

compression sickness does occur in diabetics it tends to be worse than in non-diabetics. The problem of decompression sickness in people who are using insulin is a very real one. Also there can be problems with exercise, from blood sugar level changes and changes in consciousness.

We do not allow people taking antiepileptics to dive because epilepsy can break through what is successful drug management on the surface when underwater, because of the increased partial pressure of oxygen from breathing compressed air at depth and the risk of an increase in arterial carbon dioxide, which often occurs when using scuba gear.

We as diving doctors should be on our guard when asked to see prospective divers who are on any of this range of quite legitimate genuine medication. In very many instances it is probable that they are really not suitable for diving and we should therefore recommend that they do not dive. One can say to them that if they ever consider diving and they went off diving against advice they would be a great liability not only to themselves, but to their diving companions. It is for this reason that we must strongly advise these people not to dive, or they may very soon find that the sun would set quite quickly on their existence.

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Dr Ian P. Unsworth is the Director of Diving and Hyperbaric Medicine at the Prince Henry Hospital, Little Bay, New South Wales 2036, Australia.

REASONABLE ASSUMPTIONS AND GOOD INTENTIONS MAY PROVE FATAL

Douglas Walker

The essentials of this tragedy appear simple, visitors from interstate make a deep dive together and one drowns. The investigation shows that the victim was overweighted and both were very inexperienced though trained and having an advanced diver certification. They had entered a low-air state after a failed search for the anchor and decided to make an open water ascent. The buddy was started to ascend a little ahead of the victim, a routine they had apparently developed on their (few) previous dives (i.e.. during training). Separation occurred when or before the buddy became critically low on air, inflated his buoyancy vest, then ascended rapidly the remaining distance to the surface. The

victim was later found on the sea bed, weight belt on, remaining tank air insufficient to inflate his vest.

Closer examination of the genesis of the case shows a complex interplay of misunderstandings and minor lapses which bypassed the normal safety checks designed to prevent what in fact occurred, two inexperienced divers buddied together for a dive far deeper than one at least had ever previously made.

The string of circumstances began when the two divers found they were to visit another city on business at the same time and decided to arrange to have a dive while there. Their training had been recently completed, apparently from the same dive shop, and they were friends. As both were intelligent men they had impressed their instructor and had managed to take an initial Open Water course which they immediately followed by an Advanced Diver course. Although the rules were probably "bent" somewhat the result was that three weeks from their first instruction in scuba they held certificates which informed both them and others that they were Advanced divers. It is unfortunate that they clearly believed this. They had a total of nine dives logged at this time, all made as pupils, to depths of either 20 or 40 feet except for a single short dive to 80 feet depth. It is probable that the buddy later made an additional dive because they talked later about a wreck dive, talk which lulled others into accepting their apparent status as people who had made 120 feet dives. The dive to be related took place six weeks from their introduction to diving.

In response to their request for a diving contact their instructor phoned one of the dive store's suppliers who lived in the city they were to visit. He correctly stated that they had been good pupils and held Advanced Diver certification, no mention being made of their actual diving experience. Later a phone contact was made with the instructor's acquaintance by one of the divers in order to arrange where they were to meet him and where to hire some scuba equipment. There was some discussion of possible diving locations, without mention of their inexperience surfacing from the conversation. Although this contact, an experienced diver made payment for the boat hire, when the two divers attended at the dive shop they were charged not only for the diving equipment which they were hiring but also for the proposed dive, and the charge was that for a deep dive. Although a check was made to confirm that they held certification of training there was no questioning of their having sufficient experience to make the proposed deep dive. Later the dive shop owner stated that the charge was made in error but this does not alter the facts as here recorded.

The two visitors were surprised when they found there were three other divers coming for the dive, diver friends who their contact knew would also appreciate the opportunity this boat hire presented of making a wreck dive. The chatter while waiting for the arrival of the boat, and while its driver gave details of the wreck, appeared to confirm that they made wreck dives and were experienced divers. Nobody thought to question them on their experi-

ence, their evident self confidence was so well matched to their management of their diving equipment that no suspicions arose. The boat driver, a licensed coxswain, was not a dive master nor employed as such, although he was a diver and had first aid training, so he had brought no diving equipment for himself though there was a spare air cylinder to place on the line at the decompression stop and an oxygen cylinder for use if a diving emergency situation arose.

The wreck lay somewhat scattered over the sea bottom, at a depth of about 43 m (140 fsw) and the anchor was set in this area. As one of the other divers expected to have ear trouble with equalisation it was decided that he and his buddy should dive second so that should his fears come true his buddy need not miss the dive but could join the last pair, the victim and his buddy. As it turned out, he had no difficulty and the last pair descended as intended together. They each found they had some difficulty with equalisation but reached the sea bed, one of the other divers witnessing their arrival at the anchor. He later reported that one of them seemed to be overweighted and swimming rather more vertically than horizontally as evidence of this but the victim's buddy reported they had no problems. It is not known whether either used his buoyancy vest as an aid to correcting any such problem.

When their planned no-decompression dive time expired they expected to ascend the anchor line but could not find it despite the reportedly good visibility. Soon both saw that their contents gauges indicated they were becoming low on air so they agreed with each other to make an open-water ascent. As on previous occasions, during their training, the buddy started to ascend a little ahead of his friend but believed he was close below him because bubbles were rising past him. After he had ascended to about 18 m (60 feet) depth the buddy realised that he was nearly out of air so he inflated his buoyancy vest, which had the effect of taking him rapidly to the surface. There he was able to signal to the dive boat that he was safe, then managed to swim to it. He was helped aboard and immediately laid head down and given oxygen as he seemed distressed and had come up rapidly and without decompression stops. The victim failed to surface and it was realised that he must be dead.

The coxswain was in the difficult situation of having responsibility for an ill diver and another diver was missing and certainly drowned. He correctly sent a radio notification of the incident and concentrated on giving treatment. Because he was not employed to shepherd the dive party the aid he was able to provide was fortuitous. Another dive boat was sent to offer assistance and he then borrowed scuba equipment from it and dived with one of the experienced divers it was carrying. By now an hour had passed. They found the victim lying on the sea bed in the wreck area. His buoyancy vest contained only a little air so they tried to inflate but obtained no response when they used the power inflator, apparently because the tank pressure was too low for the task. They then made an attempt to orally inflate the vest but failed so they ditched the weight belt and the body began to float upwards. For reasons of safety they allowed it to

ascend unaccompanied and they then made a slow ascent with decompression stops. It was their impression that the victim was wearing excessive weight and they noted that they had more air remaining at the end of their longer and more strenuous dive than the victim (who had 30 bar remaining), both indicators of inexperience.

When the equipment was tested a recompression chamber was used rather than the conventional open water diving test. It was noted that the buoyancy vest inflated in 10 seconds at the surface but took 45 seconds at 43 m depth. The failure of the vest to inflate when the divers who located the body used the power inflator may have been rather the result of the low rate of filling deceiving them into a belief that nothing was happening rather than a result of the low air pressure in the scuba tank. An initial suggestion that the slow inflation was a sign of vest fault was discounted and described as being what should be expected for this depth. Once again, low air and the failure to ditch the weight belt were a fatal combination for a diver separated from his buddy.

It is of interest to note why the equipment was tested in a recompression chamber rather than the sea as was routine on previous occasions when the police diving section had tested diving equipment. The reason was that police divers are bound now by the same regulations as govern commercial divers, these limiting depth for the use of scuba to less than 43 metres, a limit on depth not applying to recreational divers though most of them have sufficient common sense to avoid deep dives unless their training and planning are tuned to the proposed dive. Had the police wished to test the buoyancy vest in the sea they would have had to use a surface supply diver with a tender, stand-by diver, and recompression chamber ready at the surface. This is reminiscent of the pre-scuba days of hard hat divers with standard gear where the expense of such topside support was a complete bar to non-commercial diving. However it needs to be remembered that recreational divers can avoid diving when the conditions are unpleasant, unfavourable or possibly unsafe, and for greater durations than would be safe using a scuba supply. Nonetheless the contrast in perceived safety requirements for dives to similar depths may seem noteworthy. The police divers having to spend a week preparing for a deep dive by making dives to increasing depths and having a dive group of five while the amateurs could legally (and usually safely) dive without any special pre-dive preparation or topside back-up party. However it was the lack of experience rather than lack of a stand-by diver and a line which proved fatal to this diver.

The pathologist reported finding signs of degeneration in the tissues but saw "no evidence of air embolism in the blood of the right ventricle". As the autopsy was conducted without undue delay and decomposition changes are not usually thought to require comment except when severe, he may have been seeing post death release of tissue gas, the expressed expectation of finding air in the right ventricle indicating a possible lack of understanding that in diving related air embolism the site of air entry is pulmonary

and not systemic, as occurs in cases following trauma or surgery. It is likely that death was from drowning when he found himself unable to ascent due to excess weights and his air supply became difficult to breathe.

Comments

This tragedy occurred as the final result of a series of sins of omission, each one individually minor and non fatal in nature. Nobody did anything terribly incorrect but neither did anyone remember Murphy's Law. Those involved were trained and intelligent and well intentioned but they failed to check that matters were as they appeared to be. The initial mistake was the issue of an Advanced Diver certification to divers of such limited experience, and a failure to convey to them their continued status as grossly inexperienced divers. It was this failure which made the tragedy possible.

Next came the communication breakdown, totally correct but incomplete information being provided with the request by their instructor to another person concerning their status as divers. Their possession of the correct documentary authority to confirm their "advanced" status led to an omission of what would have been an automatic, checking of their experience, had this been a dive shop organised boat dive. Their having an unjustified belief in their diving skills (as contrasted with their undoubted knowledge) led the others on the dive trip to forget to enquire concerning their diving abilities. All such factors were in place before the dive commenced.

Such was their confidence that the two divers brushed aside comments suggesting that they were overweighted for the proposed dive, forgetting their book-learning concerning depth related loss of wet suit buoyancy. Their confident management of their equipment and talk of wreck dives made easy the very natural decision of the other divers to take their usual dive partners rather than partner the visitors, the good visibility making this appear to be a safe and simple dive.

Failure to locate the anchor when the time for ascent drew near led them to expend precious air in their search for it, so they were close to a critical low-air state when making their decision to ascend. It was here that a fault which they had acquired during training produced their final joint error in that when they commenced their ascent the victim was below and therefore out of sight of his buddy. The final actions of the victim cannot be known but he may have found his air less readily available and his buoyancy vest apparently failing to fill when the inflation button was pushed, and forgotten there was the option of dropping his weight belt.

The final item in this catalogue of misunderstandings and procedural errors was the autopsy report, although this is more a matter of conjecture than established facts. Certainly a vigorous dive to 43 metres would result in enough air being dissolved in the tissues to require subsequent elimina-

tion of excess gas after returning to the surface. This can occur via the lungs in the living but occurs in the tissues where death has prevented the circulation from assisting this task.

Dr Douglas Walker's address is P.O.Box 120, Narabeen, New South Wales 2101, Australia

THE FLYING BENDS

A review of altitude decompression sickness with case reports, from hypobaric chamber operation at RAAF Base, Point Cook.

Marcus W. Skinner

Introduction

The Royal Australian Air Force (RAAF) Institute of Aviation Medicine has conducted hypobaric chamber training (Fig. 1) at the RAAF Base at Point Cook, Victoria, since 1962. All initial entry trainee aircrew (pilots, navigators, engineers and loadmasters) of the RAAF, Royal Australian Navy, Army and Air Traffic Control trainees undergo high altitude (hypobaric pressure) training. Experienced military pilots undergo refresher training at intervals of three years. The hypobaric chamber at Point Cook is also used for other members of the Australian Defence Force, overseas defence members and for civilians who require experience in the pressure changes of high altitude, including private pilots, glider pilots, balloonists and Nepal trekkers.

Air Force members who undergo very high altitude decompression to 13,500 m (45,000 ft) with predenitrogenation include RAAF pilots and RAAF medical officers. Members undergo hypobaric experience training to prepare them for a rapid decompression, simulating the loss of cabin pressure in a military aircraft at high altitude. The effects of hypoxia and pressure breathing are also experienced in the chamber.

For the inexperienced a rapid loss of cabin pressure when at high altitude can be a frightening experience as has been clearly demonstrated in recent civilian aircraft accidents. The sudden exposure to rapid lowering of pressure is usually accompanied by loud noise, rapid drop in ambient temperature and sudden appearance of fog, all combined with rapid gas expansion within body cavities, giving rise to typical rapid pressure change symptoms such as ear pain and discomfort, abdominal distension, belching and flatus.

This article presents a review of hypobaric decompression sickness and illustrates this with some case reports.