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Some references have been provided by editorial staff where they could be easily worked out from the Editor's library.

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DIVING SAFETY, WHERE ARE WE GOING ?

John Knight

Summary

Diving safety, as for all safety, requires an attitude of mind as well as technical competence. It requires the proper equipment which must be well maintained. Inexperienced and out of practice divers dominate the diving deaths. Diving is always a serious business, but should be enjoyable. Diving for fun may mean that the diver does not bother to dive safely. Current training turns out divers who need extra training to dive safely anywhere other than where they have been trained. Experienced divers seem to be able to avoid problems if they take care.

Introduction

Scuba diving is an intrinsically dangerous sport as it is performed in an unbreathable medium with a limited air supply. It is equipment dependent. The scuba diver must have a reliable breathing system to survive. Raised nitrogen partial pressures change a diver's thinking. Immersion alters physiology and being in water increases heat loss. A diver can kill himself (or herself) by holding his breath and rising in the water. Sea conditions can change rapidly and become dangerously hostile.

Decompression sickness is an unavoidable hazard of scuba diving or any sort of diving. It is very, very, difficult to come up slowly enough to form no bubbles at all. It is a statistical accident whether one forms enough bubbles in the wrong places to get decompression sickness symptoms. There is quite a lot of evidence that coming up faster than 18 m per minute is associated with cases of decompression illness. There is also evidence that multiple ascents during a dive are associated with decompression sickness.

Breath-hold divers continue to die unnecessarily every year. Post-hyperventilation blackout has been known for about 30 years, but its dangers are regularly forgotten. One of our past guest speakers bore the scars of two chest drains and a tracheostomy, the results of a post-hyperventilation blackout in the university swimming pool. He was lucky to be rescued and revived with CPR. Thechest drains were needed for the pneumothoraces CPR gave him ! He went on to become a Diving Medical Officer in the USN.

Safe diving

What is a safe dive ? Is it one where the diver never makes a mistake or is it one when he or she survives to get back to land alive, or more importantly alive and well ? That is a huge range from which to take your pick. Diving is always a serious business, but it should be enjoyable to avoid stresses which can cause disaster. Diving for "fun" may mean that the diver does not bother to dive safely.

Diving safety requires an attitude of mind as well as technical competence. It requires the proper, well maintained equipment. It requires knowledge of the physiological effects of immersion, of hypothermia as keeping warm underwater is difficult, of the effects of partial pressure changes to name but a few requirements. It requires thought on the part of the diver. It requires judgement and courage to stick to doing what is safe, to refuse to dive because one is not happy with some aspect of the dive, often the weather or sea conditions.

Diving safety is the ability to cope with the changes and dangers of diving which leads to safe, incident free diving. Safety does not necessarily come from regulations, such as depth limits. The Queensland regulations were brought about by the failure of self-regulation in the diving industry. A few cowboys were careless and unsafe and their antics, and the importance of the diving industry to tourism, prompted what many see as unnecessarily heavy handed regulation. Equipment provision can be improved by regulation but it does not effect attitude changes.

The efforts of Carl Edmonds, Bob Thomas and others, myself among them, have popularised and raised the standard of diving medicals over the years. However only one instructor organisation (NASDS (National Association of Scuba Diving Schools) which was the Federation of Australian Underwater Instructors (FAUI) until recently) considers that a diving medical is required before the prospective diver gets wet. It is unfortunate that the diving instructor organisations refused to support properly conducted diving medicals during the preparation of the new Australian Standard 4005.1-1992.[1] I consider the questionnaires that are offered are less satisfactory methods of sorting out those who should not dive. Australia is lucky in having a large number of doctors who have had training in how to do a proper diving medical.

Last year Glen Egstrom told us of the rates that his research had shown divers came to the surface.[2] I do not think that many people actually come up at the recommended rate of 10 m per minute or less that is being advised for some diving tables and computers This rate is extremely difficult to achieve. One has to watch the depth gauge and timing device closely to make sure one rises at the correct rate. Usually I have to hover for a while because I have exceeded the ascent rate.

Accidents

What causes accidents ? It is usually diver error, and usually a series of errors. The common errors can be classed as incompetence, which can be due to inadequate training or lack of knowledge, or stupidity, such as going diving when one should not or without required equipment. The divers who died in the Mt Gambier sinkholes were either untrained in the special skills necessary for safe cave diving or did not use them properly. Sometimes the cause is beyond the diver's control such as an unforeseeable event like sudden regulator failure or an unpredicted storm.

Statistics of deaths and DCI, which are almost the only statistics about the problems of diving, are only the tip of the iceberg of errors and accidents. It is only recently that studies of diving incidents have been published. This is largely because the statistics are difficult to collect. They have shown that some pretty startling things happen without morbidity.[3,4]

Thanks to the work of Douglas Walker, in Australia with Project Stickybeak, and John McAniff, who runs the National Underwater Accident Data Center (NUADC) at the University of Rhode Island in the U.S.A., we know the factors that were associated with many deaths. Their reports started in the early 1070 and have appeared regularly since.[5,6] The most important of these appear to be inexperience and being out of practice. Unfortunately the common causes of disaster include failure to act on the part of the diver. Failure to control buoyancy properly. Failure to monitor the contents gauge and failure to start the ascent with plenty of air. Failure to inflate the buoyancy compensator. Failure to drop the weight belt. Failure to recognise dangerous sea conditions. More effective training would teach divers to avoid all these mistakes.

In a number of cases there has been equipment failure that has precipitated the pattern of events that led to a death. This seems commoner in the US deaths than in the Australian and New Zealand deaths.[7] There are many more occasions when equipment failure occurs but is coped with without any problems.

If one is relatively close to the surface when the regulator O-ring blows it is not very difficult to get back to the surface. It is a bit more difficult when one is at any depth and the regulator suddenly refuses to give any air or free flows. One way to the surfaces is to do an emergency, out of air, swimming ascent. Another escape routeis that the diver can breathe in and out of the buoyancy compensator, which will be expanding as one goes up.

If one runs out of air one should immediately head for the surface. That is where there is certainty of getting another breath and perhaps of being rescued. Too many people have died after failed air sharing. I have no faith in the ability of every diver to breathe out at the correct rate while attempting a controlled swimming ascent, free ascent, buoyant ascent or any other sort of ascent without the regulator in the mouth.

Stress, if nothing else, is likely to mar the performance. There is also the risk that the effort of swimming will use up the diver's oxygen reserve and cause unconsciousness from hypoxia.[8] This of course leads to a drowning death. There is a better way of coping with emergency out of air ascents. The **continuous breathing cycle ascent protocol** was published in the SPUMS Journal in 1978[9] with follow up articles in 1982[10] and 1984.[8]

The introduction of this protocol led to a large reduction in out-of-air accidents leading to death or requiring treatment at the Hyperbaric Unit at Tobermory in Canada. Between 1974 and 1982 there were 37 serious diving accidents in the Tobermory area of which 15 died, 12 without ever reaching the surface. By September 1984 there were so few diving accidents requiring treatment that the chamber was virtually unused.[8]

The **continuous breathing cycle ascent protocol** is

1 Do not remove the regulator from your mouth unless you have another to replace it with, or in cases of entanglement. The regulator provides a safety valve and a possible source of air.

2 Continue to attempt to breathe in and out at all times even if out of air or without your regulator. This ensures an open glottis and larynx and minimizes the chance of small airway closure.

3 Make certain you become positively buoyant by inflating your buoyancy compensator or dropping the weight belt or both. This guarantees that you will reach the surface despite hypoxia.

In other words keep the regulator in the mouth and try to breathe in and out all the way up. Attempting to breathe in and out will keep the larynx from closing and so decreases the chances of bursting a lung. As one rises in the water the pressure in the cylinder will eventually exceed the ambient pressure and let one take another breath. If you really want to make it to the surface you should blow the expense and drop your weight belt as soon as you run out of air. The cost of replacing your weight belt will probably encourage you to watch your contents gauge more closely on your next dive.

Where is diving safety going?

There is no doubt that the standard of instruction has risen but I have some doubts whether it has risen far enough. Diving instruction organizations in Australia now qualify people as Open Water Divers according to AS 4005.1-1992.[1] Unfortunately they need not have done a boat dive, they need not have dived anywhere except in sheltered water and they do not have to be able to work out all the questions on decompression table problems correctly. They are said to be trained properly in buoyancy control but looking around when I have gone diving, this is not always being achieved. The Australian recreational diver standard does not say the diver is trained to dive anywhere, as did the old C-card. He or she is trained to dive in the area in which he has been trained and needs further training before being safe to dive elsewhere.

Unfortunately I suspect that this extra training is not likely to occur for two reasons. One is that it represents an extra cost and the other is that divers like to think that after their training they can dive safely anywhere. I have been consulted by a number of people who were trained in Queensland, without a thick wetsuit, who dived in Victoria with a thick wetsuit, and got into trouble with their buoyancy, their ascent rate and decompression illnesses.

I know the economic incentives for short courses to teach people to dive. However, I think that many of the people who are trained these days, are not receiving a fair deal. They are being turned out as not "quite safe" and not "quite unsafe" divers. They need more supervision and practice in doing the things that are the more difficult to do, like buoyancy control, floating at a level and ascending slowly. We have got to teach people that they have to look at their contents gauges more often than they do and to look at their depth gauges and their timer as well as to do all the other things they are taught.

Where should diving safety go ?

I hope the standard of training will continue to rise. I am sure that the length of time underwater should be increased considerably before a person is certified as capable. It really seems to me that when somebody can become an "Advanced Diver" by doing two courses which total about 14 or 15 dives, the word advanced is being used very loosely. Experience based on a proper grounding in essentials is the only way that somebody can develop into an advanced diver. Glen Egstrom said it took up to 21 tries at buddy breathing for his students to do it properly every time and that they required reinforcement every six months or they became incompetent.[11] This suggests that every time a diver has a six months lay off from diving the first dive should be in sheltered or easy diving conditions so that he or she can re-establish the self confidence, properly based on competence, which enables one to be safe underwater.

One still sees people who have bought a new piece of equipment who, quite obviously, cannot use it. It is usually a buoyancy compensator. They cannot use it properly, they are not comfortable with it because the buttons for inflation and deflation are different from their last one. It takes time to adapt to new equipment. Just being shown, in the shop, how it works without it being attached to the tank, is hardly a proper instruction in how to use a new and complicated piece of equipment.

My 1977 decision, as the Secretary of SPUMS, to insist that all those diving with SPUMS must have buoyancy compensators was greeted, in some quarters, with dismay. In those days some people still considered that one did not need to compensate for wet suit compression, or abdominal compression, decreasing ones volume and making one relatively heavier. In 1977 we were lucky that nobody burst a lung when they activated their buoyancy compensators, because at least three people came rapidly to the surface in a flurry of foam. This happened because they had not been taught how to use their new buoyancy compensators.

The rise in the standard of instruction does not seem to have made any difference to the number of people who do not understand how to use their decompression tables. It is sometimes advanced in favour of diving computers that they are simpler to understand than the tables as they tell you what to do, so that the diver does not have to understand anything

about decompression theory. This may be a practical solution when computers no longer allow unsafe repetitive dives but it is a "cook book" solution, liable to go wrong with the present generation of diving computers.

Some years ago one of the diving instruction organizations wrote to SPUMS asking for advice on what we thought was important in the final exam before qualifying people as divers. The Committee felt very strongly that the trainee should be able to pass a test on using the tables without making a mistake. As far as I know this advice has not been implemented.

Those are the things that will have to be addressed in the future of diving safety. The training agencies have the responsibility to make sure that every diver can control buoyancy properly, knows the hazards of depth (nitrogen narcosis, cold, increased use of air, increased risk of decompression illness) and sea state, can always calculate decompression requirements accurately, is determined never to run out of air underwater and knows how to reach the surface even if unconscious. This involves dropping the weight belt and inflating the buoyancy compensator. Knowing all these things does not detract from ones enjoyment of a dive.

It is lucky that human beings are tough and our bodies can stand a great deal of ill treatment. Otherwise there would many more diving accidents with serious consequences than there are at present. But we should not rely on this to reduce diving accidents.

What is needed is the attitude that diving safety is the diver's responsibility and this requires education in depth and a serious attitude to safety. Both Brett Gilliam's report[12] and Bob Halstead's survey[13] show that depth limitations are ignored safely by many experienced divers. The reason is probably that they are careful to dive safely and avoid making mistakes. Perhaps they are properly prepared for every eventuality or perhaps they know how to keep out of trouble and when to abort a dive. Perhaps they even know, as should every diver, what to do if they do get into trouble and how to contact assistance. Australia has a good recovery system for the Barrier Reef, but it is only as strong as the weakest link, which is usually a human.

Diving safety depends on having fit, well trained, thoughful, competent divers using well maintained equipment who are sensible enough not to do anything stupid or foolhardy.

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This paper presents the views of Dr John Knight which are not necessarily those of SPUMS.

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DIVER RESCUE AND RETRIEVAL IN NORTH QUEENSLAND

Geoff Gordon

The presence of generally fine weather and warm sea temperatures makes diving in the tropics very attractive and further conspires to increase both the number of dives per day, and the length of each dive. Most of this diving takes place in areas remote from tertiary medical facilities. As dive numbers increase so does the incidence of significant decompression illness (DCI). There is thus the need for a co-