the animal model may not be the appropriate research tool with which to attempt to address these issues. Field data have shown that divers do not always adhere to dive plans, tables, or computers, and other factors may intervene to render a dive unsafe, such as sea or weather conditions. How a diver responds to a diving emergency may depend on their experience, health, or even simply 'how he feels on the day'. Therefore, perhaps the way forward lies in a programme of education focusing on the effects, types, classes, and duration of effects of the most commonly used illicit drugs.

Although the fixed-option response limited the quality of the general health questions, the significant relationship between illicit drug use and anxiety and depression in our data broadly supports the literature from non-diving populations.[1,4,5,25,26] The prevalence of divers, both illicit drug users and non users, reporting anxiety or depression should be of concern to both physicians and educators in the diving industry. In this study, a small number of the respondents suffered from depression, took illicit drugs and were also taking a range of prescribed medication for other conditions: a potentially hazardous cocktail.

During the time of this study, one UK diving organisation, when asked regarding their training advice on recreational drug use, confidently replied that "*it was covered in their lectures*". However, when pressed for details, it transpired that the lectures encompassed only very basic information, stating that "*it is not safe to dive and use drugs*". There was no provision for class, effect, residual and detection times, and type of illicit drug use and effects. Conversations with sport, commercial and military divers on the subject of illicit drugs have revealed attitudes ranging from bravado through to sheer disbelief if not naivety that illicit drug use was taking place freely within the diving community. It would appear there is an educational vacuum in this area needing to be addressed both for the physician and the diver. Whether this is due to complacency by those in authority that divers would simply not 'do drugs', or whether it is an inability to admit that illicit drug use is taking place, or both, remains unclear. What is clear, however, is that there is plainly an opportunity for the dive training agencies worldwide to implement a programme of awareness on all aspects of illicit drug use whilst diving, not only to promote safer diving but to provide greater understanding generally of illicit drug use and abuse.

Conclusions

This study supports anecdotal reports that divers use illicit drugs around the timing of their diving activities. A clear relationship between depression and anxiety and the use of illicit drugs was demonstrated. With the pharmacodynamics of drugs at increased pressure not fully understood, and with the sport of diving more widely available to a greater spectrum of the population from all ages and health circumstances, the diving community has a duty of care to address the associated potential risks of illicit drug use in the diving environment and to provide information and education on this subject to divers.

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Marguerite St Leger Dowse is a researcher at the Diving Diseases Research Centre (DDRC), Hyperbaric Medical Centre, Plymouth, Devon, United Kingdom.
Steve Shaw, PhD, is senior lecturer at the School of Mathematics and Statistics, University of Plymouth, Plymouth.
Christine Cridge, MRCP, MRCGP, PGDipMedSci (DHM), was a hyperbaric physician at the DDRC, Hyperbaric Medical Centre, Plymouth, at the time of the study.
Gary Smerdon, PhD, is Research Director at the DDRC, Hyperbaric Medical Centre, Plymouth.

Address for correspondence:
Marguerite St Leger Dowse
DDRC, Hyperbaric Medical Centre
Tamar Science Park, Research Way
Plymouth, United Kingdom
Phone: *+44-(0)1752-209999*
Fax: *+44-(0)1752-209115*
E-mail: *<marguerite@mstld.co.uk>*

The use of drugs by UK recreational divers: prescribed and over-the-counter medications

Marguerite St Leger Dowse, Christine Cridge and Gary Smerdon

Key words
Recreational divers, drugs, risk factors, medications, fitness to dive, health survey, epidemiology

Abstract
(St Leger Dowse M, Cridge C, Smerdon G. The use of drugs by UK recreational divers: prescribed and over-the-counter medications. *Diving and Hyperbaric Medicine*. 2011;41(1):16-21.)
Introduction: Various prescribed and over-the-counter medications may theoretically be incompatible with the diving environment. Anecdotally, it is known divers regularly take medications around the time of their diving activities for different health conditions, possibly ignoring the recommendations not to do so. As part of a diversion in a study of illicit drug use in sport divers, secondary data regarding the use of prescribed and over-the-counter medications were gathered.
Aims: The aim of presenting these data is to attempt to evaluate and promote debate surrounding the fitness of some divers to participate in the sport and the potential problems medication may cause whilst diving.
Methods: Anonymous questionnaires addressing diving demographics, general health, alcohol, smoking, illicit drugs, prescribed and over-the-counter medications were circulated via United Kingdom dive clubs, schools, dive shows and conferences. Divers were asked if they were currently taking medication prescribed by a physician, if they had ever taken any over-the-counter drugs within six hours before a dive, and to give details. Questions were fixed-option and free-format.
Results: A response rate of 26% provided 531 records (68% male, 32% female) for analysis. Over-the-counter medication was used by 303 (57%) of the respondents 6 hours or less before diving. Analgesics were the most commonly reported (180/303), with the use of decongestants (132/303) the next most regularly reported. Prescribed medications were used by 23% of respondents, with 10% reporting the use of cardiovascular drugs. The majority of the cardiovascular medication was for primary disease prevention; however, drugs only used in the treatment of symptomatic cardiovascular disease were reported, indicating individuals were diving with medical conditions recommended not compatible with diving. Other medication reported would also suggest liaison with a diving physician should have been undertaken prior to diving.
Conclusion: Although these data were diversionary, secondary and therefore open to criticism, the range of prescribed medications reported in this study was broad and suggested a need for further investigation regarding medication use and fitness to dive.

Introduction

The safe use of physician-prescribed and over-the-counter medications has been a topic of debate within the diving community and often remains a difficult area when considering fitness to dive. Studies, theoretical possibilities and anecdotal evidence have been used to assess the effect of diving and drugs, but the information available is inadequate for conclusions to be drawn definitively regarding the huge variety of medication used by recreational divers.[1–14]

Many divers take medications prescribed by their physician or other health professionals. Studies have shown, and it is anecdotally known, that divers regularly take medications around the time of their diving activities for minor complaints such as sea-sickness, headache, nasal congestion, and coughs and colds.[11–14] This is despite being advised during dive training not to do so because of the risk of diving-related problems occurring, and medical standards defined in the self-declaration medical questionnaire.[15,16]

The potential compatibility or risks of a medication whilst diving is a common query posed to diving medicine physicians. Prescribed medications are diverse and the implications in relation to diving and their use may not be realised by a non-diving prescriber. Divers may ignore the recommendations of their physician or consultant through lack of understanding of latent issues with regards to diving.[17] Admissions of use of a certain type of medication can be an indicator of an existing medical condition that previously had not been declared by the diver. A report in 2002 showed that a number of divers clearly disregarded any recommendations they may have been given and were regularly diving using analgesics containing opioids, anti-convulsants, anxiolytic, hypnotic drugs and a range of other potentially risk-enhancing medications.[17]

In the United Kingdom (UK), recreational divers complete self-declaration medical questionnaires. UK divers only have to contact a diving medicine physician or undergo a diving medical examination if a condition is indicated on the self-declaration form.[18] However, in the UK an individual has a single medical record in the primary-care domain, which is transferred when a patient moves to a different general practice. Secondary care services are obliged to provide information to the general practitioner regarding hospital appointments or admissions. This means that the past medical history of an individual is relatively complete

Table 1
Diving demographics of respondents

	Males (*n* = 360)		Females (*n* = 171)	
	Number	(%)	Number	(%)
Diving experience (yr)				
<2	26	(7.2)	33	(19.3)
2–5	63	(17.5)	53	(31.0)
6–10	72	(20.0)	38	(22.2)
>10	195	(54.2)	44	(25.7)
No data	4	(1.1)	3	(1.8)
Dives in last year				
0	4	(1.1)	13	(7.6)
1–50	211	(58.6)	115	(67.3)
51–100	103	(28.6)	37	(21.6)
>100	42	(11.7)	6	(3.5)
Dives since learning				
<100	62	(17.2)	65	(38.0)
100–500	126	(35.0)	64	(37.4)
501–1000	80	(22.2)	25	(14.7)
>1000	82	(22.8)	13	(7.6)
No data	10	(2.8)	4	(2.3)
Maximum depth dived (msw)				
<31	38	(10.6)	50	(29.2)
31–50	151	(41.9)	79	(46.2)
51–100	156	(43.3)	38	(22.2)
>100	15	(4.2)	1	(0.6)
No data	0		3	(1.8)

at a single source and an invaluable source of information should permission be gained to access it. This much reduces the possibility of concealment, mistruth or oversight by the diver undergoing dive medical examination, if a diving physician is fastidious in requesting appropriate background medical history.

In order to covertly gather data regarding the prevalence of illicit drug use in divers, we conducted a study entitled *Health of divers*. This was performed against a background of a diversionary set of questions regarding general health, and prescribed and over-the-counter medication use. The aim of these secondary data presented here is to promote awareness of a diver's fitness or possible unfitness to dive.

Methods

A detailed methodology for this study is presented in the accompanying paper on illicit drug use by UK divers.[19] The questionnaire *Health of divers* was compiled using diver and diving demographic questions designed and used in previous field studies, which included the number of years' diving experience, number of dives since learning to dive, number of dives in the last twelve months, and maximum depth ever dived.[20] General health fixed-option (yes/no) questions based on the UK Sport Diving Medical Committee (UKSDMC) self-certification form were included.[18] Information regarding smoking and alcohol consumption was also requested. Respondents were asked to list current prescribed medication, and if appropriate any over-the-counter medication they had ever taken within 6 hours of diving. The format and order of questions was designed to suggest to the diver that the sole purpose of the study was to gather data regarding their general health, e.g., asthma, diabetes and other health problems. All age groups were used in the analyses. Where appropriate, data are reported as range (median). Confirmation in writing was received from the Chair of the Cornwall and Plymouth Research Ethics Committee that ethics approval was not required for this study. Statistical analysis was performed using SPSS version 17.

Results

Completed questionnaires were received from 531 respondents with a response rate of 26% from hard copy questionnaires. There was a small response (2%) from the internet from questionnaires that were printed out, completed on hard copy and mailed back; the facility to electronically return completed questionnaires was not available for this study. All 531 records (68% male, 32% female), were suitable for analysis, with an age range of 13–70 years (median 43). There were proportionally more females (40.9%) than males (16.1%) in the 20 to 34 age groups, and more males (48.9%) than females (31.6%) in the older age groups.

Diver and diving demographics are shown in Table 1 and follow similar trends to that of other DDRC data.[20] Forty-five per cent of respondents had more than ten years' diving experience. More females (50.2%) than males (24.7%) had less than five years diving experience. The most years of diving experience reported was 46 years. A total of 30,441 dives in the last 12 months (23,343 male, 7,098 female) were reported by 514 divers, with average annual dives 66 for males and 45 for females. Altogether, 517 divers reported a total of 388,209 dives (322,773 male, 65,436 female) since learning to dive.

OVER-THE-COUNTER DRUG USE, SMOKING AND ALCOHOL

A wide range of over-the-counter medication use was reported by 303 (57%) of the respondents within 6 hours of diving (Table 2). Analgesics were the most commonly reported, with the use of decongestants the next most regularly reported. Some divers reported using more than one category or type of medication. Antibiotics reported were purchased 'off prescription' whilst overseas.

Smoking and alcohol use are shown in Table 3. Amongst those who did smoke cigarettes, 40 per day was the greatest number reported. The alcohol habits of divers showed the

Table 2
Over-the-counter drugs taken within 6 hours of diving activities, n = 303

Category	Frequency	Comments
Analgesics	180/303	Paracetamol, ibuprofen, aspirin, codeine
Decongestants	132/303	Oral pseudoephedrine Topical – unspecified
Antihistamines	41/303	Sedative – cinnarizine, chlorphenamine, Non-sedative – loratadine, cetirizine diphenhydramine
Antiemetic	27/303	Unspecified
Cold/flu remedies	10/303	Cough mixture, cold/flu remedies
Gastrointestinal	3/303	Loperamide
ENT	2/303	Unspecified
Miscellaneous	3/303	Antimalarials, antibiotics

same trend as previous studies, with 414 (78%) regularly consuming alcohol and 26% of that group admitting to drinking alcohol 'frequently' 12 hours or less before diving. Thirty respondents (28 males, 2 females, 5.6% of the total respondents) reported consuming 30 or more units per week.

PRESCRIBED MEDICATION USE

The use of prescribed medications was reported by 121 (22.8%) of the respondents (Table 4). Some respondents reported more than one type of medication, with 70 (57.8%) of respondents in this group also reporting the use of over-the-counter medications within 6 hours of the time of a dive.

Discussion

The primary objective of the *Health of divers* project was to gather data regarding illicit drug use in recreational divers, and these data are reported in the accompanying paper.[19] The questions with regard to the use of prescribed and over-the-counter medications were diversionary and as such were part of a 'piggy-back' method used to gather data from an otherwise covert population. As a result, some areas of information pertaining to prescribed and over-the-counter medications were not available for analysis. For example, some divers who listed prescribed medications for cardiovascular conditions did not provide detailed data with respect to that condition; whilst conversely some divers who provided data concerning specific conditions did not list their medications in detail, if relevant. Additionally, data relating to frequency of medication use were not gathered.

Methodologies in collecting data from covert populations such as illicit drug users are well documented, with 'piggy-backing', as used in this study, acknowledged as a credible method.[21] The authors acknowledge the problems and any possible bias associated with anonymous methodology due to an inability to follow up. However, there are clear advantages to this method inasmuch as those respondents who feel they have something to hide may be more willing to participate in the project.

This study confirmed that some divers may be using a wide range of medications, both over-the-counter and prescribed, around the time of their diving activities. It is possible that the limited advice given during dive training to exercise caution with regard to diving and drug interactions is not being heeded. It is not known if divers are seeking advice regarding the safety and suitability of diving with various medical conditions or whilst on medication, or if the divers are concealing this when completing their self-declaration medical certificates.[17] The use of some prescribed medications reported in a few cases also suggests underlying medical conditions that may not be compatible with diving, for example symptomatic ischaemic heart disease and asthma.[22,23]

Anecdotally, there appears to be confused understanding in the grass roots of diving as to the suitability of some prescribed medication use and scuba diving. Some studies have attempted to evaluate the use of prescribed medication in divers.[11–14] The issue of prescribed medication is a common theme in 'fitness to dive' enquiries to medical referees, but is a sensitive area to address, with divers perceiving the threat of being declared unfit to dive.[23–27]

Even allowing for methodological issues, these data have provided a useful insight into some of the medications used by divers. With nearly 25% of the total respondents having used over-the-counter decongestants, and some additional cough, cold and flu remedies reported, many divers appear to be ignoring recommended standards.[15–17] Problems could manifest themselves as a rebound effect causing reverse ear barotrauma, pulmonary barotrauma due to mucous plugging, or the theoretical risk of lowering the seizure threshold through decongestant use. All may endanger a diver or their buddy or impair their performance underwater.

Table 3
Regularly smoking and/or consuming alcohol

	Males (n = 360)		Females (n = 171)	
Smoking use	Number	(%)	Number	(%)
Yes	40	(11.1)	13	(7.6)
No	320	(88.9)	158	(92.4)
Alcohol use				
Yes	284	(78.9)	130	(76.0)
No	76	(21.1)	41	(24.0)

Table 4
Prescribed medications reported by respondents (*n* = 121) (numbers reported)

Category (in descending frequency of responses)	**Medication** (in descending frequency within category)	**Actual medication used**
Cardiovascular *(53)*	Angiotensic converting enzyme inhibitors /Angiotensin-II receptor antagonists *(15)*	Ramipril, irbesartan, perindopril, valsartan, lisinopril, losartan, enalapril
	Lipid lowering agents *(12)*	Simvastatin, atorvastatin, rosuvastatin, ezetimibe, fenofibrate
	Antiplatelet drugs *(10)*	Aspirin *(9)* and clopidogrel *(1)*
	Diuretics *(6)*	Bendroflumethiazide
	Calcium-channel blockers *(3)*	Felodipine, amlodipine
	Beta-adrenoceptor blockers *(3)*	Atenolol
	Alpha-adrenoceptor blockers *(1)*	Doxazosin
	Anti-anginal *(1)*	Nicorandil
Endocrine *(23)*	Diabetes agents*(9)*	Metformin *(7)*, Insulin *(2)*
	Thyroid replacement *(9)*	Levothyroxine
	Female hormones *(9)*	Norethisterone, hormone replacement therapy
Analgesics *(18)*	Non-steroidal anti-inflammatories *(10)*	Diclofenac, naproxen
	Opioids *(6)*	Tramadol, codeine phosphate, morphine
	Gabapentin *(1)*	for neuropathic pain
	Paracetamol *(1)*	
Respiratory *(16)**	Short-acting B2 agonists *(4)*	Salbutamol, terbutaline
	Inhaled steroids *(4)*	Budesonide, beclomethasone
	Inhaled combined steroid and long-acting B2 agonists *(3)*	Symbicort (budesonide and formeterol)
	Nasal sprays *(4)*	Fluticasone, mometasone, triamcinolone, Beclometasone
Gastrointestinal *(9)*	Proton pump inhibitors *(8)*	Lansoprazole, omeprazole
	Histamine-2 receptor antagonists *(1)*	Ranitidine
Drugs for infection *(7)*	Antibiotics *(4)*	Amoxicillin, amoxicillin/clavulanate, Metronidazole
	Antiviral *(2)*	Aciclovir
	Antifungal *(1)*	Fluconazole
Psychotropic *(6)*	Selective Serotonin Reuptake Inhibitors *(5)*	Citalopram, fluoxetine, paroxetine
	Benzodiazepine *(1)*	Diazepam
Neurological *(5)*	5 HT_1 agonist *(4)*	Rizatriptan, sumatriptan
	$Dopamine_2$ antagonist	Cabergoline
Musculoskeletal *(5)*	Arthropathy	Allopurinol, hydroxychloroquine, glucosamine
	Osteoporosis	Alendronate
Miscellaneous *(5)*	Antihistamines	Fexofenadine, loratadine
	Cancer	Anastrozole
	Skin (dermatitis herpetiformis)	Dapsone
	Opthalmology	Unspecified drops for glaucoma

**Listed according to Management of Chronic Asthma British Thoracic Society Guidelines*

There was a wide variety of medications recorded by the 23% of respondents who reported taking prescribed drugs. The issues arising from the compatibility within the diving environment of the medication being taken and the condition itself that requires the medication in the first place are of concern.[13,17] For example, an individual requiring medication such as Nicorandil, used in the management of symptomatic ischaemic heart disease, is at risk of in-water incapacitation and is also placing his fellow divers at risk in the event of a required rescue. The potential side effects of some medication could also cause problems during diving. This could range from cardiovascular performance impairment in an individual on beta-blocker medication, to increased risk of convulsion on medication such as selective serotonin reuptake inhibitors. It is recognised that some risks or side effects decrease with time on medication, but these time-factor data were not available to the investigators.

When addressing the fitness of an individual to undertake diving, understanding is needed of how the condition or medication required may impact on the diver or be influenced by the diving environment. Many non-diving medical practitioners will be unaware of possible risks associated with diving whilst taking specific prescribed medications and, therefore, are not able to pass on this information to the diver. In a suggested framework for fitness to dive, thought should be given as to:

- how the health condition of the diver will be affected by the activity of diving
- how the health condition will affect diving performance
- whether there is an increased risk of diving-related illness
- what is the liability to the safety of others in the dive party?[23,25]

For instance, there was report of neuropathic analgesic use. This may affect a diver's alertness, judgement, and decision-making abilities, resulting in impairment of in-water performance. Both the indication for the neuropathic analgesia and the drug itself call into question the diver's fitness to dive due to a risk of incapacitation, which could cause symptoms that might also be confused with DCI.

Some of the prescribed medication reported may suggest primary prevention of cardiovascular disease or, indeed, treatment of existing disease; this information detail was not available from this study. Much of the cardiovascular medication documented may fall into the category of primary prevention, perhaps reflecting preventative health strategies by general practitioners in the UK. Other medications are for secondary prevention in the treatment of existing cardiovascular disease (Table 4). Some divers may be diving with conditions that not only put themselves at risk, but potentially increase the risk of incident to others. This is an area that warrants further investigation, as has been undertaken, for instance, with regards to diabetes and diving. Health declines with advancing years and many divers continue diving irrespective of the fact that their health differs as they become older. Growing into a health problem may 'condition' a diver to the health complaint and any risk factor associated with diving may be either ignored or simply not appreciated. In the UK, the use of the Recreational Scuba Training Council Medical Statement, and the UK Sport Diving Medical Committee self-declaration medical form, whilst broadly successful, clearly enables some divers to avoid medical guidance, thus increasing the potential for risk whilst diving.[26–30] UK reports in 2009 noted that there was a disproportionate trend towards fatalities in the older age groups amongst divers and cardiovascular disease features annually in diving fatality statistics in the UK.[31]

In recognising that medications are used widely within the sport, the question needs to be asked by both physicians and divers as to whether there is a lack of education in this area, or whether the recreational dive industry is adequately informed but divers are simply choosing to ignore the advice given. With the lack of available data regarding the influence of medications on diving incidents, the opportunity exists for a closer liaison between the dive training agencies and the medical fraternity.

Conclusion

These data support anecdotal and published reports that divers use over-the-counter and physician-prescribed medications around the timing of their diving activities. The wide range of physician-prescribed medications reported by divers also confirmed a need for further investigation into use of medication such as cardiovascular drugs and compatibility with recreational scuba diving.

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Marguerite St Leger Dowse is a researcher at the Diving Diseases Research Centre (DDRC), Hyperbaric Medical Centre, Plymouth, Devon, United Kingdom.
Christine Cridge, MRCP, MRCGP, PGDipMedSci (DHM), was a hyperbaric physician at the DDRC, Hyperbaric Medical Centre, at the time of the study.
Gary Smerdon, PhD, is Research Director at the DDRC, Hyperbaric Medical Centre.

Address for correspondence:
Marguerite St Leger Dowse
DDRC, Hyperbaric Medical Centre
Tamar Science Park, Research Way
Plymouth, United Kingdom.
Phone: *+44-(0)1752-209999*
Fax: *+44-(0)1752-209115*
E-mail: *<marguerite@mstld.co.uk>*

Mental health measures in predicting outcomes for the selection and training of navy divers

Charles H van Wijk

Key words
Psychology, military diving, training, performance, questionnaire, research

Abstract
(van Wijk CH. Mental health measures in predicting outcomes for the selection and training of navy divers. *Diving and Hyperbaric Medicine*. 2011;41(1):22-6.)
Introduction: Two models have previously been enlisted to predict success in training using psychological markers. Both the Mental Health Model and Trait Anxiety Model have shown some success in predicting behaviours associated with arousal among student divers. This study investigated the potential of these two models to predict outcome in naval diving selection and training.
Methods: Navy diving candidates (n = 137) completed the Brunel Mood Scale and the State-Trait Personality Inventory (trait-anxiety scale) prior to selection. The mean scores of the candidates accepted for training were compared to those who were not accepted. The mean scores of the candidates who passed training were then compared to those who failed. A number of trainees withdrew from training due to injury, and their scores were also compared to those who completed the training.
Results: Candidates who were not accepted were more depressed, fatigued and confused than those who were accepted for training, and reported higher trait anxiety. There were no significant differences between the candidates who passed training and those who did not. However, injured trainees were tenser, more fatigued and reported higher trait anxiety than the rest. Age, gender, home language, geographical region of origin and race had no significant interaction with outcome results.
Conclusions: While the models could partially discriminate between the mean scores of different outcome groups, none of them contributed meaningfully to predicting individual outcome in diving training. Both models may have potential in identifying proneness to injury, and this requires further study.

Introduction

Anxiety and panic experiences are common occurrences in recreational scuba diving.[1,2] Although one study could not predict actual panic events using trait anxiety in experienced scuba divers,[3] trait anxiety has been identified as a predictor of panic in beginner diving students.[4] Very low and very high levels of arousal could be expected to predict poor performance, and it has been demonstrated that as divers' stress and subsequent arousal increases, so their performance decreases.[5] Panic experiences are extreme forms of autonomic arousal.

Given the costs of diving training, and the risks associated with increased anxiety (i.e., poor task performance, panic, fatalities), two models have been enlisted to predict success in training using psychological markers. These are the Mental Health Model (MHM) and Trait-Anxiety Model (TAM).

MENTAL HEALTH MODEL

The MHM specifies that positive mental health enhances the likelihood of success in sport, whereas psychopathology is associated with a greater incidence of failure.[6] The model uses the Profile of Mood Scale (POMS) to measure psychological distress. This widely used measure identifies and assesses transient, fluctuating affective mood states.[7] The POMS measures six identifiable affective states (tension, depression, anger, vigour, fatigue and confusion).

Elite athletes were found to possess a unique mood profile, which was labelled the 'iceberg profile'.[6] The term refers to the graphic picture that POMS raw scores create when they are plotted on a profile sheet. Successful athletes tend to possess more of an iceberg profile than less successful athletes. However, the usefulness of the iceberg profile to predict sporting performance has been questioned.[8,9] For example, it was found that the POMS accounted for only 1% of general performance outcomes,[8] although it is much more effective as a predictor of single performance.[10] Recent research indicated the utility of the shorter version of the POMS, the Brunel Mood Scale (BRUMS) in predicting dichotomous (win/lose) outcome in some sport competitions, and academic performance.[11–14]

In spite of the above, the POMS is still widely used. Good concurrent and criterion validity have been reported for the BRUMS,[11] and South African (SA) norms for elite athletes are available.[15] Further, a number of studies reported the use of the POMS for diving research, with two that are of particular interest here. The POMS was included in a national diver survey (n = 245 USA scuba divers), and it was found that divers conform to the typical iceberg profile associated with successful athletes across a variety of sports.[16] Divers as a group scored lower than age-matched controls in undesirable mood variables such as tension and depression and higher for the desirable factor of vigour. Another study followed 42 student scuba divers through 16 weeks of training and found that the POMS (total mood score) predicted students who exhibited panic behaviours better than chance, but was less powerful in predicting panic than using trait-anxiety scores.[17]

TRAIT-ANXIETY MODEL

Trait anxiety represents an enduring feature of a person's personality, and reflects a person's general experience of anxiety. The State-Trait Anxiety Inventory (STAI) and the State-Trait Personality Inventory, Trait Anxiety (STPI) are the most widely used measures of trait anxiety.[18]

The trait-anxiety model (TAM) posits that individuals with higher trait anxiety are at higher risk for panic experiences during diving. The STPI appears to differentiate sporting performance at elite level.[19] One mechanism could be the association between high trait anxiety and measures of chronic elevated arousal.[20] In this regard trait anxiety was originally identified as a predictor of panic in beginner diving students.[4]

More recently, the TAM was tested in the study of the 42 student scuba divers.[17] It was predicted that students with STAI trait-anxiety scores ≥ 39 would exhibit panic behaviour during training. This produced an accurate prediction rate of 83%.[17] Trait anxiety and panic were considered in experienced scuba divers (n = 1415 male divers), using the STPI population average to predict panic.[3] This produced an overall prediction rate of 21%, which questioned the value of the trait-anxiety model. However, when the STPI average score + 1 standard deviation was used, the overall prediction rate went up to 81%.[3] Using survey data, no significant difference was found in average trait anxiety (STPI) scores between panickers and non-panickers among experienced scuba divers.[3]

RATIONALE FOR THIS STUDY

The above models have shown some success in predicting panic behaviours (among others), and they may, therefore, also be useful to predict other performance outcomes associated with heightened arousal. Elevated levels of anxiety or psychological distress may pose a particular risk for adverse underwater experiences. Predicting this would then be important from both safety and training perspectives.

South Africa is a country with limited resources with many social demands vying for restricted state funding. Military diving training is expensive, and accurate prediction of performance (i.e., 'success') may improve selection, thus maximising the use of the limited resources available to the military. This study set out to test the MHM and TAM in the South African Navy (SAN) diving environment, to determine whether any of these models would contribute to predicting success in diving training in the South African context, with its multicultural landscape and, in particular, in its naval context. The usefulness of the models and the value of their measuring instruments were investigated. Measurements were taken prior to any diving involvement, and were used to predict success in selection, as well as overall success during the diving training programme.

Methodology

PARTICIPANTS

Ethics approval for the study was obtained from the South African Military Health Service Ethics Committee. One-hundred-thirty-seven navy sailors (mean age 27.3, SD 6.0), applied to do a volunteer-only entry-level military diving course. Participants completed the BRUMS and STPI on the day prior to their selection. After selection, 73 sailors, 62 men and 11 women (mean age 28.1, SD 6.2) commenced with training. Candidates came from diverse race and language groups and geographical regions of origin. All participants were medically healthy, having completed a comprehensive diving medical assessment (including psychological screening) prior to their selection.

MEASURES

BRUMS

The BRUMS is a shortened version of the POMS.[11,15] It consists of 24 mood items that measure six identifiable affective states through a self-report inventory, with respondents rating a list of adjectives on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely), based on subjective feelings. The instructions referred to how participants "*have been feeling in the past week, including today*". The six mood state subscales are tenseness, depression, anger, vigour, fatigue and confusion. A Total Mood Distress (TMD) score can also be calculated.

STPI

The STPI is a self-administered, 10-item questionnaire, consisting of the ten most valid items from the STAI, designed to measure dispositional anxiety in adults.[18] Respondents rate statements on a four-point frequency scale. Scores range from 10–40, with higher scores indicating a greater level of trait anxiety. The SAN mean is 14 (SD 4) for both women and men.[21]

SELECTION OUTCOME

Selection outcome was either 'accepted' or 'not accepted'. This was based on the decision of an independent naval panel, who were naive about the psychometric measurement results. Acceptance into the training programme is based on objectively prescribed criteria.

PERFORMANCE DURING TRAINING

Performance or success during training is a complex concept and difficult to circumscribe. Successful completion entails candidates having to meet both academic and physical requirements as set down in naval policies. For ease of analysis, two categories were created to describe outcomes, namely qualify within the prescribed time-frame ('pass'), and not qualify within the prescribed time-frame ('fail'). A third category ('injured') was added later, when it became apparent that a number of candidates did not complete the course as a result of injuries.

STATISTICAL ANALYSIS

Prediction rates for the BRUMS were determined using mean score only, as well as mean score +/-1 SD. Prediction rates for the STPI were determined using the SAN mean of 14, as well as +/-1 SD. Overall prediction rates were calculated by dividing the number of accurately predicted cases by the total and reporting the result as a percentage. Comparisons of outcomes were done by means of a t-test for independent groups for selection outcomes, and by means of ANOVA for training outcomes. Effect sizes were calculated using Cohen's d, and eta squared, respectively.

Results

SELECTION OUTCOMES

Of the 137 candidates, 83 (60.6%) were selected for the diving course. The BRUMS failed to predict acceptance significantly better than chance would. Although candidates who were selected did not display a more distinct iceberg profile than candidates who were not (Figure 1), there were significant differences in three of the subscales and the TMD scale (Table 1). Candidates who were not accepted were more depressed ($P < 0.01$), more fatigued ($P < 0.05$), and more confused ($P < 0.01$), and had a higher overall TMD score ($P < 0.05$). The effect size in each significant difference was only moderate.

Figure 1
Iceberg profile of 137 diving candidates per selection outcome

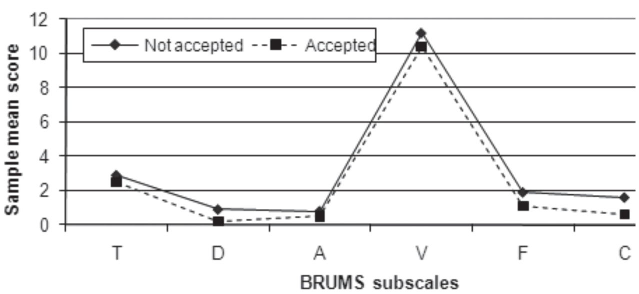


Table 1
BRUMS and STPI mean (SD for STPI) scores of study sample according to selection outcomes

	Not accepted (*n* = 54)	Accepted (*n* = 83)	t	d
BRUMS				
Tension	2.9	2.5	0.8	0.2
Depression	0.9	0.2	3.6‡	0.7
Anger	0.8	0.5	0.9	0.2
Vigour	11.2	10.4	1.5	0.3
Fatigue	1.9	1.1	2.2*	0.4
Confusion	1.6	0.6	3.1†	0.6
TMD	-2.9	-5.7	2.3*	0.4
STPI	14.1 (3.1)	12.5 (2.5)	2.7†	0.5

*$P < 0.05$, † $P < 0.01$, ‡ $P < 0.001$

The overall prediction rate for the STPI was only 60%. It correctly classified 86% of candidates who were accepted, but only 21% of those who were not. Candidates who were not accepted had a significantly higher mean score ($P < 0.01$) (Table 1).

As these self-report measurements were completed shortly before selection, the possibility of a response bias could not be excluded. However, inspection of scores revealed a normal distribution curve.

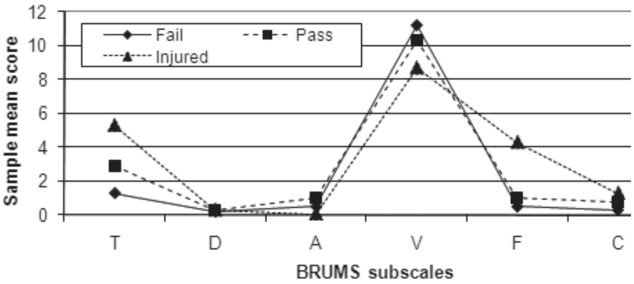
TRAINING OUTCOMES

Of the 83 candidates who were accepted after selection, 73 started on the diving course (ten had conflicting operational commitments). Forty seven (64.4%) qualified, 20 (27.4%) did not, while 6 (8.2%) did not complete the course because of injuries sustained during training.

The BRUMS again failed to predict success and/or failure significantly better than chance. Both 'pass' and 'fail' candidates displayed an iceberg profile (Figure 2), without significant differences on any of the sub-scale scores (Table 2). However, candidates who had to withdraw due to injuries sustained during the course were more tense ($P < 0.01$), more fatigued ($P < 0.001$), and had a higher overall TMD score ($P < 0.001$) prior to commencing the course than both the candidates that passed and those who failed. The effect size in each significant difference was again only moderate.

The STPI was 64% accurate in its prediction. Here, 33% of injuries, 0% failures, and 93% passes were correctly classified. There were no significant differences on the mean scores between the participants who passed and those who failed. Again the injured group scored significantly higher ($P < 0.05$) than the successful group ($P < 0.05$) and non-successful group ($P < 0.05$) (Table 2).

Figure 2
Iceberg profile of 73 diving candidates per training outcome



Age, gender, home language, geographical region of origin and race had no significant interaction with the outcome results.

Discussion

Within the MHM, all candidates conformed to an iceberg profile, although the outcome groups differed on some of their mean scores. However, notwithstanding the differences in mean scores, the model failed to predict individual performance with significant accuracy.

In spite of the MHM being used in previous diver studies, concerns have been raised regarding its power to predict performance outcomes.[8,9] It was concluded previously that it would be less effective as a predictive instrument in environments with strong demand characteristics,[8] and in samples with heterogeneous levels of skill and physical conditioning, and it has been suggested that mood assessment is more relevant to short duration activities.[9,10] Selection and diving training are conditions with strong demand characteristics, extending over prolonged periods of time, and where the entrance fitness of candidates may vary considerably, which may explain why the MHM was not supported. While the BRUMS distinguished between the mean score of outcome groups on some of the sub-scales, the high number of false negatives and false positives limits its ability to predict individual passes or fails with confidence.

The TAM has been used to predict panic among beginner divers,[4,17] but this study did not find the STPI useful to predict training success. Some of the previous studies used the STAI, which may influence comparisons. The psychological screening done during the diving medical assessment may have sifted out individuals with raised inner apprehension, leaving a group generally less prone to anxiety. While the STPI distinguished between the mean scores of the outcome groups, it was only able to predict individual passes with some sense of accuracy, and none of the failures, which limits its usefulness. This can again be attributed to the high number of false negatives and false positives. In contrast to a previous study,[3] the addition of 1 SD to the scores (both up and down) did not improve the predictive accuracy of the STPI.

The injured subgroup was only added during data analysis, and did not come with a clear theoretical basis. It was, therefore, unexpected that the measures identified, to some extent, the injury-prone group from the rest. The small number of injured candidates (n = 6) and very moderate effect sizes would caution against premature interpretation. Still, the injured group were more tense, had higher trait anxiety, and were more fatigued prior to selection, similar to the associations that others have found with the BRUMS scores of athletes with performance-induced injuries.[22,23] While this association may be co-incidence, it could also indicate poor physical preparation (e.g., fitness training left too late, and thus tired on days preceding selection), from which they never recovered during the training. It is interesting to note that the reasons for withdrawal were stress injuries. Thus, it could be hypothesised that their efforts to maintain or improve their fitness might have led to the stress injuries experienced. The ‘injury-prone’ psychological associations might add value in two spheres, namely at the point of initial screening of candidates, and also to alert instructors to monitor such candidates closely during training, in order to reduce withdrawal due to injury. However, the link remains hypothetical, as the fatigue could also be an indication of superior motivation (e.g., train hard until the last moment), and this association will need to be explored in future studies.

None of the participants exhibited a consistent pattern of extreme arousal (raised scores across all measures), which would have more clearly been problematic (in terms of leading to non-success). This may be a result of their positive mental health status, and other groups may display a greater range of unhealthy psychophysiological arousal.

Table 2
BRUMS and STPI mean (SD for STPI) scores of study sample according to training outcomes

	Fail (n = 20)	Pass (n = 47)	Injured (n = 6)	F	η^2
BRUMS					
Tension	1.3	2.9	5.3	7.8†	0.06
Depression	0.2	0.3	0.3	0.1	0.01
Anger	0.5	1.0	0.7	0.1	0.01
Vigour	11.2	10.3	8.7	1.7	0.04
Fatigue	0.5	1.0	4.3	16.7‡	0.08
Confusion	0.3	0.8	1.3	0.9	0.05
TMD	-8.5	-5.3	3.3	10.3‡	0.09
STPI	12.8 (2.4)	12.4 (2.4)	15.7 (1.9)	4.9*	0.07

* P < 0.05, † P < 0.01, ‡ P < 0.001

The focus would be on individual consistency of arousal, not on differences between mean scores of groups.

Conclusion

This study set out to test two psychological prediction models in the SAN diving environment. Although the measures could partially differentiate between successful and non-successful outcome groups, based on group mean scores, none of them contributed meaningfully to predicting individual outcome in diving training (as circumscribed in this study). This could be a result of the psychological screening process that would enhance mental health homogeneity, through sifting out vulnerable individuals. Alternatively, this could also mean that the psychological models of industrialised societies are not directly applicable in resource-limited countries such as South Africa, or that models developed on civilian sport diving cannot directly be used within the SA military context.

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Charles H van Wijk, PhD, is a psychologist practising in Simon's Town.

Address for correspondence:
Charles H van Wijk
P O Box 494
Simon's Town, 7995
South Africa
E-mail: *<chvanwijk@gmail.com>*

Short communication

Underwater working times in two groups of traditional apnea divers in Asia: the Ama and the Bajau

Erika Schagatay, Angelica Lodin-Sundström and Erik Abrahamsson

Key words
Breath-hold diving, freediving, spearfishing, performance, indigenous divers, diving research

Abstract

(Schagatay E, Lodin-Sundström A, Abrahamsson E. Underwater working times in two groups of traditional apnea divers in Asia: the Ama and the Bajau. *Diving and Hyperbaric Medicine*. 2011;41(1):27-30.)

Introduction: Traditional apnea diving for sea harvesting for a living continues in some communities in Asia, the outcome being dependent on the total underwater working time. We studied dive and surface interval durations and daily time spent submerged by Japanese Ama and the Phillipine Bajau.

Methods: Diving and surface interval durations were timed, and daily in-water working time noted for 14 female Ama (mean age 60 years) during sea-mollusc collection, and five male Bajau divers (mean age 38 years) during spearfishing, using direct observations and depth-time recorders.

Results: In the Ama, mean (SD) dive duration was 38 (8) s, with mean surface interval duration of 38 (8) s, at depths of 5–12 metres' sea water (msw), and diving constituted 50 (4)% of the total immersed working time, which was limited to 4 h per day by fishing regulations. In the Bajau, mean dive duration was 28 (9) s, with surface intervals of 19 (8) s, at depths of 5–7 msw, and diving was 60 (6)% of the total working time. Diving patterns in Hegura-Ama were similar to those previously reported, with up to 2 h per day spent under water. The Bajau total working time of 2–9 h per day suggests that some divers may spend more than 5 h per day submerged, which is the greatest daily apnea diving time reported in humans.

Conclusions: We conclude that natural human diving ability in these two groups of traditional apnea divers allows efficient sea harvesting at shallow depths and that the outcome does not seem to be limited by total daily apnea time.

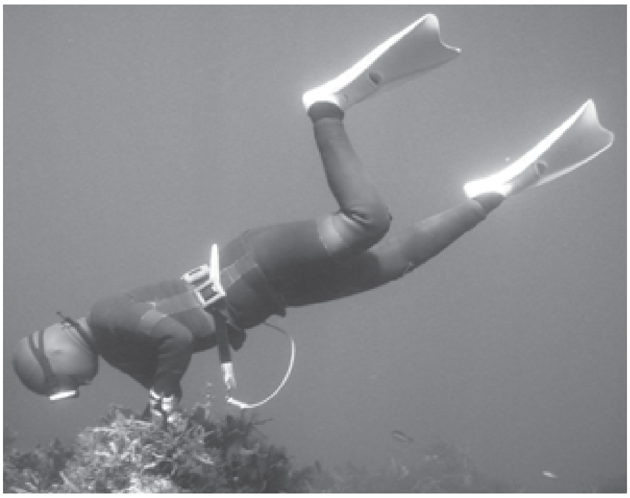
Introduction

Harvest diving on shallow seabeds has most likely been a major source of food for humans since ancient times. This natural diving continues in some communities in East and South East Asia, and its outcome is dependent on the time spent submerged and, for harvesting diving, on the resulting bottom working time. Thus, whilst in competitive apnea diving the aim is to produce one single dive of maximal duration, distance or depth, the harvest diver instead strives to produce the longest possible underwater working time per day in order to collect a sufficient catch. A strategy to make this possible is to limit apneic duration per dive to within the time allowed by accessible oxygen stores, thereby limiting accumulation of lactic acid and other by-products of hypoxia requiring prolonged surface intervals.

The Ama of Japan and related Hae Nyo of Korea have been extensively studied, and their physiology and diving patterns have been documented in several publications, and the metabolic cost and thermal consequences of repeated diving have been measured.[1–3] As these groups are active in relatively cold water, their diving may be restricted by their sensitivity to cold, and elevations of metabolism could negatively influence apneic duration.[3] When originally no suits were used, the Ama were considered to be among the most cold-resistant of humans, but the introduction of wetsuits has led to de-acclimatisation.[4] Many studies have concerned their time spent working under water, reporting varying degrees of efficiency and daily underwater and bottom times.[5–7] One group reported to spend a considerable portion of the day submerged is the Ama at Hegura Island.[7] On this island, there are now few permanent residents but during the fishing season about 60 Ama divers stay and work there. One of our aims was to visit this group to observe whether such diving was ongoing and the total daily underwater times produced.

The Asian Sea People, or Sea Nomads, are spread across vast areas of South-East Asia, and include several possibly related groups, e.g., the Orang laut in Riau, the Moken in Thailand and Burma, and the Bajau in eastern Indonesia, Phillipines, and eastern Malaysia.[8] These communities, which rely predominately on marine resources, either migrate in house boats, or have stilt-house settlements in shallow near-shore areas or on land. Although many accounts exist in the literature of the Sea People as "*excellent divers*", detailed information about their diving methods and patterns is rare. One group, studied in Indonesia by one of the authors in the late 1980s, was found to spend approximately 50% of their working time under water.[9] Little if any equipment was used during diving, often only wooden goggles (Figure 1, left). A generation earlier, no goggles were used, and even today many children dive without any equipment, and may develop superior underwater vision.[10] Nowadays, some groups are using basic freediving equipment.

Figure 1
Bajau diver, Indonesia (left), Ama diver, Japan (right) (Photos E Schagatay)



We wished to document and compare diving patterns in the Ama and Bajau, a major focus being to determine how great a proportion of the working time was spent under water and how much underwater time per day was achieved by these apnea divers.

Methods

Participants were divers among the Japanese Ama at Hegura Island and the Bajau in Davao in the Phillipines, which were visited during 2009–2010. Ama studies occurred in August and Bajau studies in March–April. All participating divers were professional divers from a young age. The divers and the village head were asked for their permission to record their diving patterns in a way that would not affect the work of the divers. Divers were observed during the entire diving shifts as a basis for total working time, but registrations of diving and surface interval durations were done during shorter periods. There was no selection of 'the best' divers, as has been the case in some previous studies, but all divers willing to participate were included.

Fourteen female Ama (mean age 60 years, range 38–77) were studied during sea-mollusc collection on the south-west coast of Hegura Island. The main catch was awabi (abalone) and sasae (turbo) shells, which are the most profitable species to collect, and for which collection is restricted by the local fishing cooperative to three months per year and 4 hours per day during this season. Diving cycles were recorded during 20–120 min per diver. Divers used full wetsuit, mask, rubber fins, weightbelt, cotton gloves, and a tool for removing the awabi shells (Figure 1, right).

Diving cycles were also measured for 5 male Bajau divers (mean age 38 years, range 16–48) during spearfishing for 20–60 min of diving per diver, which was part of a full day of diving activity. During the study, divers used goggles and swimming trunks, one or two, short, homemade, wooden fins, and one diver used a wetsuit.

Dive times and surface intervals were recorded, and depth and time for ascent and descent were measured. Data were collected via observations from the boat and in the water as well as using depth-time loggers (Sensus Ultra, ReefNet Inc, Ontario, Canada) recording time and depth at 1 s intervals. Mean water temperature was approximately 23^{O}C in Japan and 26^{O}C in the Phillipines.

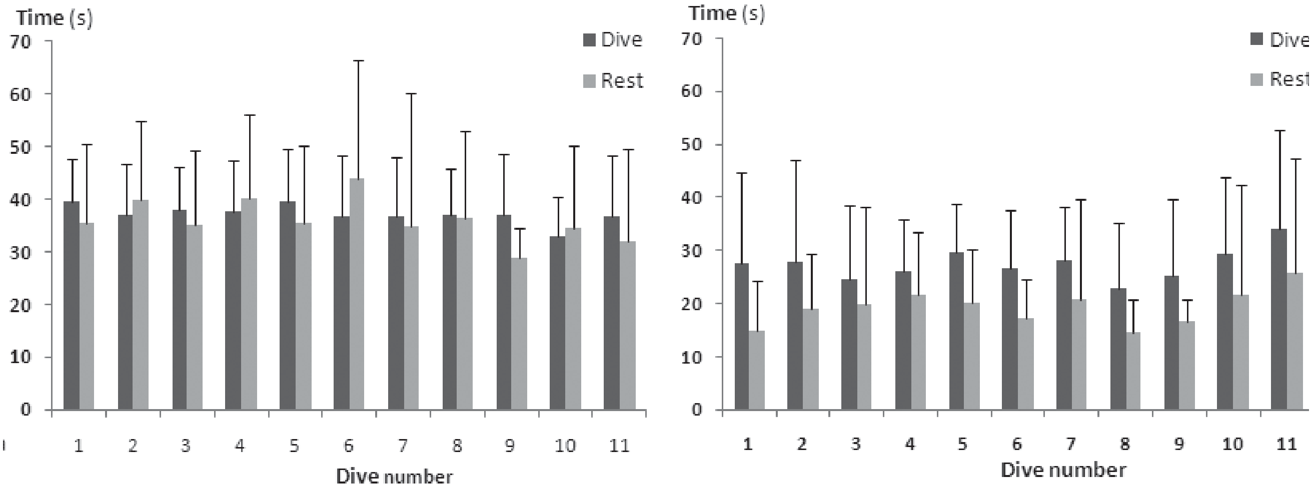
Statistical analysis

At least 11 consecutive dives and surface intervals were successfully collected for each diver and used for analysis. Dive times and surface intervals were compared within groups using paired Student t-tests and between groups using unpaired Student t-tests. Descent and ascent times were calculated for the Ama, but dives were not clearly divided into descent, bottom time and ascent in the Bajau.

Results

Ama divers were swimming slowly during most of the dive time and speed of descent and ascent was approximately 0.8 m s^{-1}. Ama divers used vertical dives to the bottom, and during most of the dive they were actively swimming looking for and collecting shells, which were placed into a floating basket on return to the surface. Divers rested hanging on to this float during surface intervals. Mean (SD) dive duration was 38 (8) s, with a surface interval duration of 38 (8) s (not significant, Figure 2a). Maximum diving depths were between 5 and 12 (mean 7.5) metres' sea water (msw). Diving constituted 50 (SD 4) % of the total immersed working time which was limited to 4 h per day. All divers spent 4 h in the water. About half of the dive time was bottom time used to collect molluscs.

Figure 2
Mean (SD) dive and surface rest interval durations in 11 consecutive dives by 14 Ama divers (left), 5 Bajau divers (right)



Bajau divers were swimming at varying depths looking for, shooting and retrieving fish, with time spent at the surface for resting, reloading the rubber sling harpoon and taking care of the fish when one was caught. Most dives were without catch. Bajau mean (SD) dive duration was 28 (9) s with surface intervals of 19 (8) s (Figure 2b). Surface interval times were significantly shorter than the dive times ($P < 0.001$). Maximum diving depths were between 5 and 7 (mean 6) msw. Submerged diving time was 60 (SD 6) % during the periods of observation, which were part of a total working time of 2–9 h a day. Mean dive times and surface intervals were shorter in the Bajau than in the Ama (both $P < 0.001$). Most of the diving time was spent hunting.

Discussion

Our observations of daily underwater times in Hegura-Ama in 2009–2010 are similar to those reported in 1995, with approximately 100 min per day spent under water in the unassisted type of diving (cachido), and 120 min in the assisted dives (funado).[7] The unassisted divers in our study, with an average age of 60 years, were thus able to produce at least the same total daily dive time as the 25-years younger divers in the 1995 study. However, the mean dive duration of 38 s in the present study was shorter than that reported in 1995 (60 s), as was the mean depth shallower, leading to a longer bottom time per dive in the 1995 study, as travel speeds were similar. However, the dive duration (37 s) and depth (7 m) produced by male Ama from Chikura were similar to those of our study, but these divers spent more time at the surface.[6]

In interviews, the Ama stated that, before the introduction of time limitations by fishing regulations, divers commonly made two dive shifts per day, interrupted by a midday break to eat, rest and warm up, with a total in-water time of 6–8 h per day (conversations with divers, 2009). This suggests that the daily dive time seen in these Ama divers may not have reached the maximal possible time. However, it is not clear if 50% underwater time could be produced throughout a full diving day; it could be that the restricted fishing time pushes the diver to produce longer dives than if a longer total working time were allowed. This will be studied further.

The Bajau produced shorter dives and much shorter surface intervals than the Ama, but spent a surprisingly high percentage of the working time submerged, 60%, with most of the time actively fishing. This is, to our knowledge, more than that reported for any other group of natural breath-hold divers. This is in the range of the percent underwater time seen in some species of marine mammals, e.g., the sea otter.[11] Few previous recordings exist from the Bajau, among which some divers were found to spend 9 h per day in the water. If they dive with the same percentage of time under water across entire working days, this means some divers would spend more than 5 h per day submerged. Observations by one of the authors in 1988 in several groups of divers in Indonesia revealed immersed working times of 2–4 h per day in some groups, while one group of Bajau in Sulawesi had working times of approximately 6 h per day on average, with individuals spending up to 10 h per day in the water.[9]

In Bajau as well as in the Ama, both female and male divers exist, though, in the Ama, a greater proportion of the divers are female, whilst among adult Bajau, predominantly men dive. We believe genders can be directly compared as no clear gender differences with respect to diving performance have been reported, and the division of labour may be mainly traditional or socio-economic in nature.[12]

The more pelagic diving profiles during spear fishing at shallower depths in the Bajau allowed a greater portion of the dive time to be spent actively working compared to the Ama, who lose valuable dive time for descent and ascent to the harvesting depths. In the Korean unassisted divers, diving to similar depths (4–7 m) as the Bajau, and with similar dive durations (29 s), the intervals between dives were apparently longer, as total non-diving time spent in the water was reported to greatly exceed the diving time.[6] In most previous studies, however, little focus has been directed toward the surface interval duration. We believe that the surface interval duration is most relevant both to determine the efficiency of human natural diving in a biological context, and to address questions concerning optimisation of recovery.

An important contributing factor allowing Bajau to spend a longer total time immersed may be the warmer water. Studies by Kang suggest that metabolic energy demand rises as a consequence of cold across a diving shift in Korean Hae Nyo, diving without suits.[3] Warm water could possibly also limit metabolism in favour of shorter recovery intervals after dives, although no such differences in dive durations between summer and winter were reported in Korean divers.[6] A study of the arterial blood gas tensions after dives in Korean Hae Nyo suggested that full recovery occurs within 15–20 s after dives of a mean duration of 62 s.[13] Thus, with the shorter dives produced by the Bajau, the interval observed would likely allow sufficient recovery.

Conclusions

Both Ama and Bajau showed efficient diving patterns with, on average, 50 and 60% of the dive time spent submerged. To our knowledge, the present study reveals the greatest proportion of time spent under water and the longest estimated total daily dive times reported for human natural apneic divers. We conclude that the natural human diving ability allows efficient sea harvesting at shallow depths and that the main limitation is not total apneic duration but other factors, possibly including water temperature, whereby the time in the water can be longer in the Bajau divers than in the Ama. Studies are planned to continue, focusing on diver fatigue and age-related diving performance.

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Erika Schagatay, PhD, is Professor at the Department of Engineering and Sustainable Development and Swedish Winter Sports Research Centre, Mid Sweden University, Östersund, Sweden.
Angelica Lodin-Sundström, BSc, is a doctoral student at the Department of Engineering and Sustainable Development, Mid Sweden University and
Erik Abrahamsson, BSc, is a Masters student at the Department of Sociology, Division of Social Anthropology, Lund University, Lund, Sweden.

Address for correspondence:
Professor E Schagatay
Department of Engineering and Sustainable Development
Mid Sweden University,
Akademigatan 1, 83125 Östersund
Sweden
Phone: *+46-(0)63-165512*
Fax: *+46-(0)63-165700*
E-mail: *<Erika.Schagatay@miun.se>*

The diving doctor's diary

Cerebral arterial gas embolism with delayed treatment and a fatal outcome in a 14-year-old diver

John Lippmann, Andrew Fock and Shalini Arulanandam

Key words
Case reports, cerebral arterial gas embolism, deaths, children, recreational diving, fitness to dive, medical conditions and problems

Abstract

(Lippmann J, Fock A, Arulanandam S. Cerebral arterial gas embolism with delayed treatment and a fatal outcome in a 14-year-old diver. *Diving and Hyperbaric Medicine*. 2011;41(1):31-4.)
In today's recreational diving climate, diving fitness examinations are not mandatory, and even divers who go for these examinations may not have routine chest X-rays (CXR) done in the absence of respiratory symptoms or a past history of respiratory problems. We present a case of an ultimately fatal cerebral arterial gas embolism in a 14-year-old boy with an undiagnosed lung cyst, the contribution of which to his death is uncertain. Various factors such as lack of oxygen first aid at the remote dive site; poor communication; lack of diving medicine expertise, poor oxygen administration and management in a local hospital and long delay to recompression therapy contributed to the poor outcome. It is imperative that dive operators and physicians working in close proximity to popular dive sites be educated on how to recognise and treat diving emergencies and be well-acquainted, as should divers, with the contact numbers of diving medical hotlines that offer timely and appropriate advice in case of emergency.

Introduction

Dive operators need to be adequately prepared for diving emergencies, with quality first-aid and oxygen-provider training, suitable and readily accessible oxygen (O_2) equipment and an appropriate accident management plan. This is especially important in areas, such as parts of the Asia-Pacific region, lacking ready access to recompression facilities and diving medical expertise.

It is also important that both prospective and existing divers are adequately screened for medical contraindications to diving. In most places, a short self-reporting medical questionnaire is used, with only those people with positive responses advised to seek medical assessment. However, in some cases, medical conditions may not be detected even by a relatively thorough pre-dive medical examination by a trained physician, with serious and sometimes fatal consequences. There remains ongoing debate about the appropriate level of medical investigation required prior to or during continuing diving activities. The following case serves as a reminder of the importance of these issues.

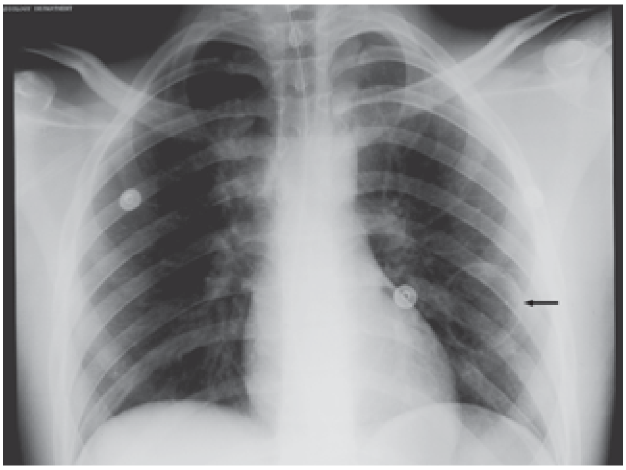
Case report

AB (not his real initials) was a 14-year-old Australian male. Permission to report his case was given in writing by his father. His past medical history was unremarkable with no serious illnesses, including respiratory problems. He was 176 cm tall, weighed about 73 kg and played sport regularly. Prior to scuba training, AB underwent a diving medical assessment in accordance with Australian Standard AS 4005.1 by a physician trained in diving medicine. This found no obvious contraindications to diving. A chest X-ray was not considered to be indicated.

AB had conducted two resort dives prior to his open-water diver training and a further four incident-free dives to a maximum depth of 15 metres' sea water (msw) during his course. He had done no further diving between certification and the day of the accident. AB and his father, an experienced diver, were diving in South East Asia. On the first dive, AB, his father and the dive guide dived to a maximum depth of 18 msw for a total of 45 minutes, following the contour of the reef and ending with a safety stop. He was described as "*very active*" during the dive, "*swimming with his arms and legs all over the place just like a newly certified diver*". However, it did not appear that he was exerting himself or changing depth levels rapidly. After surfacing, AB mentioned that he had been sneezing underwater and that he had an "*itchy feeling*" in his chest, but this did not appear to be bothering him.

After lunch and a surface interval of one and a quarter hours, they descended to a maximum depth of 18 msw, again following the reef into shallower water throughout the dive. The 40-minute dive appeared to be free of problems and the group ascended "*normally*" to a 5 msw safety stop, when AB swam to the other divers and began to squeeze his right arm as though it was numb. Soon after this, he appeared to float towards the surface. The divemaster noticed that he appeared to be "*passing out*" and brought him to the surface.

Figure 1
Initial chest X-ray showing cyst on left lung



He was quickly brought aboard the boat which departed immediately for the resort, some 10–15 minutes away. There was no O_2 equipment on board. He was initially unconscious and convulsing, with froth coming from his mouth, but breathing spontaneously. The convulsions continued throughout the boat trip to shore, although he was intermittently responsive between seizures. On arrival at the resort, O_2 was administered. The resort instructor reported that the O_2 was delivered via a rebreather mask with an O_2 flow rate of 15 litres per minute (lpm). AB's father is adamant the mask did not have a reservoir.

Shortly after, he was taken by ambulance to a nearby public hospital, where he was attended by several doctors, none with training or knowledge in the assessment and management of diving accidents. A chest X-ray revealed a large (3 cm) air-filled 'bullus' on the left lung, although there was no evidence of pneumothorax or mediastinal emphysema (Figure 1). He was then transferred to a private hospital and examined by several other doctors, again without knowledge or training in diving medicine. On examination, his Glasgow coma score (GCS) was assessed as 8, but his conscious state continued to fluctuate. There were marks on his abdomen, which were described by his father as "*bruises which resembled randomly and widely-spaced burst blood vessels*". A provisional diagnosis of cerebral vascular accident was made and computerised axial tomography (CT), a magnetic resonance image scan (MRI) and magnetic resonance angiography (MRA) were performed. The MRI demonstrated bilateral occipital lobe oedema without clear evidence of infarcts. Throughout this time, AB's conscious state continued to fluctuate, with intermittent seizures, some of prolonged duration. His vital signs remained stable, but he was unable to move his right arm or leg and appeared to have cortical blindness. O_2 was reportedly delivered in hospital via a simple face mask with a flow rate of 6 lpm.

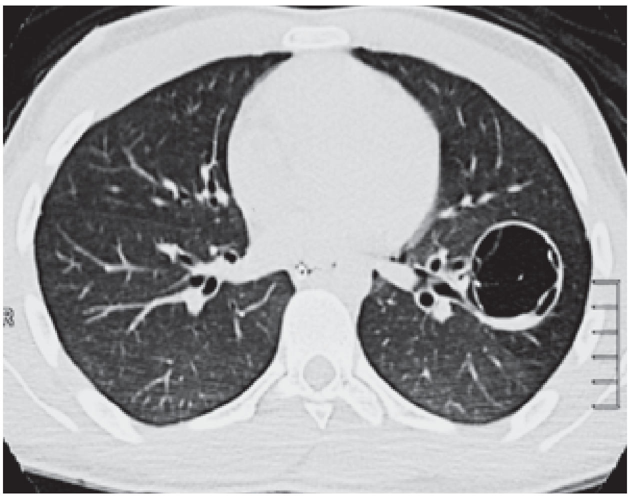
Some six hours after the accident, a local naval doctor arrived and diagnosed that AB was suffering from decompression illness. He believed the 'bruises' on AB's lower abdomen to be a decompression-related rash (*cutis marmorata*). He recommended recompression and investigated whether AB could be transferred to the nearest naval chamber, some three hours away by road and boat. Although, after several hours, permission to use the chamber was granted, the doctor was concerned that the relatively basic chamber lacked adequate facilities to manage such an ill patient, especially one with a lung bullus.

The father then contacted their travel insurer's assistance company which, after several hours' further delay, called the Diver Alert Network (DAN) America hotline for advice. The DAN physician recommended urgent evacuation to a chamber for recompression. Approximately 10 hours later, Singapore General Hospital was contacted, and permission was promptly given to transfer AB to its hyperbaric unit. The evacuation team arrived at the hospital five hours later. AB was intubated in the ambulance at the airport just prior to boarding the aircraft for the two-hour flight to Singapore, and he arrived at the hospital 32 hours post-dive.

On admission, he was unresponsive, with a GCS of 4 with doll's eyes negative, heart rate 100 per min, blood pressure 190/90 mmHg and respiratory and abdominal examination unremarkable. He was sedated and paralysed (propofol and atracurium), bilateral myringotomy performed and a left intercostal catheter inserted. The initial hyperbaric treatment was a US Navy Treatment Table 6 (USN T6).

When sedation and paralysis were reversed the next morning, he remained deeply comatose with a right hemiplegia. An MRI taken at this time showed large acute territorial infarcts involving the occipital and posterior parietal lobes, and watershed territories of the middle and anterior cerebral arteries (left more than right), cerebral oedema with mild

Figure 2
Axial view CT showing cyst; the image is reversed so the left lung appears on the right



compression of the fourth ventricle and no hydrocephalus or venous thrombosis. A further USN T6 was given, with no improvement. Following this, another brain CT confirmed the extensive watershed infarcts with cerebral oedema, now with tonsillar herniation. The decision was made to discontinue recompression therapy in view of his poor response, and the family was advised of the poor prognosis. AB was repatriated to Australia on ventilatory support, where assessment two days later in intensive care confirmed brain death and life support was withdrawn.

Discussion

CAUSATION

AB's history and symptoms make CAGE the most likely diagnosis. Gas entering the arterial system may come from one of two major sources, either entering the pulmonary veins as a result of pulmonary barotrauma (PBT) or from venous gas emboli transiting to the arterial circulation via a right-to-left shunt (e.g., patent foramen ovale (PFO) or across the pulmonary vascular tree).[1] Most commonly, CAGE is associated with a lung over-inflation injury resulting from breath-holding while using compressed gas and/or rapid ascent. In this case, the ascents on both dives were reportedly well-controlled and slow. Whether or not the CAGE resulted from a PBT, the presence of the 'bullus' must be taken into consideration. This 'bullus', actually a large lung cyst (Figure 2), was thick-walled and appeared to communicate with terminal airways. Such cysts are usually stable and may be ventilated or non-ventilated. Generally they have no effect on lung function or respiratory performance in the non-hyperbaric environment. However, it is believed that air-trapping can sometimes occur either on the basis of gas diffusion, a one-way valve mechanism, or by a volume increase upon ascent due to a narrow inlet-outlet opening.[2] While the presence of the cyst, if detected, would almost certainly have resulted in AB not being granted medical clearance to dive, there is conflicting opinion as to whether such a cyst actually poses an increased risk of PBT.[2,3] The lack of radiological evidence of PBT in this case does not preclude its presence.

An alternative is that AB had a PFO or atrial septal defect (ASD), but without the benefit of an autopsy this remains speculative. Both dive profiles involved only a few minutes at the maximum depth followed by a slow ascent up the reef. Such a dive profile would usually not be expected to result in significant tissue supersaturation. The presence of what was described as *cutis marmorata* and AB's report of an itching feeling in his chest between dives may have been due to undetected skin decompression sickness, which has been associated with the presence of a PFO.[4]

RETRIEVAL AND CLINICAL MANAGEMENT

It is disturbing that no O_2 was available on the dive boat. Prompt and effective first-aid delivery of high-concentration O_2 can often result in symptom resolution or improvement and a reduced number of recompression treatments.[5] DAN Asia-Pacific records contain numerous reports of rapid improvement of CAGE symptoms when near-100% O_2 is provided promptly. There is an expectation and, in many places, a 'standard of care' to have appropriate O_2 equipment and a trained provider present wherever diving is undertaken. The dive operator did provide O_2 back at its base but only via a mask without a reservoir bag, which would not have provided the near-100% O_2 needed.

Poor communication between various parties led to long delays before appropriate medical advice was obtained and acted upon. It would have been better to call a divers' emergency hotline (such as the DAN Diver Emergency Service in Australia). The on-call doctor would certainly have recognised the seriousness of the situation and provided appropriate management advice, as was done when a DAN hotline was finally called some 10.5 hours after the accident.

Medical professionals without knowledge or training of diving medicine often fail to recognise decompression illness, its potential severity and the urgent need for high-concentration O_2 and rapid recompression. A simple face mask with an O_2 flow rate of around 6 lpm in the hospital would have likely provided an inspired O_2 concentration of less than 40%.[6] The correct choice and management of O_2 delivery devices is well covered in several publications, and a suitably designed mask is illustrated in Figure 3.[7,8] Unfortunately, in many under-developed countries in the Asia-Pacific region, O_2 supplies are often quite limited.

Given AB's critical neurological status, it is unfortunate that he was not intubated and ventilated with high-concentration O_2 and normocapnea long before this was finally done.

Figure 3
A non-rebreather mask with reservoir; two one-way valves on the sides minimise air entrainment and one prevents exhalation of expired gas into the reservoir; the fresh gas inlet is seen on the left side

Indeed, basic management strategies for a patient with severe cerebral injury would not appear to have been instigated until his transfer to Singapore.

The decision to recompress in a local chamber or to transfer to a comprehensive chamber with ICU support can be a difficult one to make, especially where local resources are limited. While there is little doubt that immediate recompression can be life-saving, evidence would indicate that local recompression in small chambers where the medical staff are unable to deal with complex patients may result in worse outcomes.[9] In this case, consultation with a respiratory physician or suitably-trained radiologist should have indicated that the presence of the cyst posed minimal risk for recompression compared to the negative outcome from significant gas embolism. Furthermore, despite AB's fluctuating conscious state, he was haemodynamically stable during his time in the local hospital. Given the delay before being assessed by the naval diving physician, it must remain speculative whether by the time a diagnosis of DCI was made there would have been any change in outcome.

FITNESS-TO-DIVE CONSIDERATIONS

The value of a formal medical remains a matter of considerable debate.[10,11] AB underwent a medical in accordance with AS 4005.1, which does not mandate a CXR in the absence of respiratory symptoms. Indeed surface bullae, which are probably more likely to be pathological, will not usually be picked up on plain CXR. Had AB had a CXR and subsequent CT scan, it is likely he would not have been issued a fitness-to-dive certificate. However, as previously discussed, it is debatable to what extent a stable thick-walled cyst of this nature poses a real threat of PBT, or if it was the culprit in this case. Similarly, the value of screening for ASD/PFO in the absence of symptoms has been discussed extensively in the literature.[12–14] Any link between PFO and AB's injury remains purely speculative.

Conclusion

This case highlights the need for divers, especially those travelling to remote locations, to be educated about diving accidents and to carry contact numbers for diving medical hotlines so that prompt expert advice can be obtained should symptoms appear post-diving. It also indicates the need for better education of the general medical community about the management of dive accidents and the referral options available to them. Finally, it highlights the reality that some divers, who perhaps should not dive on medical grounds, will pass even a thorough dive medical assessment, sometimes with tragic consequences.

Conflict of interest: John Lippmann is the Executive Director of DAN Asia-Pacific which sells O_2 equipment, including non-rebreather masks and provides diving injury insurance. Andrew Fock is a member of the Board of Directors of DAN AP.

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John Lippmann, OAM, BSc, DipEd, MAppSc, is Executive Director, Divers Alert Network (DAN) Asia-Pacific.
Andrew Fock, MB,BS, FANZCA, Dip DHM, is a consultant to the Hyperbaric Medicine Unit, The Alfred Hospital, Melbourne.
Shalini Arulanandam, MBBS, MRCS, MMed, is a diving medical officer in the Republic of Singapore Navy and consultant to the Hyperbaric Medicine Unit, Singapore General Hospital.
Address for correspondence:
John Lippmann
P.O. Box 384, Ashburton, VIC 3147, Australia
Phone: *+61-(0)3-9886-9166*
Fax: *+61-(0)3-9886-9155*
E-mail: *<johnl@danasiapacific.org>*

Commentary on the problems of diving in remote areas and underdeveloped countries

Glen Hawkins

The death of an individual while diving, particularly one so young, should resonate throughout the diving community. It reminds us that while diving is a relatively safe sport, unpredictable events can and do occur. This case report of a diving holiday gone tragically wrong highlights two important points:

- when going on diving holidays, people have to be prepared with contingency plans for both standard and diving medical emergencies.
- fit, healthy people may die regardless of prior medical assessments.

I often find it surprising that people who go away on expensive overseas holidays with expensive equipment skimp on travel insurance. Travel insurance, which usually covers medical costs, travel delays, cancellations and lost items, is relatively cheap and if you are diving, insurance and membership, such as the Divers Alert Network (DAN) provides, makes managing the treatment and repatriation of a sick diver all the easier. An insurer that has a background in diving-related injuries allows rapid decisions to be made; it unfortunately took a long time in this case for a diving injury to be identified and for DAN America to become involved. This delay may have ultimately cost this young man his life, as urgent recompression was always going to be the required treatment.

There is also an onus on the traveller to plan for an emergency. In some locations, doctors may not be available and very few doctors (even in diving locations) have the required experience to treat or even identify diving injuries. A method of contacting a diving emergency service in one's own country, such as the Divers Emergency Service in Australia, from an international location should be part of the contingency plan for all remote diving holidays. Even if you do not have insurance, most diving emergency services will help with diagnosis and try to arrange help, but the logistics are horribly complicated by a lack of travel insurance, particularly with repatriation or transfer to a better-equipped medical facility. On top of this, you may be repatriated to a country with very expensive medical care (such as Hawaii or Guam, which both charge at USA medical rates). As an example, one patient who had to be repatriated to Australia from the Solomon Islands by Medevac Jet cost USD 85,000.00 and the insurance company would only cover 80% of this cost. This meant that the family had to come up with an immediate USD 17,000.00 on a weekend, before the plane would even leave the ground!

As part of the pre-dive plan, the dive operator needs to be asked what equipment is on board, such as a first aid kit and oxygen availability and to make sure for oneself that the cylinder is full and they are trained in its use. Responsible dive operators will be happy to demonstrate their safety equipment. The diving brief should also have plans for emergencies and prior to starting a set of dives, divers should ask what the evacuation plan would be if there were an injury or illness. If there are any concerns, it is better to live and dive another day.

The second point is one of current interest in Australia where there is a developing trend towards self-reporting medicals. The Australian Standard covering recreational diving is the AS 4005.1 (2000). However, with the exception of Queensland, this is not a mandatory item prior to scuba training. Most countries have now moved towards the self-reported medical and, as Australia moves to align with the ISO standards (for which a self-reported medical is the standard), it will be interesting to see whether or not there is an increase in morbidity and mortality in the diving community in Australia. In contrast to the Scottish data, a recent study of 1,000 diving candidates suggested that the self-reported medical potentially may miss medical problems that should exclude some people from diving.[1,2]

The crux of the problem is in the word 'potentially', and this case is a good example. Would he have been excluded with a large cyst in his lung? Most doctors would have found him unfit for scuba diving if they had known about the cyst. Would I personally have done a routine chest X-ray on AB? Probably not, and this leads to the cost-benefit balance that we all practice in medicine and that we spend a lifetime refining in the light of experience. Unfortunately, sometimes, unexpected bad things happen to 'good' people. Planning can often make the consequences of a 'bad day at the diving office' less serious, and this brings me back to my open-water training maxim "*plan the dive, dive the plan.*"

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Glen Hawkins, FANZCA, is the Medical Director of Hyperbaric Health.
E-mail: < glen@hyperbarichealth.com >

Conflict of interest: Hyperbaric Health is a company with 46 hyperbaric chambers in 20 countries throughout the Asia-Pacific region, and treats between 150–300 divers per annum.

Key words
Diving accidents, legal and insurance, communication, DES – Diver Emergency Service, medicals – diving, tourism

The world as it is

British Sub-Aqua Club (BSAC) diving incidents report 2009

Compiled by Brian Cumming, Diving Incidents Advisor

<http://www.bsac.com/core/core_picker/download.asp?id=16948&filetitle=Diving+Incident+Report+2009>

Summary of the 2009 report prepared by Colin Wilson

Since 1980, the BSAC has recorded annually on diving incidents reported by their membership and from other sources.[1–2] Summaries for years 2005 to 2008 have been discussed previously in this journal.[3–5] The information pertains to the United Kingdom (UK), with their members providing completed incidents forms. In addition, fatalities and decompression illnesses (DCI) information is collected from a number of other sources as described previously.[3–5]

There were 381 reports for 2009, close to the 10-year average of about 400. In 2009, one source provided less information than in past years but this was balanced by a new data source from another diving agency. There are limitations to the completeness of the data, though it is reasonable to accept the number of fatalities recorded as accurate. The decompression incident reports will likely exclude patients avoiding emergency services and directly referring themselves to recompression facilities. There are short reports from some agency sources of "diver illness and injury" which may have been DCI. Two-thirds of the reports occur in the northern hemisphere summer.

Ascent incidents are strongly associated with DCI, but have fallen nearly 45% over the last five years from a peak in 2006, which instigated strong campaigning and improved training, encouraging divers to pay more attention to their buoyancy. Incidents occurred from the surface to to over 60 metres' sea water (msw). In the UK, the Coastguard dealt with 238 diving incidents, with 134 involving the Royal National Lifeboat Institute (RNLI). Helicopters, about 100 per annum for diving incidents, are mainly tasked to support searches for missing divers and to transfer those with DCI to recompression facilities. This summary focuses on the fatalities and cases of DCI in the report.

Fatalities

There were 14 recorded fatalities; less than the 10-year average of 16.1, which itself has been falling. Ascertaining the cause can be difficult from often incomplete information, though multiple factors are usually involved:

- One diver had a heart attack.
- At least six cases had some serious medical complication which may have contributed.
- Eight cases involved separation; of these, two cases occurred during ascent, with one of these using an alternative gas source.
- Three cases involved three divers diving together. One separated due to a free flow, forcing him to leave his buddies, and in another case, one of the three lost contact with his buddies and was found unconscious.
- Two cases lost of consciousness under water.
- One case involved a double fatality with both divers surfacing separately, one unconscious and the other losing consciousness shortly afterwards.
- One case involved a solo rebreather who had re-entered the water for a shallow dive.

In eight incidents, the divers were aged over 50 years and six appeared to have some medical condition. With health and fitness generally diminishing with increasing age, this suggests more attention to the medical fitness of older divers is needed. The deepest fatality was at 52 msw. Sadly, rebreather divers represent more than 13% of UK fatalities over the past decade. The descriptions of events, although not as comprehensive as those reported from Australia,[6] are valuable in pointing out errors and lessons to be learnt.

From the fatalities section:

Case 1

"Three divers entered the water and swam in a strong current to reach their shotline. They descended to the wreck, to a maximum depth of 30 msw, and one of the three moved to join another dive pair as previously planned. The remaining two divers swam deeper towards the rudder of the wreck. One of the pair disturbed silt on the seabed and disappeared in the cloud of silt. The other diver hovered above the cloud looking for his buddy. The cloud rose up to the hovering diver and he rose up to stay in clearer water. He spotted his buddy's bubbles and swam towards her. The buddy then appeared out of the silt cloud and they signalled to each other to ascend. Their ascent was erratic; at times they rose too fast, at other times they sank back down. The diver who had been in the silt cloud declined her buddy's suggestion to conduct a safety stop at 4 msw and they continued to the surface. Their dive duration was 4 min. At the surface there was a sizeable swell and the buddy started to deploy his delayed SMB. He then heard the diver who had been in the silt cloud groan and then saw her faint. The buddy inflated her BCD to support her at the surface and gave an emergency signal to the boat. The casualty was recovered into the boat and resuscitation techniques were applied. She was taken ashore and further resuscitation was attempted by attending paramedics and a doctor. The diver was transferred to hospital where she was declared dead. The cause of death was given as 'convulsion while diving'."

Case 2

"Two divers conducted a wreck dive in a maximum depth of 20 msw. Towards the end of the dive, one of the pair

deployed a delayed SMB to make their ascent. Once he had done this, he looked around for his buddy and saw that he had floated up a little and was swimming back down. The diver with the SMB then indicated to the buddy to put his hand around the SMB line and they started their ascent. The diver then noticed that the buddy had started to descend so he removed the buddy's finger from the deflate button of his BCD and started to inflate it. At this point he saw that the buddy's mouthpiece had come out of his mouth and that his eyes were very large. He immediately let go of the SMB and used a controlled buoyant lift to bring him to the surface. At the surface the alarm was raised and the boat was quickly alongside the divers. The casualty was recovered into the boat where he was found to be unconscious. The Coastguard was alerted and resuscitation techniques were applied. The boat was met by a lifeboat and the casualty and his buddy were transported to hospital. The casualty failed to recover."

Decompression incidents (DCI)

In 2009, there were 117 cases of DCI in 111 reports.
As best one can tell, the major causal factors associated with these incidents were:
- 41 diving deeper than 30 msw;
- 31 rapid ascents;
- 26 repetitive diving;
- 22 missed decompression.

This does not include reports from the RNLI of undefined "diver illness" where there may have been DCI.

From the DCI section:
Case 3
"Two divers descended to a wreck at a depth of 25 msw. Visibility was very poor and one of the pair indicated that she wanted to abort the dive. They ascended to 14 m at which point the troubled diver started to panic. Her buddy tried to slow her but she kicked free and made a rapid ascent to 6 m. Other divers were still descending the shotline and the troubled diver held on to one of them tightly before losing consciousness. She started to sink back down and one of the other divers caught hold of her and brought her to the surface. She was recovered into the boat and it was found that she was not breathing and had no apparent pulse. Resuscitation techniques were applied and the Coastguard was alerted. The casualty started breathing spontaneously within a few minutes. She was airlifted to hospital where an arterial gas embolism as a result of a burst lung was diagnosed. She was transferred to a recompression chamber for treatment and was discharged the following day. A week later she had residual symptoms of headache, some nausea and aches in her left thigh. She had no memory of the period from 10 min before the dive to the following day."

Case 4
"Two pairs of divers conducted a dive to a maximum depth of 34 msw. At the end of their dive they ascended a shotline. There were other divers on the line and a current was running. At 15 msw they found the shot buoy [had been] *pulled down by the drag of the divers in the current. They were pulled down to the seabed. One pair left the line and ascended; at 6 msw they deployed a delayed SMB but sank back to 14 msw in the process. One of the divers was now low on air and had difficulty staying down, he surfaced having completed 2 min of an indicated 7 min stop, his buddy also had buoyancy problems and she surfaced, missing 4 min of stops. The second pair became separated from each other when one released the sunken shotline and the other did not. This other diver made a rapid ascent directly to the surface. The diver who had released the line made a normal ascent including all necessary stops. Back in the boat the diver who had made the rapid ascent was diagnosed with symptoms of DCI and the diver who had missed 4 min of stops developed a slight numbness in her left hand and a pain in her thumb. The other two divers were monitored for signs of DCI but none were found. The Coastguard was alerted and a lifeboat was launched to assist. The two divers who had symptoms received recompression treatment; the diver who had made the rapid ascent required two sessions."*

These reports again show the same errors are made repeatedly, but this should not detract from the lessons to be learned. Brian Cumming and the BSAC team's efforts producing these reports are again commended and should be digested by all divers, diver educators and diving physicians.

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Colin M Wilson, MB, ChB, FRCA, is Medical Director of the Dunstaffnage Hyperbaric Unit, Scottish Association for Marine Science, Oban, Scotland. He is also a GP anaesthetist at the Lorn Medical Centre and the Lorn and Islands District General Hospital, Oban and the current Chairman of the British Hyperbaric Association.
E-mail: *<colinwilson@tiscali.co.uk>*

Key words
Recreational diving, accidents, diving deaths, abstracts

Letters to the Editor

The death of buddy diving?

Dear Sir,

Revised guidelines for recreational diving medical examinations have recently been promulgated by SPUMS.[1,2] The authors are to be commended for their work. The appendices regarding people with asthma or diabetes, in particular, provide a well-considered roadmap to the assessment of these aspiring divers. This document endeavours to provide a safe transition from the traditional, 'gate-keeper' model of diving medical examination to a 'risk assessment' model where the individual can make an informed decision whether or not to proceed with diver training. Such an approach is entirely consistent with the prevailing paradigm of medical care. Patient autonomy is paramount and everyone should take responsibility for their own decisions.

Inevitably, however, the presence in diving of potentially less fit individuals places an increased impost on those who dive with them. This is explicitly stated in Appendix D of these guidelines – "*Divers with diabetes must dive with a buddy who is informed of their condition and aware of the appropriate response in the event of a hypoglycaemic episode*" and later "*an informed buddy should be in a position to assist with or initiate this process*" (of dealing with an underwater hypoglycaemic emergency).[1,2]

The role and responsibility of the buddy diver have been subject to recent legal scrutiny within Australia.[3,4] There can be few members of the diving community in Australasia who are unaware of the tragic honeymoon death of Tina Watson and the subsequent conviction and imprisonment of her husband for criminally negligent manslaughter.

Section 290 of the Queensland Criminal Code states: "*When a person undertakes to do any act the omission to do which is or may be dangerous to human life or health, it is the person's duty to do that act, and the person is held to have caused any consequences which result to the life or health of any person by reason of any omission to perform that duty*."[5] The maximum penalty is life imprisonment.[4]

Despite acknowledging that the accused's mask and regulator were dislodged whilst attempting to assist his wife during her difficulties, the judges held that, having undertaken to act as his wife's dive buddy, he failed to perform his duty towards her when he surfaced to seek assistance rather than following her as she sank. It is possible that this incident could have been handled better, but, ignoring the media-led speculation surrounding this case, a clear legal precedent has now been established. A buddy bears significant responsibility in the event of mishap. No longer is buddy diving simply an informal agreement to watch out for each other, it is an arrangement with formal duty-of-care responsibilities.

It is not unknown for the medical and legal professions to work at cross purposes. An unintended consequence of the conjunction of these two, unrelated documents is that buddy diving is now considerably more hazardous. Less fit divers are potentially more likely to require assistance (and less able to render it if situations are reversed) and now the diver who dares to survive, when their buddy perishes, faces a possible custodial sentence. It would be timely for the two professions to discuss the implications of these developments before fear of the consequences leads to the demise of buddy diving and a subsequent reduction of diving safety.

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Paul David Cooper, MB, ChB, FCICM, FANZCA, CertDHM (ANZCA), is a Staff Specialist in Intensive Care and Diving & Hyperbaric Medicine, Royal Hobart Hospital, Hobart, Tasmania, Australia.

E-mail: *<david.cooper@dhhs.tas.gov.au>*

Keywords

Medicals – diving, buddies, diving deaths, legal, manslaughter

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Editor's comment

Dr Cooper has raised a very important issue that potentially has international ramifications for recreational diving.

I invite members of the SPUMS sub-committee that prepared the revised SPUMS diving medical, representatives of the recreational diving industry and their legal advisers to respond to Dr Cooper's letter in the pages of this journal. Open debate on this subject would be of considerable value.

Michael Davis, Editor

Women and pressure

Dear Editor,

We welcomed the comment in the review by Janet Watterson and Michael Standen that overall our book, *Women and pressure: diving and altitude*, was an enjoyable read.[1] However, of concern to the editors were the remarks relating to the lack of definitive answers regarding issues of gender, menstrual cycle, and pregnancy in relation to diving. The editors had hoped that the reader would appreciate the paucity of high-level science in these areas, but would gain an informed understanding of the limited peer-reviewed literature and the limitations of such studies, as recognised in other reviews of this book. It is regrettable that until such time as the obstacles of funding and manpower to study a minority cohort can be overcome, then the studies that do exist, as summarised in the book, will remain the basis to inform the diving and aviation industry.

The reviewers also dwelt on the problems involving indexing, which were due to errors at the printers and outside the editors' control. However, the editors would like to take this opportunity to announce, with pleasure, that a second, corrected limited edition is now published. This edition is in full colour with the appropriate paper quality, 400 pages, CD, and available from Best Publishing, price US $49.99. As before, all royalties will be used by the Diving Diseases Research Centre in Plymouth, England, to support further diving research.

Reference

1 Watterson J. Book review. Women and pressure: diving and altitude. *Diving and Hyperbaric Medicine*. 2010;40:164-5.

Caroline Fife and Marguerite St Leger Dowse
E-mail: <*cfife@intellicure.com*>
<*marguerite@mstld.co.uk*>

Reply

Dear Editor,

Thank you for the opportunity to respond to the authors' concerns about our review of their book, *Women and pressure: diving and altitude*. I am very pleased to hear that an accurately indexed edition, in full colour, is going to be available for a very reasonable price.

I stand by my comments regarding the lack of clarity about diving in pregnancy, which was seen as a deficiency. A chapter devoted to this issue with a human and clinical input could have been included. The chapters mentioning pregnancy in the text are about esoteric research on sheep or buried in a chapter about women's health in general. I accept that the research is inconclusive; however, the use of hyperbaric oxygen in some countries during pregnancy is not even mentioned and would have been an interesting addition. I believe that a text such as this should have made it easier for a clinician or diver to at least partially answer the question "have I harmed my baby by diving during pregnancy?"

Dr Janet Watterson, MBBS(hons), FRACGP, DRANZCOG, MFM, FARGP
Pambula Medical Centre
NSW 2549
Australia

Editor's comment

The two other book reviews mentioned by Dr Fife and Ms St Leger Dowse were both by well-known, long-standing diving 'experts', John Bevan and Karl Schreeves, neither of whom are medically qualified. I invited Dr Watterson to review this book because she reflects exactly an important part of the audience this book appeared to be aimed at – a younger generation than Bevan (or myself), a busy family doctor (and mother) with a diving medicine component to her practice, who has undergone basic training in diving medicine and is herself a keen diver. Added to that, her husband is a dive centre operator/diving instructor.

I hope, therefore, that the authors will not discount their comments in considering future editions of this useful addition to the diving medicine library.

Michael Davis, Editor

Key words
Women, diving, scuba diving, health, physiology, pregnancy, risk factors, letters (to the Editor)

From the recent literature

Decompression illness

Vann RD, Butler FK, Mitchell SJ, Moon RE

Department of Anesthesiology and Center for Hyperbaric Medicine and Environmental Physiology, Duke University Medical Center, Durham, NC 27710, USA. <richard.vann@duke.edu>

Abstract

Decompression illness is caused by intravascular or extravascular bubbles that are formed as a result of reduction in environmental pressure (decompression). The term covers both arterial gas embolism, in which alveolar gas or venous gas emboli (via cardiac shunts or via pulmonary vessels) are introduced into the arterial circulation, and decompression sickness, which is caused by in-situ bubble formation from dissolved inert gas. Both syndromes can occur in divers, compressed air workers, aviators, and astronauts, but arterial gas embolism also arises from iatrogenic causes unrelated to decompression. Risk of decompression illness is affected by immersion, exercise, and heat or cold. Manifestations range from itching and minor pain to neurological symptoms, cardiac collapse, and death. First-aid treatment is 100% oxygen and definitive treatment is recompression to increased pressure, breathing 100% oxygen. Adjunctive treatment, including fluid administration and prophylaxis against venous thromboembolism in paralysed patients, is also recommended. Treatment is, in most cases, effective although residual deficits can remain in serious cases, even after several recompressions.

Reproduced with kind permission from: Vann RD, Butler FK, Mitchell SJ, Moon RE. Decompression illness. *Lancet*. 2011;377(9760):153-64.

Key words
Decompression sickness, decompression illness, arterial gas embolism, cerebral arterial gas embolism (CAGE), recompression, treatment, review article, reprinted from

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Passive flooding of paranasal sinuses and middle ears as a method of equalisation in extreme breath-hold diving

Germonpré P, Balestra C, Musimu P

Abstract

Breath-hold diving (BHD) is both a recreational activity, performed by thousands of enthusiasts in Europe, and a high-performance competitive sport. Several “disciplines” exist, of which the “no-limits” category is the most spectacular: using a specially designed heavy “sled”, divers descend to extreme depths on a cable, and then re-ascend using an inflatable balloon, on a single breath. The current world record for unassisted descent stands at more than 200 meters of depth. Equalising air pressure in the paranasal sinuses and middle ear cavities is a necessity during descent to avoid barotraumas. However, this requires active insufflations of precious air, which is thus unavailable in the pulmonary system. We describe a diver who, by training, is capable of allowing passive flooding of the sinuses and middle ear with (sea) water during descent, by suppressing protective (parasympathetic) reflexes during this process. Using this technique, he performed a series of extreme depth breath-hold dives in June 2005, descending to 209 meters of sea water on one breath of air.

Reproduced with kind permission from: Germonpré P, Balestra C, Musimu P. Passive flooding of paranasal sinuses and middle ears as a method of equalisation in extreme breath-hold diving. *Br J Sports Med*. doi:10.1136/bjsm.2007.043679 . Published Online First 28 February 2008.

Key words
Breath-hold diving, ENT, ear barotrauma, abstracts, reprinted from

Book reviews

Masterminding wounds

Michael B Strauss
Co-authors:
Stuart S Miller and Igor V Aksenov

Hardcover, full color, 480 pages
ISBN: 9781930536524
Best Publishing Company, Flagstaff AZ, 2010
Available from: <www.bestpub.com>
Price: USD159.99

On the publisher's website, this book is announced as "*an exciting new text that optimizes the evaluation, management, and prevention of wounds.*" I am pleased to say that the contents match this description well, apart maybe for the word "new", since Strauss' concepts of wound evaluation and care have been evolving over many years.

The book is organised into five parts, each one dealing with a specific aspect of wound care. Part I, *Setting the stage for wound care,* is an introduction to the 'chronic wound epidemic' (my words) including evidence-based medical and healthcare cost considerations, and a description of the pathophysiological elements that increase the risk for developing a chronic wound.

Part II, *Evaluation of wounds*, is a comprehensive overview of the various evaluation methods and scoring systems available for diabetic and other chronic wounds. Each method is summarised and then evaluated using Strauss' scale of five criteria (objectivity, adaptability, guide to wound management, validity, reliability). Finally a ranking table is presented, where the strengths and weaknesses of each scoring system are summarised. Such an overview can never be completely comprehensive, and a Medline search soon revealed at least two non-listed scoring systems, both claiming to be the 'definitive tool' to guide wound management. It is, however, possible to score each new method using Strauss' criteria. Strauss then proposes his own 'Wound Score'.[1]

Out of over 50 points by which wounds have been evaluated in the literature, five have been chosen as what he sees as the most useful: appearance of the wound base, size, depth, infection/bioburden and perfusion status. Each is scored from 0 to 2 giving a maximum score of 10. It is claimed this incorporates the most important wound information, dynamically reflecting the evolution of a wound, and allowing integration with other components of wound management such as host factors and preventive measures. However, I am unaware of any formal prospective validation of this wound-scoring system by other wound centres, so it is difficult to ascertain that it is indeed more efficacious than some of the other tools presented. Theoretically, it provides a management strategy for even difficult cases, and corresponds better to the ultimate goal, which, by the way, is not always complete healing.

Part III, *The strategic management of problem wounds*, elaborates on the second stage of a "Master Algorithm", the multidisciplinary management of the problem wound. Medical management, preparation of the wound base, protection and stabilisation of the wound, selection of wound dressing, and oxygenation (including hyperbaric oxygen therapy) are discussed. The text is written in a clear, didactic manner, and offers, in a logical fashion, a comprehensive critical overview of what is available. The number of references is not excessive, reflecting the fact that these are not meant to be 'systematic reviews' but, rather, reviews based on the authors' clinical experience, and designed to better understand the management elements of the algorithm and how the Strauss 'wound score' influences these. Again, a simple yet comprehensive scoring tool is presented for the evaluation of different wound dressings and techniques, based on five points (adaptability, availability, cost, effectiveness, versatility), each scored from 0 to 2.

Part IV, *Evaluation and management of the "end-stage" wound*, defines 'end-stage' as wounds that are so serious that healing of the wound or avoidance of a major amputation is only a marginal possibility, and offers an overview of current practice and possibilities. Guidelines are provided for the decision-making between amputation or attempting to salvage the limb and, for the latter, special considerations such as trial of hyperbaric oxygen therapy, minimally invasive surgeries, or strategies to "*live with a chronic, stable wound*" are discussed. End-stage wounds, such as pressure ulcers, venous stasis ulcers, post-traumatic wounds and severe burns, are all discussed; again, a chapter full of practical tables and figures that almost take the form of a 'tips and tricks' section.

Finally Part V, *Prevention of new and recurrent wounds*, deals with prevention, from patient education, through skin care and protective footwear to minimally invasive proactive surgeries.

After each chapter, several questions are posed, which help the reader focus on the key points raised in that chapter. The appendices include:

- wound topics from A to Z with text references to supplement the questions at the end of each chapter;
- copies of the "Master Algorithm", scoring assessments, and data recording systems;
- listing of and comments about wound care guidelines/ position papers, journals, and organizations, plus references to the authors' own publications and presentations.

The text is easy to read, and offers a good insight into the authors' vast experience in wound care management acquired over several decades. It contains much information, presented in a comprehensive, clear manner and, above all, it contains loads of common sense. It promotes the KISS principle for surgical interventions (“keep it simple and speedy”) and throughout, the same KISS attitude (“keep it simple and safe”) is present. To clinicians, this is always a comforting thought – never over-complicate matters! On the other hand, over-simplifying may be equally dangerous, and I confess that the sheer multitude of tables, evaluation tools and decision algorithms worried me at times; could the art of chronic wound care actually be reduced to ‘cook-book medicine’? I hope this was not the authors’ intention; rather, they should be congratulated in distilling these simple tools out of the forest of information available.

This is very much a clinical textbook rather than a scientific reference work. To have been the latter, it is, at times, a little too ‘uncritical’ (I feel reluctant to use the word, because taken as a whole, a critical attitude is omnipresent). However, for instance, the evaluation tool proposed by the authors in Part 2 has not been validated by others. Another example is the short section on thermal burns, where only references by a single centre/author are cited on the beneficial role of HBO therapy, whereas this remains a topic of considerable debate. The author’s wound score, as mentioned above, does not appear to have been prospectively validated in other wound centres and the algorithm has not gained wide acceptance in the global wound healing community. I am unsure whether this book will achieve that goal.

The book is well finished, with good-quality colour prints and drawings. The ‘cartoonesque’ drawings on the front cover would be a matter of personal taste. At least they illustrate the content nicely. That being said, I enjoyed this book very much and consider it a valuable addition to my library. If this were to be Michael Strauss’ legacy then it would be an appropriate one. I have encouraged all members of my nursing and medical staff to read it, and even if we might not adopt the “Master Algorithm” in its entirety, lots of useful information will be drawn from it. Seriously recommended!

Reference

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Peter Germonpré, MD
Director of the Center for Hyperbaric Oxygen Therapy, Military Hospital Queen Astrid, Medical Director of DAN Europe Benelux, President of the EUBS.

Key words
Wounds, chronic wounds, textbook, book reviews

Dangerous marine animals:
Mediterranean, Caribbean, Indo-Pacific

Matthias Bergbauer, Robert F Myers and Manuela Kirschner

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German edition, 2007
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Available from: <macmillandistribution.co.uk>
Price: £29.99

Matthias Bergbauer and Robert Myers are distinguished marine biologists who have written extensively about marine fishes. Manuela Kirschner is a renowned underwater photographer and has received international awards for her work. Some of her work is featured on the book covers.

This book contains a worldwide survey of dangerous marine life covering 350 species of fish, reptiles and invertebrates. It features over 640 colour photographs. It starts with an introduction outlining what makes an animal dangerous, and breaks this down into the several categories.

The first category outlined is traumatogenic, which includes marine animals that bite, cut or puncture. A few species use electricity to shock their prey. With the exception of feeding, territorial behaviour or cases of mistaken identity, fish that injure humans do so defensively and are only dangerous because of the actions of humans. The other categories are venomous and poisonous animals and they are divided into those that are actively venomous with a venom apparatus, and those that are passively poisonous, where the venom absorption occurs enterally, via the intestinal tract of the victim. The introduction also includes some general and specific medical treatment advice. It includes two highlighted pages with specific safety tips and precautionary measures, and advice on what to do if stung or bitten by a venomous animal.

The body of the book is broken into sections about fish, reptiles and invertebrates. The marine animals in each of these categories are then grouped under the type of injury they can cause, i.e., traumatogenic, venomous and passively poisonous, as applicable. No surprise is that invertebrates do not cause traumatogenic injuries, but now that I know that turtles are capable of cutting through skin and flesh with their beaks, I will keep my distance from these beautiful and graceful creatures.

Finally, each section regarding the specific marine animal includes some or all of the following information: behaviour, appearance, typical accidents, prevention, classification and distribution, and a highlighted section on treatment. It is beautifully illustrated with photographs and diagrams.

This book is a great and affordable resource for all divers and snorkellers and, as a small paperback, would fit nicely into one's carry-on bag; interesting and informative reading while travelling to and from the exotic dive sites we like to frequent, preparing us for the potential perils that lie ahead if we do not take care while visiting a marine environment. It would also be a useful guide for clinicians.

Catherine Meehan
Macleod Street Medical Centre, Cairns

Key words
Marine animals, injuries, envenomation, toxins, first aid, general interest, book reviews

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Diving pioneers and innovators

A series of in depth interviews
Bret Gilliam

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OCEAN TECH
54 Stonetree Rd
Arrowsic, ME 04530
<bretgilliam@gmail.com>
Price: US$60.00 plus postage and handling

Bret Gilliam should need no introduction to the readers of this journal; he has been professionally involved in the diving industry since 1971 and has logged more than 18,000 dives over a career that has covered virtually every aspect of the diving industry, both commercial and recreational. His contributions to the diving industry are many and varied and have been chronicled in numerous places including the final chapter of this book.

As the sub-title suggests, this book is a series of interviews with diving industry pioneers and innovators. Bret first started interviewing some of his subjects for *Deep Tech* magazine and then later in *Fathoms*. In 2005, he decided to turn these interviews into a book and widen the content to include more of the industry's, in his words, movers and shakers.

Being a former Englishman, now Australian, with a military and offshore diving industry background, I must admit that when I first looked at the list of interviewees I recognised only about seven out of the nineteen names. This is unashamedly a book with a North American bias, which reflects its target audience. However, once I started reading, I was totally enthralled with the backgrounds and achievements of every single one of these amazing people. While there are interviews with well-known diving equipment developers and manufacturers, from both the recreational and commercial industries, the majority of interviewees gained fame in the media. All of them have one thing in common: a shared passion for diving and the conservation of the world's oceans.

There is an interview for everyone in this book. Those lovers of *Sea hunt* will enjoy the interview with Zale Parry who co-starred with Lloyd Bridges in that classic series. For me, having been one of the first divers in the Royal Navy to use the iconic Kirby Morgan Band Mask, Bev Morgan's interview was fascinating, as was the interview with Peter Benchley; *Jaws* had just been published as I started my diving career!

Technical and wreck divers will enjoy the interviews with Wes Skiles, John Chatterton, Bob Ballard and Bret Gilliam himself. Underwater photographers and cinematographers are spoilt for choice with all of the other interviews, but for me the stand out of all these was Al Giddings, not just because of his work on *Titanic* and *The Abyss*, but his views on the future of high-definition technology and digital non-linear editing.

However, it is unfair to pick out names and interviews; they all deserve a place in this book. Bret Gilliam conducts 13 of the 19 interviews, guest interviewers conduct the rest, but what shines through are the obvious personal relationships between interviewer and subject. These are not mainstream media interviews for the general public with snappy prepared answers. These are warts-and-all, no-holds-barred, candid conversations with sometimes lifelong friends documenting the ups and downs of their careers; hard questions are asked and answered. What is more, Gilliam's easy writing style has you believing you are in the room having the conversation yourself. I found it hard to put down an interview without finishing it.

With a cover photo of Bev Morgan in standard diving dress, this is a coffee table book *par excéllence* with an excellent layout making it an easy read. As you would expect with so many underwater photographers being interviewed, the book is superbly illustrated. In the synopsis inside the dust jacket, Gilliam promises to "*take the reader on a journey of adventure and entertainment never before available*", a promise on which he certainly delivers. While the original print run is now sold, Bret still has a number of copies available and anyone interested in a signed copy is invited to contact him at the above address.

Steve Goble
Head Hyperbaric Technical Officer
Royal Adelaide Hospital

Key words
Diving, general interest, book reviews

Continuing professional development

CME activity 2011/1

Diver drug use and mental health

Christian Fabricius

Key words
MOPS (maintenance of professional standards), diving, drugs, medications, mental health

Accreditation statement
To complete a course successfully, 80% of questions in each quiz must be answered correctly. Activities published in association with *Diving and Hyperbaric Medicine* are accredited by the Australia and New Zealand College of Anaesthetists Continuing Professional Development Programme for members of the ANZCA Diving and Hyperbaric Medicine Special Interest Group under Learning Projects: Category 2 / Level 2: 2 Credits per hour.

Intended audience
The intended audience consists of anaesthetists and other specialists who are members of the ANZCA SIG in Diving and Hyperbaric Medicine and members of EUBS. However, all subscribers to DHM may apply to their respective CPD programme coordinator or specialty college for approval of participation.

Objectives
The questions are designed to affirm the takers' knowledge of the topics covered, and participants should be able to evaluate the appropriateness of the clinical information as it applies to the provision of patient care.

Faculty disclosure
Authors of these activities are required to disclose activities and relationships that, if known to others, might be viewed as a conflict of interest. Any such author disclosures will be published with each relevant CPD activity.

Do I have to pay?
All activities are free to subscribers.

Background reading
Practitioners are referred to two articles in this issue (St Leger Dowse M, et al. *The use of drugs by UK recreational divers: illicit drugs* and *The use of drugs by UK recreational divers: prescribed and over-the-counter medications*) as well as the relevant chapters in:
Brubakk AO, Neumann TS, editors. *Bennett and Elliot's physiology and medicine of diving*, 5th ed. Edinburgh: Saunders; 2003.
Bennett PB, Cronjé FJ, Campbell ES, editors. *Assessment of diving medical fitness for scuba divers and instructors*. Flagstaff, AZ: Best Publishing Company; 2006.
In addition to this, information about drug tests can be found at various internet sites.

How to answer the questions
Please answer all responses (A to D) as true or false.

Answers should be posted by e-mail to the nominated CPD coordinator. Members of both EUBS and SPUMS should submit their answers to Christian Fabricius <christian.fabricius@mecon1.se>, except for members of the ANZCA Diving and Hyperbaric Medicine Special Interest Group, who should submit to Assoc. Prof. Mike Bennett, <M.Bennett@unsw.edu.au>. On submission of your answers, you will receive a set of correct answers with a brief explanation of why each response is correct or incorrect.

Successful undertaking of the activity will require a correct response rate of 80% or more. Each task will expire within 24 months of its publication to ensure that additional, more recent data have not superceded the activity.

Question 1: What percentage of UK recreational divers can be suspected to have used illicit drugs (stimulants, hallucinogens, depressants, sedatives) sometime in their lifetime?

A. 5%
B. 10%
C. 20%
D. 30%

Question 2: The use of drugs can, in some cases, be a treatment of anxiety and/or depression. A Major Depression Disorder (MDD) is often treated with drugs. What is the lifetime incidence of MDD for women?

A. 5%
B. 10%
C. 20%
D. 50%

Question 3: Alcohol is a commonly used 'drug'. It could be difficult to get to know the drinking habits of a diver. One way to gain knowledge is to use a questionnaire. How many UK recreational divers, on average, admit to using alcohol less then 12 hours before a dive?

A. 5%
B. 10%
C. 20%
D. 30%

Question 4: To find out if a diver has been drinking excessively (here defined as at least 50 grams of alcohol per day for 2 weeks) a blood test can be performed. Which test can detect such drinking up to 2–4 weeks after the period of drinking?

A. GGT (y-Glutamyl Transpeptidase)
B. ALP (Aminotransferase) and AST (Aspartate Aminotransferase)
C. CDT (Carbohydrate Deficient Transferrin)
D. BAC (Blood Alcohol Concentration)

Question 5: Even if a drug is prescribed for a medical condition that is not, per se, a contraindication for diving, the treatment of the condition could be. Which one of the following drugs is contraindicated for a commercial diver?

A. Tetracycline
B. Fluoxetine
C. Warfarin
D. Digoxin

SPUMS notices and news

South Pacific Underwater Medicine Society Diploma of Diving and Hyperbaric Medicine

Requirements for candidates (updated October 2008)

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 medically qualified, and be a current 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 facility. The list of approved facilities providing two-week courses may be found on the SPUMS website.
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, in a standard format, for approval *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. Accompanying this written report should be a request to be considered for the SPUMS Diploma and supporting documentation for 1–4 above.
6 In the absence of documentation otherwise, it will be assumed that the paper is submitted for publication in *Diving and Hyperbaric Medicine*. As such, the structure of the paper needs to broadly comply with the 'Instructions to Authors' – full version, published in *Diving and Hyperbaric Medicine* 2010; 40(2):110-2.
7 The paper may be submitted to journals other than *Diving and Hyperbaric Medicine*; however, even if published in another journal, the completed paper must be submitted to the Education Officer for assessment as a diploma paper. If the paper has been accepted for publication or published in another journal, then evidence of this should be provided.
8 The diploma paper will be assessed, and changes may be requested, before it is regarded to be of the standard required for award of the Diploma. Once completed to the reviewers' satisfaction, papers not already submitted to, or accepted by other journals should be forwarded to the Editor of *Diving and Hyperbaric Medicine* for consideration. At this point the Diploma will be awarded, provided all other requirements are satisfied. Diploma projects submitted to *Diving and Hyperbaric Medicine* for consideration of publication will be subject to the Journal's own peer review process.

Additional information – prospective approval of projects is required

The candidate must contact the Education Officer in writing (e-mail is acceptable) to advise of their intended candidacy, and to discuss the proposed subject matter of their research. A written research proposal must be submitted before commencing the 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, and that the candidate is the first author, where there are more than one.

The SPUMS Diploma will not be awarded until all requirements are completed. The individual components do not necessarily need to be completed in the order outlined above. However, it is mandatory that the research project is approved prior to commencing research.

The Academic Board reserves the right to modify any of these requirements from time to time. As of October 2008, the SPUMS Academic Board consists of:
Associate Professor David Smart, Education Officer
Associate Professor Simon Mitchell
Associate Professor (retired) Mike Davis.

All enquiries and applications should be sent to the Education Officer:
Associate Professor David Smart
GPO Box 463, Hobart, Tasmania 7001
E-mail: *<david.smart@dhhs.tas.gov.au>*

Key words
Qualifications, underwater medicine, hyperbaric oxygen, research, medical society

SPUMS

South Pacific Underwater Medicine Society
40th Annual Scientific Meeting

23–28 May 2011

Venue: Hilton Resort and Spa, Tumon Bay, Guam

Call for Abstracts, Conference Information and Registration Forms

Themes:
Medical aspects of military, occupational and recreational technical diving
Head injury and diving workshop – review of clinical cases and guidelines
Management of acute diving injuries

The Head Injury and Diving Workshop will include medical risk assessment for diving post-head injury and post-seizure. Current guidelines will be examined and specific cases reviewed. Management of acute diving injuries will also be covered in the workshop forum.

Keynote speakers:
David Doolette, PhD, US Navy Experimental Diving Unit, Panama City, USA
Simon Mitchell, PhD, FANZCA, The University of Auckland
Andrew Fock, FANZCA, The Alfred Hospital, Melbourne

Abstracts:
Abstracts for presentations should be submitted before 31 March 2011 as a Word file of up to 250 words (excluding references – 4 only) and with only one figure.

Intending speakers are reminded that it is SPUMS policy that, wherever possible, their presentation should be submitted for consideration of publication in *Diving and Hyperbaric Medicine*.
The Editor will contact speakers prior to the meeting.

Papers should preferably reflect the themes of the conference. However, all free papers relevant to diving and hyperbaric medicine will be considered. Late submissions may be considered.

If you wish to present a paper please contact:
SPUMS ASM 2011 Convenor:
Dr Sarah Lockley
E-mail: <spumssecretary@gmail.com> or <secretary@spums.org.au>
Mobile: +61-(0)4-3114-4817

Register via the SPUMS website <www.spums.org.au>
or contact the Convenor for a Registration Brochure.
Registrations not done via the website will incur a handling fee.

The SPUMS Annual General Meeting 2011 Notice of meeting

The AGM for SPUMS 2011 will be held at Hilton Guam Resort and Spa, Guam, at 1630 h, Friday 27 May 2011

Agenda

Apologies:
Minutes of the previous meeting:
Minutes of the previous meeting will be posted on the notice board at Hilton Guam Resort and Spa and were published in *Diving and Hyperbaric Medicine*. (Minutes of the Annual General Meeting of SPUMS held at Berjaya Resort, Redang Island, on Thursday 27 May 2010. *Diving and Hyperbaric Medicine*. 2010;40:169.)
Matters arising from the minutes:
Annual reports:
President's report
Secretary's report
Education Officer's report
Annual financial statement and Treasurer's report
Journal Editor's report
Subscription fees for 2012:
Treasurer
Election of office bearers:
President
Secretary
Committee Member
Appointment of the Auditor 2011:
Treasurer
Business of which notice has been given:
Nominations for office bearers and expressions of interest for the President, Secretary and the Committee Member positions, are to be forwarded to the Secretary by 17 May 2011.
No notices have been received at this stage for other business. Any notice for other business must be received in writing to the Secretary by 31 April 2011.
Appointment of new Public Officer by the Committee:

Sarah Lockley, SPUMS Secretary

Membership notice

Dear SPUMS members,

Thank you for being a member of SPUMS of the past 12 months.

Membership is from 01 January every year, so we would like to remind you to renew your membership for 2011 on the society website <www.spums.org.au>. Membership renewal not done via the Society website incurs an additional handling fee of AUD $10.00. This will ensure that you continue to receive your copy of *Diving and Hyperbaric Medicine*, have access to the member's section of this website and discounts for the ASM, as well as being a requirement for being on the Diving Doctors List.

If you have not already done so, please renew as soon as possible to ensure continuity of membership.
Thank you for your continuing support.

SPUMS Executive Committee

Website news

There was a slight surprise for everyone in the New Year in the form of a renewal e-mail for SPUMS. The reminder was sent out automatically by a section of the software that had been activated without our knowledge by a security update. The message was a little 'generic' and I apologise to anyone who was confused or offended by the message, as it caught us by surprise as well! We have subsequently found the generic message and hopefully next year a nicer version will be sent out to remind members to renew.

We have been trying to reduce the workload for both Steve Goble (the Administrator) and myself by getting the membership database under control. I am progressively implementing automated tasks and the next one will be checking the Diving Doctors List against the membership database. Please note that to be on the List you have to be a member of SPUMS. There will be two months' grace to renew membership prior to doing the auto-check, but after February each year, if you are not a member then you will be taken off the Diving Doctors List. Please check your membership details are correct and current, as the professional address is what is available to the people searching the database.

We are also implementing some new features over the next year:
- a diving and hyperbaric jobs section in the forums
- better access to position papers and SPUMS paperwork
- encouraging people to post in the forums, including resident experts for people who have questions in diving and hyperbaric medicine
- promotional material for SPUMS including a Powerpoint presentation for use at local meetings for all members and non-members to use and view.

This is on top of the features that we already have, such as full copies of *Diving and Hyperbaric Medicine* and information on the SPUMS ASM and other meetings around the region and world.

So the website is slowly crystalizing towards a user-friendly, accessible part of your SPUMS membership as my time permits. Suggestions are welcome, so e-mail me at <webmaster@spums.org.au>.

Glen Hawkins, SPUMS Webmaster

Minutes of the Annual General Meeting of the Australian and New Zealand Hyperbaric Medicine Group, 09 September 2010, Crowne Plaza Hotel, Darwin

Opened: 0900 h

1. Attendance
D Wilkinson, M Bennett, S Mitchell, S Szekely, I Millar, C Cridge, M Hodgson, R Webb, N Banham, C Meehan, B Spain, G Hawkins.

2. Apologies
D Smart, M Walker, J Lehm, B Trytko, M Davis.

3. Office Bearers
Not discussed. No change to current office bearers.

4. Minutes of 2009 Annual General Meeting
Accepted.

5. Business arising
Discussed under current agenda items.

6. Address by Chair of ANZHMG (presented as a written document in the absence of Assoc Prof Smart)

6.1 Hyperbaric medicine funding in Australia – MSAC
I summarised the background issues relating to MSAC in my 2009 Report. In January this year, the ANZHMG put in two major submissions to the Federal Government totalling over 500 pages, which were accepted in February 2010. We have been informed that the assessment will take place; however, once again there have been considerable delays from MSAC. At this point, there is no date scheduled for an opening meeting to commence the assessment, but Associate Professor Mike Bennett and Associate Professor David Smart have been invited to join the Supporting Committee.

The reviews cost nearly $300,000 and this is the third review to take place. The funding in dispute is for Item 13015, which is approximately $850,000 per annum Australia-wide. The cost of three reviews exceeds the annual budget spent on patients.

We have been assured that the funding for Item 13015 will continue until the Committee's deliberations are complete. The submissions are strong and are very favourable supporting hyperbaric oxygen treatment in the two medical conditions. In particular, soft-tissue radiation injury has very limited evidence for any treatment other than HBO. On the basis of our submission this year, considerable pressure has been to put on MSAC to look at the bigger picture rather than HBOT in isolation.

6.2 Research
HOLLT and HORTIS are progressing very slowly with enrolments in single figures from Australia. I encourage all units to become involved in this.

6.3 ANZ list of indications for hyperbaric oxygen treatment.
There are no updates this year as the indications were updated in 2009.

6.4 Health technology assessments
These seem to keep pumping out of bureaucrats at a rate of knots. Yet another has been published from Canada in recent times.

6.5 Courses in diving and hyperbaric medicine
Three courses in Australia continue to be supported and referenced by SPUMS. These are the Royal Adelaide Diving and Hyperbaric Medicine Course, Prince of Wales Introductory Course in Diving and Hyperbaric Medicine, and the Royal Australian Navy Course of the HMAS Penguin. Well done to all those supervising and contributing to these courses. They are conducted voluntarily and with considerable personal effort by the convenors.

As SPUMS Education Officer, I have been invited to join an international group examining the educational needs for courses and training objectives for a diving medicine physician. This is an exciting initiative which may result in worldwide parity between courses and a degree of consistency that we have not seen in the past.

7. MSAC report and federal government funding issues
Following the last review of hyperbaric oxygen therapy by MSAC, an interim Medicare number (13015) was given for the indications of soft-tissue radiation injury and non-diabetic, hypoxic, non-healing wounds. There has been a delay in commencing the MSAC review of this item number; however, we have received confirmation from Medicare that this item number can continue to be used until the review process has been completed.

Weighty reports have been compiled and submitted by the ANZHMG in support of the continuation of this item number. Assoc Prof Mitchell led a consensus of congratulations to Associate Professors Bennett and Smart in recognition of their work. Some discussion related to hyperbaric facilities that process patient treatments via Medicare using this Medicare number and others that process treatments via 'Day Admission' status and state-based health funding using a 'Diagnostic Related Group' system; some facilities use a combination of both. Medicare present data recording utilisation of the item number 13015. Implications of this variable administrative approach were discussed.
(**Action:** Assoc Profs Bennett and Smart to distribute these reports via the chat line)

8. Hyperbaric problem wound study
Data continues to be added to this ever-increasing body of experience under the direction of Dr Hawkins. There are currently about 500 patients in the database, which

reports a high level of healing at the 12-month review point. It is hoped that the latest data can be presented to the MSAC Supporting Committee when they do meet. All are encouraged to continue supporting this project.

9. HORTIS

Little to note since the publication of the HORTIS-coordinated radiation proctitis study. Associate Professor Bennett was keen to promote involvement in the radiation cystitis arm as a priority although he expressed some concern about a relatively small sample size.

10. ANZHMG/SIG list of approved indications for HBO

No changes to this list. Of interest, Dr Millar has been involved with the Therapeutic Goods Administration during their process of registering hyperbaric chambers as approved medical devices (class 2B). These devices require a list of approved uses as part of the licence. The ANZHMG/SIG list of indications has been given to the TGA to fulfil this purpose.

11. Introductory courses in hyperbaric medicine

ANZHMG introductory course is to be run at Prince of Wales Hospital in Sydney from 21 February to 4 March 2011.

Royal Adelaide Hospital course is to be run from 29 November to 10 December 2010.

Dr Banham reported that the Fremantle Hospital will run a 3-day course on fitness-to-dive on 1–3 April 2011 with a general practitioner focus.

Discussion about opportunities for more courses aimed at equipping the general practitioner workforce to perform dive medicals and the differing requirements for occupational and recreational divers.

12. Hyperbaric training accreditation

The SIG of ANZCA oversees facility accreditation for training towards the Certificate of Diving and Hyperbaric Medicine. Facilities currently accredited are Prince of Wales, Townsville, Christchurch, Royal Hobart, Alfred and Fremantle Hospitals. Royal Adelaide and Brisbane Hospitals are intending to apply soon.

13. Australian Standards report

The change in structure and financing of Standards Australia means that any desire by a group to introduce or review a standard will require a financial commitment by that group towards the costs of the process unless a submission to Standards is successful in having the project ranked as a National Standards Australia priority project. Dr Millar spoke to this item as he has been involved with committees working on AS2299 and AS4005.1.

AS4005.1 is the entry-level recreational diving training standard and at present there does not appear to be industry support for its maintenance. The ISO organisation does have a standard for recreational diving and, if the Australian standard was to be abolished, the ISO document may replace it. The ISO standard requires only questionnaire-based medical fitness assessment. SPUMS is monitoring this situation.

AS/NZS2299 and AS2815 are the occupational diving standards series and these will continue with ADAS (Australasian Diver Accreditation Scheme) as the secretariat on behalf of Standards Australia, although AS/NZS 2299.3 (recreational diving at a workplace) will be omitted from this process. Occupational diving regulations may be influenced in the future by Safe Work Australia, which is a federal government body aimed at harmonising differing state-based occupational health and safety systems.

AS4774 will be discussed below in 18. HTNA issues.

14. *Diving and Hyperbaric Medicine* journal

The apology of the Editor was noted. There was discussion regarding the continuing high standard of the Journal. It is listed with EMBASE and with ISI (impact factor thought to be 0.4). It narrowly failed to be listed by Medline under some fairly ill-defined criteria. In response to representations, the Journal has been offered an accelerated review towards potential Medline listing.

15. Minimum data set/registry developments

No significant advance of this item. Dr Webb had commenced the process of identifying a list of agreed data fields but, as he has just commenced directorship of the new hyperbaric facility in Brisbane, he has little time. No alternatives discussed. Need to consider the future of this issue.

16. Hyperbaric medicine clinical indicators

Collection of the agreed clinical indicators commenced at the beginning of this year. It was noted that there was no talk scheduled during this meeting to present the current data. Discussion as to the current indicators and the potential for changes to the set of indicators used.

(**Action:** Assoc Prof Bennett to promote the presentation of clinical indicators at subsequent HTNA meetings)

17. Clinical trials for discussion

Multicentre Trial Meeting to be held tomorrow. Associate Professor Bennett advised that Prince of Wales will be seeking support for a study on idiopathic sudden sensory-neural hearing loss. 20 HBO sessions will be provided at 243 kPa for 90 minutes for cases of hearing loss of less than two weeks' duration. Steroids will be given and an MRI will be required. Hearing thresholds will be measured as well as a Quality-of-Life survey and the Amsterdam Functional Hearing Scale. The involvement of the local ENT department was recommended to facilitate the progress of this study.

(**Action:** Assoc Prof Bennett to arrange distribution of information to hyperbaric facilities in seeking collaborators)

18. HTNA issues

The HTNA requested that their Standards Committee have the opportunity to talk to the ANZHMG attendees regarding AS4774 (Compressed Air Workers, Hyperbaric Facilities). The HTNA Standards Committee was represented by Corry van Den Broek, Peter Atkinson and Sue Thurston. It was noted that AS4774 was more than five years old and required review. As noted above, any review of Australian standards now requires some group or body to drive and finance the process. The HTNA is intending to convene an industry-wide consultation group to discuss the future of AS4774. The HTNA has requested Hyperbaric Medical Officer representation on this group.

The discussion continued following the departure of the HTNA Standards Committee. The President of SPUMS tasked the ANZHMG with this issue as it was squarely in the field of influence of the ANZHMG, that is, compressed air and hyperbaric facilities. The ANZHMG recommended two members to represent the ANZHMG in this process – Associate Professor Bennett and Dr Hawkins.
(**Action:** Assoc Prof Bennett and Dr Hawkins to represent the ANZHMG)

19. Other business

19.1 HTNA 2011
Next year's HTNA will be held in Sydney and will coincide with the official opening of the new chamber complex (it should be worth attending for this alone). All hyperbaric doctors and the ANZHMG in general were encouraged to support this and subsequent HTNA meetings. Our attendance, involvement and offers of presentations are important and valued.

19.2 CME
There was discussion regarding the value of some organised CME event. It was suggested that a panel discussion involving leading clinicians along the lines of the popular "Hypothetical" could work well. It might be held in conjunction with an HTNA meeting.
(**Action:** Dr Millar and the Alfred team tasked with developing this idea)

19.3 Mild HBO
The ANZHMG has a position paper on Mild HBO which has been published in DHM. (ANZHMG statement on the administration of mild hyperbaric oxygen therapy. *Diving and Hyperbaric Medicine*. 2010;40:78-82.)

19.4 SPUMS Dive Medical
The new SPUMS Dive Medical is on the website.

Meeting closed: 1200 h

David Wilkinson, Hon Secretary ANZHMG

SPUMS members' news

Peter Buzzacott

Peter Buzzacott, an Associate Member, recently successfully defended his thesis *Determinants of risk factors for recreational diving morbidity and mortality in Western Australia* for the degree of Doctor of Philosophy through the School of Population Health, Faculty of Medicine, Dentistry and Health Sciences, at the University of Western Australia. Peter has published a series of papers related to this topic in *Diving and Hyperbaric Medicine* and the Editorial Board extends our congratulations to him.

Peter Buzzacott, photo taken during time spent at the Center for Hyperbaric Medicine and Environmental Physiology, Duke University Medical Center, Durham NC, USA.

The Canterbury earthquake, Australian floods and South Pacific cyclones

The 6.3 Richter earthquake on 22 February was shallow and close by, devasting the centre of Christchurch and the nearby port of Lyttelton. Sadly, unlike the 4 September 7.1 quake, there have been many casualties and thousands are homeless. Fortunately my family and that of my Assistant, Nicky McNeish, are all safe. Emergency and medical services have coped outstandingly, reinforced by NZ Defence forces and huge international help. With 80% of Christchurch initially without power, water and sewerage, and many roads severely damaged, it will take years to repair the infrastructure.

This has potential implications for *Diving and Hyperbaric Medicine*, as we are working under considerable duress. With the Editorial Board's support, we will continue to produce a high-quality journal in as timely a manner as possible.

We are not alone in the Pacific in experiencing the worst of the forces of Nature. Terrible floods in Australia, especially Queensland, followed by cyclones clobbering South Pacific islands, Queensland (again!) and northern New Zealand have all left a trail of tragedy behind them this southern summer. Now, as we do the final proof-read, there are reports of a terrible earthquake and tsunami in Japan.

We share in the adversity facing some SPUMS members at this time; but there is always light at the end of the tunnel.

Michael Davis, Editor

ANZCA Certificate in Diving and Hyperbaric Medicine

Eligible candidates are invited to present for the examination for the Certificate in Diving and Hyperbaric Medicine of the Australian and New Zealand College of Anaesthetists.

Eligibility criteria are:

1 Fellowship of a Specialist College in Australia or New Zealand. This includes all specialties, and the Royal Australian College of General Practitioners.

2 Completion of training courses in Diving Medicine and in Hyperbaric Medicine of at least 4 weeks' total duration. For example, one of:
   - a ANZHMG course at Prince of Wales Hospital Sydney, **and** Royal Adelaide Hospital or HMAS Penguin diving medical officers course **OR**
   - b Auckland University Diploma in Diving and Hyperbaric Medicine.

3 **EITHER:**
   - a Completion of the Diploma of the South Pacific Underwater Medicine Society, including 6 months' full-time equivalent experience in a hyperbaric unit and successful completion of a thesis or research project approved by the Assessor, SPUMS
   - b **and** Completion of a further 12 months' full-time equivalent clinical experience in a hospital-based hyperbaric unit which is approved for training in Diving and Hyperbaric Medicine by the ANZCA.

   OR:
   - c Completion of 18 months' full-time equivalent experience in a hospital-based hyperbaric unit which is approved for training in Diving and Hyperbaric Medicine by the ANZCA
   - d **and** Completion of a formal project in accordance with ANZCA Professional Document TE11 "Formal Project Guidelines". The formal project must be constructed around a topic which is relevant to the practice of Diving and Hyperbaric Medicine, and must be approved by the ANZCA Assessor prior to commencement.

4 Completion of a workbook documenting the details of clinical exposure attained during the training period.

5 Candidates who do not hold an Australian or New Zealand specialist qualification in Anaesthesia, Intensive Care or Emergency Medicine are required to demonstrate airway skills competency as specified by ANZCA in the document "Airway skills requirement for training in Diving and Hyperbaric Medicine".

All details are available on the ANZCA website at:
<www.anzca.edu.au/edutraining/DHM/index.htm>

Dr Margaret Walker, FANZCA
Chair, ANZCA/ASA Special Interest Group in Diving and Hyperbaric Medicine

Important notice: New Continuing Professional Development Coordinator needed for 2011

Associate Professor Michael Bennett is now the Chief Examiner for the ANZCA Certificate in Diving and Hyperbaric Medicine. He is advised by the College that he will not be able to continue to produce the CPD exercises in future issues of *Diving and Hyperbaric Medicine* due to a potential conflict of interest. Therefore, we are seeking a volunteer to continue the coordination of these CPD exercises. As from this year, members of EUBS will also be supporting this programme.

ANZCA SIG members: Time to front up and support your college, this journal and your colleagues! It is very disappointing to note that no volunteers have yet come forward.

Those interested should contact the SIG Chairperson, Dr Margaret Walker, e-mail: <margaret.walker@dhhs.tas.gov.au>, or Associate Professor Michael Bennett, e-mail: < M.Bennett@unsw.edu.au>.

EUBS European Underwater and Baromedical Society

EXECUTIVE COMMITTEE (as of September 2010)

PRESIDENT
Dr. Peter Germonpré
Centre for Hyperbaric Oxygen Therapy
Military Hospital Brussels
B-1120 Brussels, Belgium
Phone: +32-(0)2-264-4868
Fax: +32-(0)2-264-4861
E-mail: peter.germonpre@eubs.org

VICE PRESIDENT
Prof. Costantino Balestra
Environmental & Occupational
Physiology Laboratory
Haute Ecole Paul Henri Spaak
91, Av. C. Schaller
B-1160 Auderghem, Belgium
Phone & Fax: +32-(0)2-663-0076
E-mail: costantino.balestra@eubs.org

IMMEDIATE PAST PRESIDENT
Prof. Alf O. Brubakk
NTNU, Dept. Circulation & Imaging
N-7089 Trondheim, Norway
Phone: +47-(0)73-598904
Fax: +47-(0)73-597940
E-mail: alf.brubakk@eubs.org

PAST PRESIDENT
Dr. Noemi Bitterman
Technion, Israel Institute of Technology
Technion City
Haifa 32000, Israel
Phone: +972-(0)4-829-4909
Fax: +972-4-824-6631
E-mail: noemi.bitterman@eubs.org

HONORARY SECRETARY
Dr. Joerg Schmutz
Foundation for Hyperbaric Medicine
Kleinhuningerstrasse 177
CH-4057 Basel, Switzerland
Phone: +41-(0)61-631-3013
Fax: +41-(0)61-631-3006
E-mail: joerg.schmutz@eubs.org

MEMBER AT LARGE 2010
Dr. Jean-Michel Pontier
Department Underwater Medicine
French Navy Diving School BP 311
F-83800 Toulon cedex 09, France
Phone: +33-(0)494-114568
Fax: +33-(0)494-114810
E-mail: jean-michel.pontier@eubs.org

MEMBER AT LARGE 2009
Dr. Andreas Møllerløkken
NTNU, Dept. Circulation & Imaging
N-7089 Trondheim, Norway
Phone: +47-(0)73-598907
Fax: +47-(0)73-598613
E-mail: andreas.mollerlokken@eubs.org

MEMBER AT LARGE 2008
Dr. Peter Knessl
Steinechtweg 18
CH-4452 Itingen, Switzerland
Phone: +41-(0)44-716-7105
E-mail: peter.knessl@eubs.org

LIAISON OFFICER
Dr. Phil Bryson
DDRC, The Hyperbaric Medical Centre
Tamar Science Park, Research Way
Derriford, Plymouth
Devon, PL6 8BU, United Kingdom
Phone: +44-(0)1752-209999
Fax: +44-(0)1752-209115
E-mail: phil.bryson@eubs.org

HONORARY TREASURER & MEMBERSHIP SECRETARY
Ms. Patricia Wooding
16 Burselm Avenue
Hainault, Ilford
Essex, IG6 3EH, United Kingdom
Phone & Fax: +44-(0)20-85001778
E-mail: patricia.wooding@eubs.org

EUROPEAN EDITOR, DIVING AND HYPERBARIC MEDICINE JOURNAL
Dr. Peter HJ Mueller
Dudenhofer Str. 8C
D-67346 Speyer, Germany
Phone: & Fax: +49-(0)6232-686-5866
E-mail: peter.mueller@eubs.org

EUBS European Underwater and Baromedical Society

EUBS 37th ANNUAL SCIENTIFIC MEETING 2011

24–27 August 2011
Gdansk, Poland
Second Announcement

Hosts: The National Centre for Hyperbaric Medicine, Gdynia
Venue: The Medical University of Gdansk

Zdzislaw Sicko, Chairman of the Organising Committee <zsicko@ucmmit.gdynia.pl>
Jacek Kot, General Secretary of the Organising Committee <jkot@gumed.edu.pl>

Scientific Committee: Alessandro Marroni (IT) (Chairman), Mike Bennett (AU), Alf Brubakk (NO), Maide Cimsit (TR), Jordi Desola (ES), Peter Germonpre (BE), Yoram Grossman (IL), Michal Hajek (CZ), Erik Jansen (DK), Jacek Kot (PL), Folke Lind (SE), Daniel Mathieu (FR), Peter Radermacher (DE), Maria Wujtewicz (PL)

Main topics:

Diving physiology and medicine, non-dysbaric disorders
Research in deep diving and dysbaric diving disorders
Basic research and clinical hyperbaric medicine
Hyperbaric safety, technology and organisation

There will be several satellite meetings during the conference including:
ECHM Workshop on "HBO in Emergency Medicine"
EBAss meeting
EDTCmed meeting
DAN Divers' Day

Abstracts

Abstracts for oral and poster presentations should be submitted electronically to the website <www.EUBS2011.org>
Abstract submission deadline is 01 May 2011. All abstracts will be reviewed by members of the Scientific Committee.
Notification of acceptance will be sent to authors by 15 June 2011.

Conference office: (registration, accommodation, travel, payment)
Phone: +48 46 856 30 13
Fax: +48 46 856 30 13
Mobile: +48 604 203 244
E-mail: <office@eubs2011.org>

Visit our website:

<www.EUBS2011.org>
and register today

The EUBS website is at
www.eubs.org
Members are encouraged to log in

EUBS 38th Annual Scientific Meeting 2012

Dates: 12–15 September 2012
Venue: Sava Centar, Belgrade, Serbia

ECHM Consensus Conference on Hyperbaric Medicine
11–12 September

Enquiries to: Mariana Sedlar
E-mail: <chm@scnet.rs>

International Congress on Hyperbaric Medicine

President: *Dr Frans Cronje*
Executive Director: *Dr Alessandro Marroni*
Secretary: *Associate Professor Michael Bennett*

The ICHM is a world-wide organisation, with minimal formal structure, entirely dedicated to hosting an international scientific congress every three years with the purpose of improving understanding among the hyperbaric community. The *First International Congress on Hyperbaric Medicine* was held in Amsterdam in 1963, under the auspices of the Founding President, Professor Boerema. Since then, congresses have been held all over the world, the 17th in South Africa as this issue of DHM goes to press.

Communication among members is via the website at <www.ICHM.net>. With the endorsement of SPUMS and EUBS, a regular page of news and information about the ICHM will appear in *Diving and Hyperbaric Medicine* (DHM). We welcome comments from readers, whether or not they are members of the ICHM.

Also under negotiation is the possibility of publishing the proceedings of each congress under the *Diving and Hyperbaric Medicine* banner – watch this space. Members of the ICHM who wish to publish scholarly articles are encouraged to consider submission to DHM. All submissions will be subject to the Journal's peer-review process.

For all enquiries contact Mike Bennett:
E-mail: <m.bennett@unsw.edu.au>

Inter-university Diploma in Diving and Hyperbaric Medicine, France

For further information go to:
<http://www.medsubhyp.org> or
<http://medecine.univ-lille2.fr/format/diu/hyperbar.htm>

German Society for Diving and Hyperbaric Medicine (GTUeM)

An overview of basic and refresher courses in diving and hyperbaric medicine, accredited by the German Society for Diving and Hyperbaric Medicine (GTUeM) according to EDTC/ECHM curricula, can be found on the website:
<http://www.gtuem.org/212/Kurse_/_Termine/Kurse.html>

Scott Haldane Foundation

The basic course (Part I plus Part II) complies fully with the current EDTC/ECHM curricula, and the different advanced courses offer modules to achieve Level IIa status according to the EDTC/ECHM guidelines.
2–8 April: Basic course part I (Hilversum)
9–16 April: Basic course part II, AMC (Amsterdam)
12–19 May: Basic course part II, Marsa Alam (Egypt)
24–25 June: 17th Advanced course, Dive safety (NL)
17 September: Refresher course Fitness to Dive (AMC, Amsterdam, NL)
7–8 October: 17th Advanced course, Dive safety (NL)
12–19 Nov (departure 10 Nov): Basic course diving medicine Part I (Palau)
19–26 Nov (departure 17 Nov): 19th Advanced course (Palau)
26 Nov–3 Dec (departure 24 Nov): 19th Advanced course (Palau)

For further information: <www.scotthaldane.nl>

Oxygen and Infection: European Committee for Hyperbaric Medicine (ECHM) Conference Proceedings

Free video lectures from the May 2009 Stockholm meeting are available for your iPhone or computer
<www.hyperbaricoxygen.se>

5th Karolinska Postgraduate Course in Clinical Hyperbaric Oxygen Therapy
14 lectures on fundamental concepts and front-line knowledge in the clinical use of HBO.

ECHM Conference 'Oxygen and Infection'
22 lectures and three panel discussions are available on topics such as necrotizing fasciitis and the diabetic foot.

For further information contact:
Folke Lind, MD PhD,
E-mail: <folke.lind@karolinska.se>
Website: Editor <www.hyperbaricoxygen.se>

DIVING HISTORICAL SOCIETY AUSTRALIA, SE ASIA

P O Box 347, Dingley Village, Victoria, 3172, Australia
Email:
<deswill@dingley.net>
Website:
<www.classicdiver.org>

Instructions to authors

(Short version, updated November 2010)

Diving and Hyperbaric Medicine welcomes contributions (including letters to the Editor) on all aspects of diving and hyperbaric medicine. Manuscripts must be offered exclusively to *Diving and Hyperbaric Medicine*, unless clearly authenticated copyright exemption accompanies the manuscript. All manuscripts will be subject to peer review. Accepted contributions will also be subject to editing. An accompanying letter signed by all authors should be sent.

Contributions should be sent to:

The Editor, Diving and Hyperbaric Medicine,
C/o Hyperbaric Medicine Unit, Christchurch Hospital,
Private Bag 4710, Christchurch, New Zealand.
E-mail: *<editor@dhmjournal.com>*

Requirements for manuscripts

Documents should be submitted electronically on disk or as attachments to e-mail. The preferred format is Microsoft® Office Word 2003. Paper submissions will also be accepted. 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 generally be subdivided into the following sections: an Abstract of no more than 250 words, Introduction, Methods, Results, Discussion, Conclusion(s), Acknowledgements and References. Acknowledgements should be brief. Legends for tables and figures should appear at the end of the text file after the references. Conflicts of interest and funding sources should be identified.

The text should be 1.5 or single-spaced, using both upper and lower case. Headings should conform to the current format in *Diving and Hyperbaric Medicine*. All pages should be numbered. Underlining should not be used. SI units are to be used (mmHg is acceptable for blood pressure measurements; bar for cylinder pressures); normal ranges should be shown. Abbreviations may be used after being shown in brackets after the complete expression, e.g., decompression illness (DCI) can thereafter be referred to as DCI.

Preferred length for **Original Articles** is up to 3,000 words. Inclusion of more than five authors requires justification, as does that of more than 30 references. **Case Reports** should not exceed 1,500 words, and a maximum of 15 references. Abstracts are required for all articles. **Letters to the Editor** should not exceed 500 words and a maximum of five references. Legends for figures and tables should generally be shorter than 40 words in length.

Illustrations, figures and tables must NOT be embedded in the wordprocessor document, only their position indicated. No captions or symbol definitions should appear in the body of the table or image.

Table data may be presented either as normal text with tab-separated columns (preferred) or in table format. No gridlines, borders or shading should be used.

Illustrations and figures should be submitted as separate electronic files in TIFF, high resolution JPG or BMP format. If figures are created in Excel, submit the complete Excel file. Large files (> 10 Mb) should be submitted on disk.

Photographs should be glossy, black-and-white or colour. Colour is available only when it is essential and will be at the authors' expense. Indicate magnification for photomicrographs.

References

The Journal reference style is the 'Vancouver' style (Uniform requirements for manuscripts submitted to biomedical journals, updated August 2009. Website for details: <http://www.nlm.nih.gov/bsd/uniform_requirements.html>). References must appear in the text as superscript numbers at the end of the sentence after the full stop.[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 exact format for a standard paper and a book 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.

Accuracy of references is the responsibility of the authors.

Manuscripts not complying with the above requirements will be returned to the author before being considered for publication.

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 (and consent forms) should be available if requested.

Copyright

Authors must agree to accept the standard conditions of publication. These grant *Diving and Hyperbaric Medicine* a non-exclusive licence to publish the article in printed form in *Diving and Hyperbaric Medicine* and in other media, including electronic form. Also granting the right to sub-licence third parties to exercise all or any of these rights. *Diving and Hyperbaric Medicine* agrees that in publishing the article(s) and exercising this non-exclusive publishing sub-licence, the author(s) will always be acknowledged as the copyright owner(s) of the article.

Full instructions to authors (revised June 2010) may be found on the DHM Jounal, EUBS and SPUMS websites.

DIVER EMERGENCY SERVICES PHONE NUMBERS

AUSTRALIA
1800-088200 (in Australia, toll-free)
+61-8-8212-9242 (International)

NEW ZEALAND
0800-4DES-111 (in New Zealand, toll-free)
+64-9-445-8454 (International)

SOUTH-EAST ASIA
+852-3611-7326 (China)
+10-4500-9113 (Korea)
+81-3-3812-4999 (Japan)

SOUTHERN AFRICA
0800-020111 (in South Africa, toll-free)
+27-10-209-8112 (international, call collect)

EUROPE
+39-06-4211-8685 (24-hour hotline)

UNITED KINGDOM
+44-07740-251-635

USA
+1-919-684-9111

The DES numbers (except UK) are generously supported by DAN

DAN Asia-Pacific DIVE ACCIDENT REPORTING PROJECT

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 regard to identifying details, is utilised in reports on fatal and non-fatal cases.
Such reports can be used by interested people or organisations to increase diving safety through better awareness of critical factors.
Information may be sent (in confidence unless otherwise agreed) to:
DAN Research
Divers Alert Network Asia Pacific
PO Box 384, Ashburton VIC 3147, Australia
Enquiries to: <research@danasiapacific.org>

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-AP website: <www.danasiapacific.org>
They should be returned to:
DIMS, 30 Park Ave, Rosslyn Park, South Australia 5072, Australia.

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