

ences in the numbers probably is explained by the greater dive detail in the ANZ cases.

It seems as if the buddy concept, if used at all, was mainly employed when it was not needed. More buddies voluntarily separated from the victim at the start of problems (usually when low on air) than actually stayed together.

Even when it is applied, the less experienced diver, or the one who will consume more air, is initially given the task of following the more experienced divers until he runs out of air and he is then sent to the surface to swim back alone! Or he is buddied with another low on air diver.

Traditionally, companion diving was recommended and the need was self evident because of the recognition that diving was a hazardous activity. As diving is now promoted as being a safe sport, perhaps the need for companion diving is less appreciated. For uneventful dives this attitude may be adequate. For others it is not.

The observations in both the NUADC and ANZ fatality series for the 1980s, should emphasise the need for buddy diving, in which the divers do genuinely take responsibility for each other for the whole time, until they return to shore or safety. It needs to be taught, understood and practiced.

Conclusion

The real tragedy of this survey was that it shows that the lessons and teachings of yesterday, are still not sufficiently appreciated today. The requirement for a high standards of physical fitness as well as a freedom from many medical diseases, together with training in accident prevention and management, an appreciation of the limitations of equipment and a healthy respect for a potentially hazardous environment, are as important for safe diving now as they ever were.

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PROVISIONAL REPORT ON DIVING-RELATED FATALITIES AUSTRALIA 1987

Douglas Walker

Summary

There were four breath-hold and four scuba diving deaths identified as having occurred in Australian waters during 1987. A common finding in all was that the victim was either diving alone or was separated from others at the critical time, though this was not a invariably a factor which determined the course or outcome. Three of the breath-hold

fatalities involved overseas visitors to the Great Barrier Reef, a statistical quirk of no relevance to the critical factors but of possible importance for other reasons. If it was not that these deaths occurred in association with outings on which people were invited to snorkel dive they might have been regarded as simple misadventure drownings and not included in the present review. However the circumstances of these accidents show how difficult it can be to watch over a group of swimmers who are not firmly under the control of a supervisor. The fourth fatality in this group was unfortunately typical of competition spearfishing breath-hold divers, a post-hyperventilation blackout which was followed by the drowning of the unobserved diver.

The four scuba diving fatalities resulted from four very dissimilar circumstances and each case had some singularity which differentiates them from the general run of scuba diver deaths. There was a shark attack, (the first shark caused scuba diving death recorded in Australian waters), an apparent acute myocarditis death, a gross pulmonary barotrauma (which the pathologist called decompression sickness), and a sea cave death which was probably as the result of water surge which arrived unexpectedly causing the victim temporary but fatal problems.

Case Reports

BH 87/1

The victim was apparently healthy and had decided not to go to view the reef from a glass bottomed boat as he wished to go for a quiet snorkel to view the reef, here close to the beach. His wife was on the beach watching him until he called to her that he had seen a fish he wished to photograph and asked that she go and fetch his camera from their room. When she returned she could see him floating quietly face down a little off the beach, his failure to respond to her return being ascribed to him having become very interested in watching the reef below. It was only after the wake from the returning boat washed over him without him responding in any way that the first suspicion arose that something was wrong, a suspicion which led the boatman to return after disembarking most of his passengers. The victim was unconscious and did not respond to resuscitation efforts. His wife was unaware of anything out of the ordinary until the boat returned to her husband.

The autopsy revealed that he had an enlarged heart, which was mainly left ventricular hypertrophy, and the coronary arteries showed gross atheroma and calcification. Some myocardial fibrosis was noted in the postero-septal area. His wife did not report him as being unfit or on treatment and noticed nothing to indicate he was unwell that day.

SOLO. SEVERE SYMPTOMLESS CORONARY ARTERY DISEASE. CALM WATER. NO INQUEST.

BH 87/2

During the trip out to view the Barrier Reef there was an opportunity for passengers to attend a talk on the correct manner to snorkel dive at their destination, a pontoon moored over one of the reefs. Attendance was optional, the presence of a bar on board being an alternative way to spend the time. The victim was noted as not attending the talk. On arrival at their destination a meal was provided and the victim requested, obtained, and consumed, twice as much or more than most others. He had snorkelled for a time before this meal and returned to the water after eating his fill. There was a person keeping watch over the area close to the dive platform, the same person who had given the safety talk, and passengers who were uncertain of their swimming abilities were offered buoyancy vests to provide them with confidence and safety. It is unknown whether the talk included instructions that swimmers and snorkellers remain in the supervised area but it is unlikely any such a restriction was made as the water conditions were good. The victim was noticed by chance by another crew member, face down at the surface around the side of the pontoon out of sight of the safety man. Both these men entered the water and swam to the victim immediately he was seen. His mask, which contained some blood and vomit, was removed and two quick breaths of EAR were given before taking him to the pontoon to start resuscitation efforts and call the emergency service helicopter.

The autopsy showed hyperaemia of the bronchial mucosa but no vomit was observed. Death from drowning was diagnosed, with the assumption that his large meal played a part in this incident. He may have been experiencing abdominal discomfort then felt that he was about to vomit, inhaled some water, and drowned. There was some coronary atheroma but this was not thought to be of significance.

SEPARATION/SOLO. SNORKEL EXPERIENCE NOT STATED. EXCESS DRINK AND FOOD THEN SNORKEL SWIM. CALM SURFACE. SILENT DEATH. FOUND FLOATING. NO INQUEST.

BH 87/3

This group of overseas visitors were making a day trip to the Barrier Reef and were taken out to a pontoon moored there. It was suggested they could swim with snorkels off the pontoon, there being a supervised area for this purpose, with luncheon and a trip in a glass bottomed boat to follow. The victim asked one of those with her in the group to watch her belongings while she snorkeled and this was agreed. Although she was not seen to enter the water or with either mask or snorkel it is assumed that she had done as she had stated because a search of the boat and the pontoon later failed to find her, this search resulting when her failure to come to reclaim her belongings after half an hour began

PROVISIONAL REPORT AUSTRALIAN DIVING-RELATED FATALITIES 1987

CASE	AGE	TRAINED/EXPERIENCED VICTIM	BUDDY	DIVE GROUP	DIVE BASE	DIVE PURPOSE	WATER DEPTH M (FEET)	INCIDENT DEPTH M (FEET)
BH/1	74	Not stated	Not applicable	Solo	Beach	Recreation	Not Stated	Surface
BH/2	48	Inexperienced	Not applicable	Crowd	Boat Solo	Recreation	Not Stated	Surface?
BH/3	57	Not stated	Not applicable	Crowd Solo	Boat	Recreation	Not Stated	Surface?
BH/4	25	Trained Experienced	Experienced	Group Solo	Boat	Spear-fishing Competition	15 (50)	Not Stated
SC/1	34	Trained Inexperienced	Trained Some Experience	Trio Separation Pair	Boat	Recreation	9 (30)	Surface?
SC/2	47	Trained Inexperienced	Trained Inexperienced	Four Separation	Boat	Recreation	21 (70)	Ascending
SC/3	47	Trained Experienced	Not applicable	Solo	Boat	Scallops	13 (43)	Not Stated
SC/4	31	Trained Experienced	Trained	Group Separation	Boat	Recreation	33 (100)	33 (100)

to worry and annoy the person in whose custody they were. The body was never found.

SOLO SWIMMER CALM WATER. POSSIBLY HAD SNORKEL. NO FINS. NOT NOTICED IN GROUP OF SWIMMERS. SILENT DEATH. BODY NEVER RECOVERED. NO INQUEST.

BH 87/4

During an inter-club spearfishing competition the members of one club's team were in two boats anchored about 50 m apart as the divers hunted separately. All appeared to be normal until the comment was made by a child that one of the orange surface marker buoys had not moved for a long time. Until then it had been taken by the divers to be an unused one floating free. The float was now recognised as belonging to the victim. When its line was drawn up the victim's loaded speargun was still attached. After the divers had searched for about 10 minutes they

found him on the sea floor in 50 feet deep water and brought him to the surface and attempts were made to resuscitate him but there was no response. About one hour had passed since he had last been seen at the surface.

Although death was due to drowning it was found there had been a small subarachnoid haemorrhage and it was thought this was the reason why this very experienced spearfisherman drowned. There was no history of ill health. Naturally the possibility has to be considered that this was a post-hyperventilation diving situation in which the subarachnoid leak was an additional adverse factor.

SEPARATION/SOLO. SPEARFISHING COMPETITION. VERY EXPERIENCED. ABSENCE NOT NOTICED TILL CHILD'S COMMENT. SURFACE MARKER BUOY WITH LINE TO SPEARGUN NOT DIVER. NO SURFACE COVER. NO BUOYANCY VEST. WEIGHT BELT NOT DITCHED. SUBARACHNOID HAEMORRHAGE THEN DROWNED. NO INQUEST.

PROVISIONAL REPORT AUSTRALIAN DIVING-RELATED FATALITIES 1987

BELT ON?	WEIGHT	CONTENTS GAUGE	VEST	REMAINING AIR	EQUIPMENT CHECK	EQUIPMENT OWNER	WET SUIT	SIGNIFICANT FACTORS
No	Not Applicable	Not Applicable	No	Not Applicable	Not Applicable	Own	No	Heart attack. Calm sea.
No	Not Applicable	Not Applicable	No	Not Applicable	Not Applicable	Not Stated	No	Excess food and drink before swim. Day trip to reef
No	Not Applicable	Not Applicable	No	Not Applicable	Not Applicable	Own?	No	Day trip to reef. Solo swim. Body never recovered.
Yes	Not Stated	Not Applicable	No	Not Applicable	Not Applicable	Own	Yes	Spearfishing competition. Subarachnoid haemorrhage. Post hyperventilation, blackout? Drowned.
On	Not Stated	Yes	Inflation by buddy	Low/nil	Satisfactory	Own	Yes	Failed to follow diveplan. Unrecognised pre-dive illness. Myocarditis.
On	Not Stated Inflated	Yes	Not	Nil	Satisfactory	Own	Yes	Open-heart surgery as child. Solo out-of-air ascent. Then sank. Post mortem. Haemothorax. Torn lung.
On	Not Stated	Yes	Not Inflated	Not Stated	Satisfactory	Own	Yes	Shark attack. Body never recovered.
On	Not Stated	Yes	Partly Inflated	Low	Satisfactory	Own	Yes	Sea cave. Water surge. Separation. Found drowned. No head injury.

SC 87/1

The dive shop owner, an instructor, agreed that he would be willing to take two brothers out in his boat to scuba dive in the afternoon because they wished to spearfish in the morning when he was taking other divers out. The instructor decided that he would join them, making a trio of divers, and after reaching their chosen dive site, a rocky islet, he outlined the dive plan he proposed for them to follow. However when they were still only about 20 metres from the anchor they heard it bumping over the rocky sea bed. The dive leader, the instructor, indicated to them to remain where they were while he returned to reposition the anchor but on his return they were not there. He made a quick search underwater and of the surface, then repeated this without success despite swimming along the length of the proposed dive. Realising that to make a surface search using the dive boat might result in problems if the divers returned during his absence and panicked on finding no boat there so he resolved to remain in the boat till they returned.

After about 1 hour had passed he was starting to consider what action he should now take, then saw coming round the northern tip of the islet what looked like two divers so he drove the dive boat there to pick them up. He found the objects were the ditched backpacks, then observed one of the missing divers signalling from the rocks. He learned that the other diver had become unconscious and had been pulled up onto the rocks. As it was not possible for the boat to come safely into the rocks and take the victim aboard he made a rapid return to land to obtain assistance, then returned to the islet and swam ashore with a rope. Resuscitation (EAR) had been started by the victim's buddy and was continued during their return journey, but without success. The instructor was criticised later for his failure to radio for assistance and in rebuttal was able to show that his action resulted in the most rapid rescue of the victim and any of the emergency services would have taken far longer to reach the islet and recover the victim. Suggestions on incident management made by persons who were not present often show a lack of appreciation of the problem and a tendency to believe that by-the-book must be the only correct response.

The victim's buddy described how they had continued their dive around the islet until aware that their air was down to 50%, at which time he had surfaced to check their position. As the boat was not in sight he descended to rejoin his companion. He decided to continue swimming in the same direction around the rocky islet rather than retracing their course. He offered no reason why they had not waited the return of the instructor, their dive leader, nor why they failed to follow the agreed dive plan, which was that the divers would remain south of the islet. They continued underwater until the victim became low on air, the buddy then sharing his air with him using his octopus regulator. The victim had been quite unaware that they were out of sight of the boat until he surfaced and seemed to panic when he realised this fact and failed to obey a suggestion to inflate his buoyancy vest and appeared to be both slow and inefficient in starting to use his snorkel, inhaling some water. The buddy inflated his vest, calmed him down, and got him to resume use of his regulator as his tank still contained some air. The buddy started to tow him, hopeful of rounding the northern tip of the islet and seeing the boat, but had to hurriedly change this plan when the victim became unconscious and the regulator dropped from his mouth.

Faced with this crisis the buddy decided it was essential to get the victim out of the water and attempt EAR resuscitation. He ditched both his and the victim's backpack and weight belt (he realised their wet suits gave buoyancy) and it was these floating backpacks which were seen by the dive leader. This made him more agile, better able to get the victim up onto the rocks despite the one metre swell breaking on the islet. He managed to avoid the waves washing him back into the sea and commenced EAR resuscitation. It should be noted that he was forced to sacrifice the buoyancy vest at the same time as the tank as they were a single backpack unit.

The heroic efforts made by the buddy were unsuccessful as there was a factor he could not control. He had noticed when they had been snorkelling that morning that his companion became tired when they had been swimming for only 5 minutes and had assumed this to be an effect of the victim's obesity and general poor fitness, but the pathologist found changes in his heart which showed him to be suffering from myocarditis and this would have caused him to have a greatly reduced exercise tolerance. A viral cause was believed to be probable. The stress situation after surfacing had resulted in his suffering an acute cardiac failure.

SEPARATION OF TRIO GROUP AFTER ONE LEFT TO SECURE THE ANCHOR. FAILED TO FOLLOW AGREED DIVE PLAN. FAILED TO RECOGNISE EXTENT OF ATTEMPTED DIVE. CONTINUED SWIMMING AWAY FROM DIVEBOAT WHEN ONLY 50% AIR REMAINING. VALUE OF OCTOPUS REGULATOR. TANK ABLE TO PROVIDE AIR AFTER SURFACING. VALIANT BUDDY RESPONSE. DITCHED WEIGHT BELTS AND BACKPACKS SO ALSO UN-

AVOIDABLY DITCHED INFLATED BUOYANCY VESTS. WATER POWER PROBLEMS EXITING ONTO ROCKS. ACUTE MYOCARDITIS. ACUTE CARDIAC FAILURE.

SC 87/2

Although the four members of this family had successfully completed a scuba diving course about seven months before, and had dived during a one week holiday following this, the victim had not dived again since then while the others may have made a boat dive so obtained a little more experience. The dive boat was owned and run by the dive shop where they had been trained and there was on board in addition to this family group and the boat man, one other diver, but he dived solo and was not involved in the incident. The four divers were admittedly a little apprehensive and made errors during their kitting up for the dive. One of the children had ear equalisation problems and the victim had to borrow two additional weights, which were placed in the pocket of his buoyancy vest with the desired effect of reducing his buoyancy. Eventually they were all successful in reaching the sea bed, 20 metres depth.

After about 20 minutes the victim's wife saw she was down to 50 atms on her contents gauge, though the others still had twice that amount, and indicated that she was going to ascend and the others should remain till they had used up more air. After surfacing she sat in the boat talking to the boat man until the sudden surfacing of one of her children who cried out that her father was in trouble. The victim floated to the surface before any serious search could be organised. There was no response to resuscitation attempts.

Nobody was attempting to practice buddy diving procedures so when his wife ascended she assumed that he was remaining below and the two others assumed he would surface with her. When he was next seen he was slowly descending, making no attempt to clear his ears (which fact drew the attention of one of his children to the strangeness of the situation) but was seeming to be attempting to swim towards the surface. One of them took the two weights out of his buoyancy vest pocket, and when he still failed to ascent tried to ditch his weight belt but he then held onto the belt so firmly that it could not be removed. His eyes were starting, his face was blue, and his contents gauge was seen to read EMPTY. Very naturally they panicked and surfaced to seek help. The body floated up when he lost consciousness and the weight belt dropped from his hands. They were unable to inflate his vest because it was supplied from his tank, which was empty.

The most singular fact in this tragedy, beyond the act of the survivors seeking to blame the dive shop for allowing them to dive at this location (they were all trained, intelligent, and knew the rules for safe diving), was the autopsy. This was conducted by a forensic pathologist who carefully

followed the advised methods for a diving-related death but who evidently had no understanding of "diving pathology" and lacked awareness of the disasters which await an expert witness in court when subject to a rigorous cross examination and is found to have missed obvious findings. In this case the right pleural cavity was found to be obliterated by very dense fibrous adhesions, there was emphysema of the parietal pericardium with adhesions joining the parietal to visceral surfaces, a left sided haemothorax of about 1 litre, and a laceration (6 cm) in the base of the left lung. This was diagnosed as decompression sickness, hardly an intelligent finding.

The victim had been medically examined and also completed a medical history form before being accepted for training. He had failed to mention that 35 years previously he had been one of the first to have an operation to repair a "hole in the heart" and it is remarkable that the operation scars on his chest were noted by neither the doctor nor the pathologist. There is no evidence that he had ever had a chest X-ray taken. It is possible that this was not a medical history which should have precluded scuba diving. A point to note is that it was the left lung which tore and not the right (which was protected by the adhesions?). It is probable the lethal damage occurred as he was making a solo low air/out-of-air ascent. As he had a contents gauge there was no necessity for him to find himself in an out-of-air situation. A torn lung is a very unusual finding and there is nothing to suggest that air embolism occurred, death being the result of internal haemorrhage and shock with drowning as final factor. No inquest was thought necessary.

TRAINED. INEXPERIENCED. GROUP FOUR. ONE SOLO ASCENT THEN VICTIM SOLO ASCENT OUT-OF-AIR. HAD CONTENTS GAUGE. BUOYANCY VEST INOPERATIVE AS TANK EMPTY. REFUSED TO RELEASE GRIP ON WEIGHT BELT UNTIL UNCONSCIOUS. CHILDHOOD HEART OPERATION. LEFT HAEMOTHORAX AND LACERATION LUNG BASE. HIGHLY INACCURATE PATHOLOGY DIAGNOSIS. NO INQUEST.

SC 87/3

The victim was a careful and experienced diver who on this occasion was alone, diving for scallops from his anchored boat at a scallop bed often visited by local divers. At first his failure to return home at the expected time was thought to indicate that, due to tide or weather conditions, he had avoided such problems by returning to another harbour, but a check showed that this was not the case. When his radio was found to be unanswered a friend went out in his boat to investigate. The victim's boat was located but was empty. Searchers found a bag of scallops, the backpack with a damaged buoyancy vest, and a weight belt, but no trace of the body. The damage was consistent with that a shark would

cause. Later it was reported that a fisherman some distance away had witnessed agitation of the surface at the probable time of the shark attack and possibly saw the fin of a shark.

SOLO EXPERIENCED SCUBA DIVER. SHARK ATTACK. BODY NEVER RECOVERED.

SC 87/4

The dive was to be at a rock which had a cave entrance to a passage which passed through it. There were three divers in one of the boats, one of whom had dived through the passage on several previous occasions, and four in the second, two of whom had brought underwater cameras with them. One person remained in each boat as a safety precaution. The group met at the cave entrance, which was at 30 metres depth, and the experienced diver offered to lead them through the passage. Only one diver actually followed him through though they had expected the others to come after them. There was some surge apparent in the cave entrance and for fear of damaging his camera one of the divers quickly retired to open water, though as he was adjusting his buoyancy there the camera washed from between his knees and he never recovered it. The second camera-carrying diver evidently penetrated further into the cave and the returning pair of divers found his body there on their return, lying on the floor of the cave with his regulator out of his mouth. There is nothing noted concerning the actions of the other three divers.

They dragged him out of the cave and were there joined by the diver who had been trying to find his lost camera. He ditched the victim's weight belt and backpack (which were retrieved at a later time) and assisted them bring the victim to the surface and to one of the boats. Their resuscitation efforts were unavailing. The mask was in position when the victim was found but one of his fins and that bootie were missing. His buoyancy vest was noted to contain some air and his tank contained some air though it became empty before it was formally checked later by the police.

Although some abrasions were present on his nose and both hands there was no evidence of any head injury. It is possible he was tossed about by a surge of water, lost his grip on the demand-valve mouthpiece, and drowned. There was a piece bitten out of the rubber of the regulator's mouthpiece, damage which apparently took place during the incident. The damage made it difficult to retain a grip on the regulator.

GROUP. SEPARATION/SOLO. SEA CAVE. POSSIBLY LOST REGULATOR FROM MOUTH WHEN EFFECTED BY WATER SURGE. VALIANT RESCUE EFFORTS BY OTHERS IN DIVE GROUP. BITTEN MOUTHPIECE. NO INQUEST.

Discussion

It is fortunately possible to discuss the four fatalities which involved snorkel divers because the police investigated the incidents and the statements they obtained were retained when the respective coroners decided that no inquest was necessary. In two instances the victims were members of tourist groups making a day trip to view The Reef and the fatalities occurred despite attempts to supervise people when they were in the water. These deaths are a warning to those running such trips of the ease with which some serious incident can occur. There are public relations reasons in such cases for a formal public examination of the circumstances, a consideration not necessarily apparent to coroners concerned with reducing delays by concentrating on cases requiring more detailed investigation of the facts.

There was no way in which the unexpected cardiac death of the victim in the first case could have been prevented because no intimation of his cardiac condition was apparent even to his wife and his death can fairly be described as happening when he was in the water rather than because he was snorkelling. Nevertheless the incident is a warning that however careful the planning, emergency situations can arise "out of the blue", and this man could just as easily have been in the launch or snorkelling with the other members of his group as being alone when he was taken ill. In any discussion of the remaining fatality in this group, which took place during a spearfishing competition, there is always the presumption that any such death is a consequence of pre-dive hyperventilation followed by a determined pursuit of a fish. The finding of evidence that a subarachnoid haemorrhage had occurred does not prove this was the cause of death. Both factors may have combined to disable him and the fact of him being alone and unsupervised added to the adverse factors influencing the outcome.

There were four scuba diving fatalities, in three of which the victim was alone at the critical time, although in the case of the shark attack this cannot have effected the outcome. There may have been a chance for survival in the cave death as had the victim been located immediately following the (presumed) loss of his regulator, or damage to the rubber mouthpiece which made it unusable, he could have been assisted out of the cave, if necessary utilising the "octopus" second regulator of one of the group. The risk in any sea cave of being helplessly tossed about and hitting the rock walls should be recognised by all who venture into these places.

Fatality reports frequently make adverse reference to the separation of divers, or their solo diving, as a significant factor influencing the course of the incident. Similarly inexperience is noted. In the second case both factors were present. Although the victim was trained he lacked experience. He carried from his past a possibly forgotten additional adverse factor, the residual scars of an open chest operation on his heart. It is evident that there was no

inevitability of this scarring proving fatal as he managed the training diving without medical problems. Unfortunately there was, as events showed, a reduced safety margin when pulmonary over-pressure occurred during his ascent. Although an attempt was then made to assist him he was then suffering the effects of a serious lung tear and may also have had some cerebral arterial air emboli effecting his responses. The autopsy in this case was notable for failure to regard a torn lung and haemothorax as significant when reporting the cause of death.

In the first case there were breaches of the correct dive procedures but when the incident occurred the buddy showed he was fully competent in the management of a difficult situation he now faced. The instructor also showed an ability to respond in such a manner as seemed most appropriate in the situation rather than in the "text book" manner. Unfortunately, the medical condition which affected the victim was unsurvivable, but the buddy's response was one which would have saved him had this possibility existed. This death might have happened even had he not dived but his chances would have been improved if he had taken notice of the ill health which was apparent during his morning swim.

Acknowledgements

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PROJECT STICKYBEAK

The objective of this project is to collect reports on all types of diving-related misadventures which range from the fatal to those so well managed that there was no "incident" to report. Medial Confidentiality is at all times afforded such reports. This means that the reporting of asthma or diabetes, etc., will NOT result in the affected diver losing his or her diving certification. It is only through having accurate, adequate, and up-to-date information that diving can reach and maintain acceptable levels of safety. Reports are urgently required to enlarge the scope of the project.

Reports should be sent to:-

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