THE WORLD AS IT IS

OZTEK99 DIVING TECHNOLOGIES AND REBREATHER FORUM A NON-MEDICAL REVIEW

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Key Words

Decompression illness, equipment, meeting, mixed gas, rebreathers.

Introduction

On April 24th and 25th 1999 the inaugural OzTeK Diving Technologies Conference and Rebreather Forum was held in Sydney, Australia. The 1999 Asia-Pacific TDI (Technical Diving International) Members Forum had been held over the two previous days, so some attendees had 4 enthralling days of presentations and workshops from some of the World's leading Technical Diving identities.

Opening address and history of rebreathers

The convener, Richard Taylor, (TDI Australia and New Zealand) welcomed us to the conference on Saturday morning. Bret Gilliam (President TDI) then set the scene with a keynote speech reviewing the past, present and future of technical diving. This included a look at some video footage taking advantage of the relative silence of a rebreather, enabling the cameraman to get close in amongst a school of hammerhead sharks. Adding reality and entertainment to the scene was the fact that the microphone had picked up the adrenaline-mediated increase in heart rate of the cameraman as the sharks swam so unbelievably close! Bob Ramsay of the Diving Historical Society Australia and South East Asia (DHS ASEA) followed, with a history of rebreathers. He informed us that the first documentation of "rebreather" use dated as far back as 1624, with a description of a submarine made out of a barrel, and containing a special pot of unknown liquid, being used in the River Thames. The first design of an oxygen rebreather was first documented in 1778.

Decompression theory and application

From a historical overview, the morning evolved into decompression theory and application starting with Chris Parrett (author of the Abyss Advanced Dive Planner) discussing the micro-bubble theory and its relevance to technical diving requiring decompression stops. This theory supposes that tiny bubble "nuclei" (microscopic pockets of gas) are naturally present within our bodies and that excess gas diffuses into these nuclei, expanding them and so creating bubbles. Once bubbles form they may join together and form larger bubbles and may distort other tissues. Bubbles can become trapped and put pressure on nerves, damage tissues or block the blood supply to vital organs. As the ambient pressure is reduced during ascent, the bubbles grow in accordance with Boyle's Law (*P*ressure x *V*olume = *k* constant). In addition, since the pressure inside the bubble will always be roughly equivalent to ambient pressure, any gas which remains dissolved in tissue at greater than ambient pressure (from a previous depth) will tend to move into the (lower pressure) bubble, causing it to expand further causing more damage.

It has been suggested that these micro-bubbles can be crushed by high pressure. This is the basis of the controversial theory behind making an initial deep dive for a few minutes, before the day's diving activities, to crush the micro-bubbles. It is thought that the micro-bubbles take somewhere between hours and days to regenerate so, theoretically, regular diving every few days may have beneficial effects by keeping micro-bubbles crushed.

Of interest to technical divers, Chris presented evidence to show that on decompression dives, deep, short (1-3 minute) stops have advantages. The long ascent to the first stop, in traditional decompression profiles, because of its steep gas to ambient pressure gradient, produces many bubbles. Shorter, deeper stops reduce this pressure gradient and so theoretically reduce the potential for bubble formation. Also eliminating bubbles formed early decompression reduces overall decompression time.

Chris translated the micro-bubble theory into general practical safe diving advice, which applies to both technical and recreational divers. He noted that Doppler monitoring of divers has revealed that the number of bubbles peaks approximately 30-60 minutes after surfacing. With this in mind, Chris suggested that repetitive dives within this window of maximal bubble formation (30-120 minutes after a dive) should be avoided. For the same reason, multiple surface ascents within a dive should also be avoided. Other practical applications of the theory include making a slow ascent of 10 m/minute and making a stop in the 3-6 m range on all dives. Diving at altitude requires careful consideration as bubble excitation and bubble growth rates are enhanced by a decrease in ambient pressure. In other words, bubbles grow more easily at altitude and can have greater impact on the diver.

Chris pointed out that the micro-bubble model has not been validated and is sometimes in conflict with the tissue-based model. However early results have been encouraging. Chris also gave participants a chance to win a copy of the Abyss98 Advanced Dive Planning software!

In-water recompression

After lunch there was a very informative forum on in-water recompression (IWR) with three eminent speakers, Dr Ann Kristovitch (Medical Officer), Richard Pyle (Deep Reef Explorer) and Dr Carl Edmonds (Director, Diving Medical Centre). It is accepted within the diving medical community that, in general, IWR should not be attempted as it carries inherent risks. However, in certain circumstances, such as in remote areas or after failed decompression stops in deep technical diving, in-water recompression may be the best, or the only, immediate option. Three important points were emphasised. The correct equipment, including a full-face mask for the delivery of 100% oxygen, must be available for safe IWR. In the case of deep technical divers with missed decompression stops, immediate treatment is essential. Following IWR, a diver should be transported to a medical recompression facility as soon as possible. Various methods of IWR were discussed.

Medical aspects of closed circuit rebreathers

Then Dr Robyn Walker (Royal Australian Navy) enlightened us about medical problems with rebreathers. The main take home message was the importance of checking and re-checking that the level of oxygen is as planned before starting the dive. When oxygen is breathed at partial pressures of greater than 1.4 bar (ATA) the degree of central nervous system toxicity rapidly increases. Unless one is wearing a full-face mask acute oxygen toxicity under water is nearly always fatal. Oxygen toxicity causes fitting without warning, resulting in the diver losing the regulator. The respiratory muscles go into spasm and the diver stops breathing. When respiration restarts the diver will inhale water and drown. Often the first signs of oxygen toxicity are recognised by others observing slightly unusual behaviour, as the diver often does not recognise the subtle indications such as nausea, light headedness, ringing in the ears, a sense of impending doom, sweating and pallor. She also touched on CO_2 toxicity, caustic cocktails and dilution hypoxia.

Cave diving in Australia

After all this fascinating information, I was pleased to sit back, relax and watch Neil Vincent show us wonderful pictures of his cave diving exploits in Australia. Fantastic water clarity and rock formations. Although I do not think you will catch me diving down through the "birth canal" (in McCavity Cave at Wellington, NSW) and waiting for someone to push my scuba gear after me!

The evening session proved to be both stimulating and entertaining with three presentations. Richard Pyle talked about deep reef explorations and researching new species of fish using the CIS-Lunar MkV rebreather around the Hawaiian Islands at depths of 75-150 m. Jim Bowden gave us an insight into the tremendous physical and psychological demands of the Deep Project in the jungles of Mexico where exploration has led to diving to nearly 300 m (1,000 ft). Finally Nuno Gomes took us through the meticulous planning and execution of his world record scuba dive to 282 m at altitude in South Africa! The audience was mesmerised by the sheer dedication of these men, though there was a teaser thrown out, that no woman has yet dived to beyond 180 m (600 feet).

Diving with closed circuit rebreathers

On Sunday Peter Readey (CABA/Steam Machines) enlightened us with the unexpected things that one can do on your first dive using a rebreather. For example if you want to swim above an obstacle, in traditional scuba you would inhale but if you do this with a rebreather you will crash head long into it! The volume in your lungs and the counter-lung exchange, but remain constant. Also, a gentle reminder was not to leave the mouthpiece in the open position at the surface. This lets the rebreather bag deflate and you will sink!

Treating decompression illness in mixed gas divers

Dr Simon Mitchell, a Specialist in Diving and Hyperbaric Medicine, has left the Royal New Zealand Navy and is now the Medical Director of the Wesley Centre for Hyperbaric Medicine in Brisbane. He briefly reminded us of the mechanisms and manifestations of decompression illness (DCI) and discussed the relative advantages and disadvantages of using helium and/or nitrogen as the inert portion of the diver's breathing gas. His attention then focussed on the treatment of DCI in technical (mixed-gas) divers. The emphasis here was on the divers being prepared and having a plan of action, which can be implemented immediately if the need arises.

DCI resulting from deep technical diving is often neurological DCI with early onset of symptoms and a very rapid deterioration. The window of opportunity to help the situation is small. Involving the nearest recompression facility so they can be on stand-by is an important part of the planning process, as is having correct emergency equipment on hand at the dive site. Dr Mitchell's recommended hierarchy of intervention options in rapidly progressive DCI are:

1 Immediate (in less than 30 minutes) recompression in an appropriate recompression chamber,
2 In-water recompression if done early and with the proper equipment,
3 First aid at the site with evacuation to a recompression chamber.

It is very important to give 100% oxygen immediately in all options.

Controversy surrounds the administration of aspirin in suspected DCI. Gas bubbles in the blood can damage the vessel lining and the body produces platelets, which aggregate to help mend the damage. A consequence of this natural response is that platelets can also stick to the bubbles, so making them more likely to cause a blockage and facilitate the immune response and contributing further to DCI. Aspirin reduces platelet aggregation and theoretically this may help reduce some of the effects of DCI. However, Dr Mitchell pointed out that there is no data, in either animals or humans, which suggests aspirin administration improves the outcome in DCI. Moreover, aspirin may exacerbate any haemorrhage into the spinal cord occurring in the pathology of spinal DCI. The weight of evidence at present, in his opinion, favours not giving aspirin to victims of DCI.

He then addressed some of the logistical concerns in treating technical divers in a recompression chamber. Treatment in a recompression chamber is likely to involve recompression to 18 msw and breathing 100% O_2. Deep technical divers may need to be taken deeper that 18 m to control the bubbles more quickly, but the risks associated with oxygen toxicity mean that 100% O_2 cannot be administered beyond this depth. So a diluent gas must be added with deeper treatments and the dilemma of whether to use helium or nitrogen was discussed.

The basic take home message was “the earlier the treatment the better the results” but sadly, not everyone will have a complete recovery. Dr Mitchell concluded his presentation with his usual panache and entertained the audience with a couple of stories from his navy days.

CO_2 absorber design

The later morning sessions included a look at the Royal Australian Navy (RAN) experiences of rebreather CO_2 scrubber design faults by Dr Carl Edmonds and a review of closed-circuit rebreather failures by John Pennefather (RAN Submarine and Underwater Medicine Unit).

Rebreather try dives

After lunch we could try out a rebreather in the pool! It was $20 well spent. One could chose from Dräger Dolphin and Dräger Ray Rebreathers, Prism, Inspiration, Cis-Lunar, Halcyon, Steam Machine 1600’s and more. I had my first dive with a semi-closed circuit Dräger Dolphin. After getting used to the slight resistance on exhalation, and all the extra weight I needed, I descended to the deep end of the pool and swam around in almost silence. After a while I stopped and observed the scene. It was like a dream, observing. I could not be diving, there were no blasts of bubbles. Amazing. I definitely want to try one in the sea.

There were also presentations on the Wakulla 2 Project (John Vanderleest, one of the Australian divers on the team), Diving the World War 1 Australian submarine AE2 in Turkey (Dr Mark Spencer, the AE2 Project Leader), Doppler Monitoring of bubbles in divers after decompression (Dr Akin Toklu of the AE2 Project Turkish Support Team), and Diving the Atlanta, Britannic and Saratoga (photographer and expedition leader Kevin Denlay).

Throughout the conference, equipment seminars and rebreather forums were taking place in an adjacent room. If only I could have gone to everything!

All in all, an excellent 2 days. Congratulations to Richard Taylor (TDI Australia and New Zealand) for putting together such an excellent and informative program and to the exhibitors who made it all possible.

Lynn Taylor is a PADI IDC Staff Instructor and a DAN O_2 instructor. She came to New Zealand, from England, in 1994 and soon found a passion for diving. Her interests in the technical and medical aspects of diving have stemmed from her science and research background, BSc and PhD, and hence her interest in OzTeK. Her address is 26 Barker Rise, Browns Bay, Auckland, New Zealand. Telephone + 64-9-367-2948. Fax +64-9-367-2500. E-mail ltt21040@GlaxoWellcome.co.uk .

SUB-SPECIALTY CERTIFICATION IN UNDERSEA AND HYPERBARIC MEDICINE

The first examination for certification in Undersea and Hyperbaric Medicine (UHM) was held on 8 November 1999 by the American Board of Preventive Medicine (ABPM), which plans to offer this exam on a regular basis. The requirements to sit the examination may be met either through completion of an approved fellowship in UHM after primary board certification. Or, starting in 2003, through a combination of basic training and practical experience. The applicant must have current certification from one of the 24 Member Boards of the American Board of Medical Specialties. Detailed requirements, application forms and examination content outline are available on the ABPM’s web site at www.abprevmed.org .

Key Words

Hyperbaric oxygen, qualifications, underwater medicine.