

ORIGINAL PAPERS

PROVISIONAL REPORT ON AUSTRALIAN DIVING-RELATED DEATHS IN 1998

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Key Words

Accidents, deaths.

Summary

The deaths of eight snorkel users, nine divers using scuba and one using rebreather apparatus were identified. Each tragedy was individual but inexperience and overconfidence in personal ability were critical in some cases. It is to be noted that inexperienced users of snorkels can drown silently, close to others in shallow calm water, even when wearing a life-jacket, which unfortunately floats them face down.

Snorkel users and breath-hold divers

BH 98/1

This was the first time the victim had spearfished here, though he had often dived at other locations with this friend. Access was difficult, down a steep rocky hillside to a ledge. The buddy entered the water first, but waited for him to follow before they separated because the victim liked to hunt fish further out from shore than his buddy. When the buddy judged it was time to return to land he could not see his friend so assumed that he had already left the water, which would have been his usual practice. The climb back up the hillside was steep so when he failed to see his friend waiting on the rocks for him he assumed he had baulked at the climb and made his way back over the rocky shore. However he became anxious when the victim failed to rejoin him and dusk was falling, so called the police. A search found his speargun and float that evening, with the spear missing. Next day the body was found floating at 10 m with the weight belt in position. The belt was noted to lack a quick-release buckle, its end being threaded through the weights. There was a history of two operations on his back and of asthma, but no details of the latter's management or severity were available. The pathologist found no evidence of any acute asthma or cardiac disease at autopsy. Post-hyperventilation blackout was considered the probable critical factor, though his left ear drum was noted to be perforated and it was suggested that this might have been associated with vertigo leading to drowning.

EXPERIENCED SPEARFISHERMAN. LOST SPEAR. UNABLE TO DITCH WEIGHT BELT AS NO QUICK RELEASE BUCKLE. PROBABLE POST-

HYPERVENTILATION BLACKOUT. PERFORATED LEFT EARDRUM. HISTORY OF 2 OPERATIONS ON HIS BACK AND ASTHMA.

BH 98/2

While visiting from the USA this woman and her husband joined a day trip to view the Great Barrier Reef. She had snorkelled on previous occasions but was nevertheless somewhat anxious, afraid to be out of her depth. She not only remained in the shallows, where she could stand up, but also accepted the offer of a life-jacket aid for buoyancy. Her husband left her for a short time and on his return, intending to take her to a more interesting area, was unable to see her. He assumed that she had decided to become more adventurous and had swum to another area.

One of the staff was returning from a viewing of the reef with a group of the passengers when a child told him about a person floating nearby who was not moving. The child's mother had not regarded this information as significant but he decided to check. He found the victim floating face down. Resuscitation efforts were unsuccessful and complicated by regurgitation of fluid. It is obviously extremely difficult for a safety watcher to identify a swimmer in a crowd who gives no signal of distress.

SOME SNORKEL EXPERIENCE. ANXIOUS SO STAYED IN SHALLOW WATER. WEARING LIFE-JACKET. CALM WATER. SILENT SURFACE DEATH. CLOSE-BY SWIMMERS AND SAFETY WATCHER UNAWARE OF ANY PROBLEM. FLOATED FACE DOWN. CORONARY ARTERIES HEALTHY. VOMIT COMPLICATED CPR.

BH 98/3

After a day spent on his job of netting for sharks at a sealion colony, this man decided to dive to collect some abalone to make a meal for himself and his deckhand. They had seen few sharks that day although the area was known to have white pointers. He entered the water and was only about 3 m from the shore where the depth was about 3 m, when he surfaced obviously aware that there was a shark near. Then he was lifted from the water as the shark hit him. In response to his cry for help his boat hand bravely waded into the water and managed to pull him up onto the rocks. The shark remained close but did not attack again. Death from blood loss occurred before help could arrive.

SNORKEL DIVING SOLO FROM SHORE FOR ABALONE. AREA KNOWN FOR SEALIONS AND SHARKS. SHARK ATTACK CLOSE TO ROCKS. VALIANT RESCUE BY FRIEND. FATAL BLOOD LOSS.

BH 98/4

This 68 year old man and his wife were overseas visitors on a day trip to an off-shore resort island. All in the group were given a short talk on snorkelling before they were allowed to swim from the beach. There was one crew member on the beach as a safety watch and another in a boat outside the swimming area. Both the victim and his wife were wearing life-jackets, a safety option offered to members of the group. They were in calm shallow water, depth about 1 m, and close to about 15 others when his wife noticed he was floating face down and motionless close to her. He failed to respond to CPR efforts. No cardiac disease was found at autopsy. It is not known whether he had ever used a snorkel before.

POSSIBLY FIRST USE OF SNORKEL. CALM SHALLOW WATER. WEARING LIFE-JACKET. FOUND FLOATING FACE DOWN. SILENT RAPID DEATH NEAR OTHERS. NO EVIDENCE CARDIOVASCULAR DISEASE.

BH 98/5

Although he had to use a walking stick since a myocardial infarct (MI), this man was determined to snorkel to view the Barrier Reef. He joined a day trip to the reef. Those intending to snorkel were given a talk before wet suits etc. were issued. He mentioned that he had snorkelled some 20 years previously, but supposed equipment had changed since then. Water entry, using a ladder on each side of the boat, was supervised. He was the 12th and last into the water on his side of the boat. As he appeared to be apprehensive about putting his face underwater, the skipper suggested to a crew member that he should be given a life-jacket to wear, however this was not done. He was seen a short time later, by one of the passengers, swimming in a normal manner close to this ladder. It is uncertain whether he was wearing his mask and snorkel at that time. About 6 minutes later the skipper saw him floating face down close to the boat and failing to respond when the tip of his snorkel dipped below the surface. He was rapidly brought back aboard the boat but could not be revived. Autopsy showed there was significant coronary atherosclerosis and myocardial ventricular apical fibrosis from his previous MI so his death was ascribed to acute myocardial failure.

SNORKELLING. SOLO NEAR OTHERS. NO RECENT EXPERIENCE. APPEARED APPREHENSIVE. SILENT RAPID SURFACE DEATH. FOUND FLOATING FACE DOWN. DISABILITY FROM PREVIOUS MYOCARDIAL INFARCT. CARDIAC DEATH.

BH 98/6

Aware that his wife did not approve of his lack of fear of the sea and his habit of swimming outside flagged areas, he took care to avoid letting her know before he went fishing, swimming, or snorkelling. On this occasion he had

said he was going to some shops and might then go to the beach. Before he entered the water he asked a scuba diver who was coming ashore to mind his car keys, stating he would only be away for about 10 minutes. It was 40 minutes later when the diver noticed the passage of time, then saw a lifesaver on the beach giving CPR and realised the victim was the one whose keys he held. The lifesaver had been alerted by an anonymous phone caller and then seen the victim floating face down, mask displaced down around his neck, obviously dead. He was floating in rough water off rocks at the end of the beach. The significance of the high blood level of methamphetamine was not discussed. The reason he drowned is uncertain as no head injury or other disabling factor was identified.

SNORKELLING SOLO. ROUGH WATER NEAR ROCKS. HABIT OF UNSAFE SWIMMING CHOICES. FOUND FLOATING. TOXIC BLOOD LEVEL METHAMPHETAMINE.

BH 98/7

After he arrived at a resort island with his 2 children, this man hired a wet suit for himself and his son. He stated he had some snorkelling experience and was in good health. After booking for them both to join an organised snorkel swim that afternoon he inquired about safe areas of the beaches and was given directions. After about 45 minutes swimming here his son felt cold and returned to shore for a hot shower but his father remained snorkelling. A short time later another snorkeller saw a dark shape floating face down and found the person did not respond so turned him face up. It appeared the victim was dead but CPR was applied after the body was brought ashore. Autopsy revealed marked atherosclerosis of the coronary and basilar arteries. It was believed that this led to his cardiac related drowning death.

SNORKELLING SEPARATION. SOLO. SOME EXPERIENCE. SILENT DEATH. EXTENSIVE CORONARY ATHEROSCLEROSIS. CARDIAC DEATH.

BH 98/8

Attempts to obtain details of this tragedy have so far been unsuccessful. It is symptomatic of the lack of any proper understanding of the value of learning from the experiences of others that divers and diving organisations fail to support the reporting and investigation of diving related fatalities.

Scuba user deaths**SC 98/1 and 98/2**

This double fatality received intense international attention because the two victims were left at sea and never recovered. They were very experienced and reportedly

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and Experience Victim	Training and Experience Buddy	Dive Group	Dive purpose	Depth in metres Water	Incident	Weights On	kg
BH 98/1	31	No training Experienced	No training Experienced	Buddy Separation before incident	Spear fishing	Not stated	Not stated	On	6 kg
BH 98/2	69	No training Some experience	No training Some experience	Group Separation before incident	Recreation	Not stated	Surface	None	Not applicable
BH 98/3	26	Training not stated Experience not stated	Not applicable	Solo	Abalone fishing	3 m	Surface	None	Not applicable
BH 98/4	68	No training No experience	No training No experience	Buddy Separation before incident	Recreation	1 m	Surface	None	Not applicable
BH 98/5	76	No training No experience	Not applicable	Solo	Recreation	Not stated	Surface	None	Not applicable
BH 98/6	32	No training Experienced	Not applicable	Solo	Recreation	Not stated	Surface	None	Not applicable
BH 98/7	51	No training Some experience	No training Experience not stated	Buddy Separation before incident	Recreation	3.5 m	Surface	None	Not applicable
BH 98/8	-	-	-	No information available	-	-	-	-	-
SC 98/1	33	Trained Experienced	Trained Experienced	Buddy Not separated	Recreation	Not stated	Surface	Not stated	Not stated
SC 98/2	30	Trained Experienced	Trained Experienced	Buddy Not separated	Recreation	Not stated	Surface	Not stated	Not stated
SC 98/3	46	Trained Experience not stated	Trained Experienced	Group Not separated	Recreation	15m	Surface	On	Not stated
SC 98/4	47	Some training No experience	Trained Experienced	Buddy Separation before incident	Recreation	6 m	6 m	On	9 kg
SC 98/5	42	Trained Experienced	Trained Experienced	Buddy Separation before incident	Recreation	48 m	48 m	On	Not stated
SC 98/6	49	Some training No experience	Trained + Experienced +	Buddy Not separated	Class dive	10.5 m	10.5 m	On	Not stated
SC 98/7	47	Trained Experienced	Trained Experienced	Buddy Separation before incident	Recreation	20.6 m	Ascent	On	9 kg

DIVING RELATED DEATHS IN 1998

Buoyancy vest	Remaining air	Equipment Tested	Owner	Comments
None	Not applicable	Not applicable	Own	Weight belt no quick release. Separation. Solo.
Life jacket	Not applicable	Not applicable	Hired	Wore lifejacket. Separation. Lack of confidence. Nervous.
None	Not applicable	Not applicable	Own	Shark attack near a sealion colony.
Life jacket	Not applicable	Not applicable	Hired	Wore lifejacket. First use of snorkel.
None	Not applicable	Not applicable	Hired	Apprehensive. Ill health. Rapid heart death at surface.
None	Not applicable	Not applicable	Own	Toxic methamphetamine blood level. Solo.
None	Not applicable	Not applicable	Hired	Separation as buddy was cold. Coronary artery disease.
-	-	-	-	No details available.
Not stated	Not stated	Not applicable	Own	Double fatality. Left at reef by dive boat. No body.
Not stated	Not stated	Not applicable	Own	Double fatality. Left at reef by dive boat. No body.
Buddy inflated	None	No faults	Hired	Current ++. Instructor towed. Arrythmia death ?
Not inflated	Plenty	No faults	Hired	Heat stress. Solo entry into water. Lost demand valve from mouth at entry.
Not inflated	None	No faults	Own	Excessive depth/time, so out of air ascent. Unable to drop weights.
Not inflated	Plenty	Some adverse findings	Dive shop	Third dive. Hyperventilated. Controlled ascent. Unconscious at 7 m.
Partly inflated	Low	Some adverse findings	Own	Low air. Inverted buddy breathing ascent. Separation at 7 m. Obesity.

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and Experience Victim	Training and Experience Buddy	Dive Group	Dive Purpose	Depth in metres Water	Incident	Weights On	Weights kg
SC 98/8	46	Trained Experienced	Trained Experienced	Buddy separation before incident	Recreation	74m	Not stated	Off	Not stated
SC 98/9	48	Trained No experience	Not applicable	Solo	Recreational poaching	Not stated	Surface	Off	9 kg
RB 98/1	29	Trained Experienced	No training No experience	Buddy separation before incident	Instructor taking class	17.6 m	? 1 m	pouch weights not ditched	6 kg

careful divers, their main fault being to overstay their agreed dive time underwater. This, in concert with sloppy recording of the divers water entry and return times, resulted in a two day delay before their absence was admitted and the dive site revisited. This fatality occurred during a routine dive trip to the Barrier Reef on a boat the majority of whose passengers were making "resort dives" and snorkelling. This was their third scuba dive from the boat and there was deep water and strong currents around the bommie, which was within sight from the boat moored at a pontoon used by many dive boats. They chose to dive separately from the other scuba divers for this dive. After the dive there was a head count which was two short, but this was thought to be explained because two people had re-entered the water after being counted. The boat then made a silent departure from the dive site, and the finding of the victims' possessions on the boat after return to harbour and the disembarkment of the passengers failed to cause alarm, or even curiosity.

Intensive searches failed to find either victim, although some of their equipment was later washed up. There was comment at the inquest concerning some entries in a diary kept by one of the victims which could be taken to indicate depression in one diver, but possibly this did not give a true picture of the diver's state of mind. This diver was a poor swimmer, with poor sight, and if, as is likely, the two remained together this may have significantly reduced their chances of surviving. The boat had a quiet engine and the two divers underwater may not have heard it start up in preparation to leaving the dive area. It is thought that previous episodes of divers being forgotten and left at sea had occurred with other dive boat operators, though fortunately not with such tragic outcomes.

TWO EXPERIENCED SCUBA DIVERS. TENDED TO GREATLY OUTSTAY PLANNED DIVE TIMES. IMPERFECT LOGGING OF DIVERS IN AND OUT SO ANY FAILURE TO RETURN NOT NOTICED. TWO DAYS BEFORE THEIR ABSENCE WAS

REPORTED. CALM WARM WATER. STRONG CURRENTS. NO DESIGNATED DIVE MASTER. ONE WAS POOR SWIMMER WITH POOR SIGHT. BODIES NEVER RECOVERED.

SC 98/3

This man was a trained diver of unstated experience and was on holiday from the UK. Though he had suffered a middle ear barotrauma on a recent dive with this charter group, he was now recovered. On this occasion he was to be diving with three others, one an instructor, and they planned to ride back to the boat using the surface current. They commenced their return when all except the instructor were down to 100 bar. The underwater current had been strong and they had used their air faster than anticipated. They decided to swim back at 6 m to avoid the rough surface conditions which had now developed, but had insufficient air for the entire distance and were forced to surface after making a decompression stop. The instructor told them to inflate their buoyancy vests and use snorkels for the remainder of the return swim. But the victim became distressed after inhaling water down his snorkel and resumed using his regulator. The instructor decided to assist him and began to tow him. When about 20 m from the dive boat he reportedly said "still 70 bar", but soon afterwards said "no air" and when they were still 10 m from the boat he quietly became unconscious. He did not respond to their CPR efforts. At the autopsy his coronary arteries were found to be healthy so the pathologist diagnosed cardiac arrhythmia, followed by drowning, as the cause of death.

TRAINED SCUBA DIVER. UNSTATED EXPERIENCE. WELL MANAGED DIVE GROUP. RAPID RESPONSE TO DISTRESS DUE TO INHALED WATER DOWN SNORKEL. STRONG CURRENT. ROUGH SURFACE CONDITIONS. BUOYANCY VEST INFLATED. APPARENT ACUTE CARDIAC ARRHYTHMIA DEATH.

DIVING RELATED DEATHS IN 1998 (Continued)

Buoyancy vest	Remaining air	Equipment Tested	Equipment Owner	Comments
Partly inflated	None	Not tested	Own	Separation. Descent beyond the end of the shot line. No remaining air.
Not inflated	None	No faults	Dive shop	Solo. Abalone poaching. Catch bag unditchable. Out of air. Drowned at surface.
Not inflated	Empty when found	Some adverse findings	Dive shop	Inadequate care with gas testing. Air fill instead of enriched air nitrox (EAN) so hypoxia with exercise. Constant flow setting emptied tanks after his death.

SC 98/4

This tragedy illustrates the narrow window of time where training and experience can determine the outcome of an apparently simple problem. The victim had been informally trained by her husband, an instructor, and had made a total of 6 dives with him at a number of different locations.

On this hot day the 530 m walk from the car park to the water entry from the jetty caused a degree of heat stress. Water entry was singly, the next person waiting to allow the previous diver to swim clear. The victim stepped off the pier and submerged. Her husband, who had been standing behind her, waited to make his entry when she was clear. There was some delay before he stepped off the jetty as he had not completed his preparations. He became alarmed when he did not find her waiting at the surface for him. As he was starting to search for her a breath-hold diver saw her, dived down and easily brought her to the surface. He had found her on the sea bed, her snorkel held tightly in her mouth. Her husband had checked her equipment, and she his, before water entry. Because he was standing behind her he could not see her mouth and assumed she had the regulator in her mouth. Her air was turned on, her weight belt was on and her buoyancy vest was uninflated. It is probable that she lost her grip on the regulator during her entry and grabbed her snorkel mouthpiece in error, inhaling water when she took a deep breath. Although she responded sufficiently to CPR to reach hospital, she died there 3 days later from the anoxic brain damage she had suffered.

SOME INFORMAL SCUBA TRAINING. VERY INEXPERIENCED. 7th DIVE. SOME HEAT STRESS BEFORE SOLO WATER ENTRY. WATER ENTRY WITH UNINFLATED BCD. PROBABLY LOST REGULATOR FROM MOUTH DURING WATER ENTRY THEN MISTAKENLY GRABBED SNORKEL. DELAYED DEATH.

SC 98/5

There were four divers on the charter boat and three others. One was a diver who had an ear problem preventing him from diving, the other two owned the boat. Both were divers and one acted as the boat driver, the other as the dive master. He described the dive location to the quartet and then dived to fix a line from the anchor to the deep wreck (49 m) which was their objective. Although they had arranged to dive as two buddy pairs it was understood that this was a flexible arrangement.

One diver experienced ear problems and aborted his dive immediately after reaching the sea bed. Both the victim and his buddy had dived this wreck before and it was understood that the buddy would ascend sooner than the victim, who was carrying nitrox to reduce decompression time. The victim's failure to join his buddy at the deco bar and failure to surface alarmed the others. A bounce dive was made to look for him, though by then he would have been out of air. He was found lying free on the sea bed. His air tanks were empty, so his BCD could not be inflated. His weight belt could not be dropped because of the crutch strap. His dive computer showed he had ascended normally for 4 m, then rapidly a further 5-6 m before falling back to the sea bed. He had not attempted to use his nitrox supply. Both the victim, who carried a small tank of nitrox, and his buddy were using twin cylinders of air.

TRAINED. EXPERIENCED DEEP DIVER. GROUP PLANNED TO IGNORE BUDDY DIVE PROTOCOLS. ONE DIVER ABORTED WITH EAR PROBLEM. HIS BUDDY CONTINUED SOLO. VICTIM LET HIS BUDDY ASCEND SOLO. WEARING DRY SUIT. TWIN TANKS AIR. ALSO SMALL NITROX TANK FOR DECOMPRESSION. SLOW ASCENT FOR 4 m. THEN RAPID 5 m. THEN SANK TO SEA BED. OUT OF AIR. FAILED USE HIS NITROX. WEIGHT BELT ON.

SC 98/6

Two friends from overseas intended to dive on the Barrier Reef. One had proof of training but the victim had only made one pool and one open water dive previously so was required to have a Diving Medical check before acceptance for a live-aboard dive course. The victim's friend owned the bar he had visited for about 4 hours, 4-5 times a week for the past 6 years. He told the doctor this friend was a non-smoker, but had only ceased for 3 months. He was found to be moderately overweight and to have mild hypertension, which appeared to be a tension response.

During the course he dived with the instructor to perform mask clearing, don and doff exercises on the sea floor and was then asked to do a "fin turn" but failed to respond. Then he was seen to be taking rapid, shallow breaths. They started to ascend in close contact then at 6 m he suddenly became limp and was unconscious as the instructor brought him to the surface. Resuscitation attempts were unsuccessful. At the autopsy there was no evidence of either cardiac disease or CAGE so the cause of this fatality is undecided. No equipment faults were present.

THIRD DIVE OF SCUBA COURSE. WITH INSTRUCTOR. UNEXPLAINED ONSET RAPID SHALLOW BREATHING. CLOSE CONTACT ASCENT WITH INSTRUCTOR. BECAME UNCONSCIOUS AT 6 m. HISTORY OF HIGH BEER INTAKE. SMOKER TILL 3 MONTHS BEFORE. LABILE BLOOD PRESSURE NOTED. NO EVIDENCE CARDIAC DISEASE OR CAGE PATHOLOGY. REASON FOR INCIDENT AND DEATH UNKNOWN.

SC 98/7

A group of six divers arranged an interstate 3 day, 6 dives, land based dive package with a dive shop. All were experienced divers and they made the planned 2 dives a day on the first two days without incident. On the first dive of the third day the dive boat, skippered by a dive master, took them to the chosen location and they had the local conditions described. The dive master himself was not to dive. There were divers from another group diving nearby but closer to the rocky islet than their boat.

The victim and his buddy were at 15 m and 32 minutes into their dive when the buddy noted his air was down to 100 bar and that his companion had only 50 bar. They decided to ascend, the victim breathing from the buddy's supply to conserve his own air. At 7 m the victim was a little above his buddy, the air donor, and inverted. This prevented his BCD from venting. The buddy was also unable to vent his BCD to slow his ascent because the ball was missing from the end of the vent lanyard and without it he could not grip the lanyard adequately. To escape this situation they ceased buddy breathing and separated. The victim resumed using his own regulator but continued his inverted ascent uninterrupted. The buddy now descended

to 5 m depth to make a deco stop but the other continued directly to the surface. The dive master, in the boat, saw the victim at the surface and exchanged "OK" signals with him, then saw him swimming on his back towards the dive boat. He became uneasy and called to the buddy to swim to him when he saw him turn over, face down, his body turned a little on one side. He was found to have blood and water in his mask and to be unconscious when reached. He appeared to be dead. Resuscitation efforts were unavailing.

Although pre-autopsy films showed some air in his heart the pathologist was more impressed by the finding of narrowing to 10-20% of normal in one coronary vessel, and the evidence of drowning. There was no clear evidence of myocardial ischaemia. Clinically this was a CAGE fatality, brought about by the failure of the buddy breathing and inability of the victim to vent his BCD and thereby stop his uncontrolled ascent. It was possibly inappropriate to initiate buddy breathing if they were at 15 m and he had 50 bar, but they may have been planning for the deco stop rather than merely reaching the surface.

EXPERIENCED SCUBA DIVER. LOW AIR. DECISION TO BUDDY BREATHE DURING ASCENT. UNABLE TO VENT AIR FROM BCD. SO FASTER ASCENT THAN BUDDY LED TO INVERSION. THEN TO UNCONTROLLED ASCENT AFTER BUDDY BREATHING CEASED. SEPARATION. SURFACE OK SIGNAL AND SWIM BEFORE SILENT DEATH. EQUIPMENT FACTOR SIGNIFICANT. ONE VESSEL CORONARY NARROWING. CLINICALLY AND RADIOLOGICALLY CAGE.

SC 98/8

The organisation which ran this live aboard 5 day diving cruise was very safety conscious. All divers had to prove their competence, either by a record of 50 dives or of dives made within the previous 6 months. This woman held an Advanced Diver card and had made 35 dives and was "passed" after making a test dive with a dive master. She was then assigned a buddy, but after their first dive the buddy asked for a change, claiming that she was self centred and took no interest in her buddy, used excessive air but failed to check her own contents gauge. However there were no complaints after the group drift dive later that day, and she chose not to join the night dive.

The next day she was paired with a recently trained diver for a dive on the nearby reef. The current was checked by one of the instructors and they were assured it was not too strong and would assist their return after their dive. However the victim started her dive without waiting for her buddy and was soon out of sight as the visibility was poor. The buddy experienced sinus and ear barotrauma pain during descent and decided to abort his dive, though he had by then reached 18 m. During his ascent she rejoined him and when they surfaced they found a strong current was taking

them away from the dive boat. They were unable to attract the attention of anyone on the boat despite yelling and using a "safety sausage" (the first one they tried was faulty). The crew were at that time too busy assisting divers enter the water. The buddy decided to await rescue, holding an inflated sausage, which was leaking and became limp, but the victim chose to dive again and was soon out of sight. The buddy was soon joined by another diver whose sausage also was faulty. They remained calm and were ultimately located by an air search. The victim's body was also found on the surface, weight belt off, BCD part inflated and tank empty. There was no evidence of CAGE or coronary disease, though there was an old myocardial scar, the liver was fatty and there was a thyroid adenoma.

TRAINED. EXPERIENCED. ADVANCED DIVER. OVER CONFIDENT. IGNORED BUDDY. USED MUCH AIR BUT FAILED TO CHECK CONTENTS GAUGE. STRONG CURRENT. WASHED AWAY. "SAFETY SAUSAGES" FAULTY. LEFT BUDDY AT SURFACE AND MADE SOLO DIVE. FOUND DEAD AT SURFACE. OUT OF AIR. PART INFLATED BCD. DITCHED WEIGHT BELT.

SC 98/9

There are regulations restricting the number of abalone which a diver can collect but these are not universally respected. This man had completed his course 16 months previously but this was the first dive he had attempted since then. He was fully confident of his ability, however, telling his wife that he would not have passed the course if he was not competent. It is believed that he was not confident using a snorkel. He hired a tank, the remainder of his equipment being his own, attached a catch bag to his waist, and made his water entry off rocks into a calm sea. It was over an hour later that was seen to surface a short way off the rocks and wave one arm, then his head fell limp and he floated face down at the surface. An attempt was made to catch hold of him as he was washed past to the rocks but the water was now rough and he was swept from the grasp of his would-be rescuers. The body was recovered by a crewman dropped from a rescue helicopter. His tank was empty, weight belt missing, and a bag full of abalone (in water weight about 5 kg) hung from his waist.

The cause of death was drowning and the police investigation showed that it was probable that he would have floated vertical with his mouth above the surface if he could have ditched the abalone. He could have survived had he used his snorkel or had air remaining in his tank. Although he had a reported recent cough this was probably a minor adverse factor in this fatality.

TRAINED. FIRST DIVE FOR 18 MONTHS AFTER COURSE. SOLO. OUT OF AIR. UNABLE TO DITCH BAG OF ABALONE. DITCHED WEIGHT BELT. ROUGH WATER. POSSIBLY SOME AIR IN BCD.

Rebreather user

RB 98/1

Before this small dive cruise charter company could start offering courses in nitrox and rebreather diving it sent its diving instructor, who held a recent Nitrox Instructor qualification, and two others of its staff for a course in the rebreather's use. This was a condition before the supplier would deliver the equipment. They had, in total, made 14 dives using the equipment before this, the first commercial course. The first two pupils were experienced divers, one of whom took an Advanced Diver course before commencing the rebreather and nitrox course. The instructor was a very experienced scuba diver but of limited teaching experience. There is concern about the thoroughness of the nitrox course the instructor had taken, as both lecture and dive times appear to have been less than those officially required. After installation on the boat of the Nitrox Membrane Undersea Breathing System a technician came to instruct in its use. The crewman who was to operate it was absent so the instructor was informed directly, and was made aware of the importance of using the correct valves and purging the lines when changing air to/from nitrox production. It is believed he was not obsessive in such matters. Indeed radio advice had later to be obtained concerning operating the compressor.

They made four scuba dives the first day and two, to 31 and 26 metres, the next morning. Following these the instructor gave an apparently short talk on nitrox and the rebreather equipment. There was then a short introductory dive during which his three pupils (the deck hand, a trainee dive master, was in the group) found the gas supply appeared inadequate. The instructor assured them they would find the supply better as they dived deeper, which they later found to be true. The regulations require the introductory dive to be made in sheltered water, not the open sea. It was later noted that all these dives were poorly recorded. Their second dive was to 8-10 m for 15 minutes, without a shot line, "in a manageable current". The instructor was observed to test the tank gas mix initially and check the tanks were turned on the first two dives. The deck hand particularly noted the latter detail as the instructor was known to forget to turn his tank air on before entering the water. They returned to the dive boat after each dive.

Having made two short excursions using the equipment they re-entered the water. The current had increased and the deck hand turned his own nitrox tank on and descended solo to 5-6 m but was unable to make any headway against the current to reach the line, became short of breath and used his pony bottle air to ascend. He saw the instructor descend without taking notice of him. The two others experienced a similar problem with the current and also returned to the surface. The dinghy picked them up and as they returned to the dive boat they saw the instructor swimming about 1 m below them. The deck hand found it difficult to maintain himself at the surface as he was unable

to inflate his BCD and never thought to drop his weights. Incorrect alignment of the inflator hose was later found to have caused his BCD problem. Despite the short interval of time between sighting the instructor swimming and the divers being taken aboard the boat there was no further sighting. The body was found by searchers next day lying on the sea bed at 27 m. The weights had not been ditched and the tanks supplying his rebreather with continuous flow were empty. It is therefore not possible to determine how soon after the last sighting he drowned.

Examination of the equipment showed that his nitrox tank contained air and that one of the two mix jets was blocked by zinc carbonate, this reducing the gas flow to below the manufacturer's specifications. As the set was not designed to use air these two factors would result in hypoxia in the user. In addition the carbon dioxide container was incompletely filled. The cause of death was drowning, a consequence of loss of consciousness due to hypoxia. The three others survived because they aborted their dives sufficiently early, before becoming too hypoxic. It was found that the tank was filled with air rather than nitrox because he had failed to connect the supply line from the nitrox storage cylinder to the line he used to fill the tanks. It is assumed that all the tanks incorrectly contained air and that his observed test of the tank contents was incompetent.

EXPERIENCED SCUBA DIVER. INSTRUCTOR. RECENT TRAINING AS NITROX AND REBREATHING INSTRUCTOR POSSIBLY FAULTY. FAILED TO CORRECTLY USE NITROX FILLING SYSTEM OR TEST GAS FILL IN TANKS. CARELESS. HISTORY OF FAILING TO CHECK OWN TANK TURNED ON BEFORE WATER ENTRY. ERROR OF OPEN WATER INTRODUCTORY DIVE WITH STUDENTS. EQUIPMENT CHECK FAULTY ON STUDENT. EQUIPMENT FAULTS. FAILED TO RESPOND TO PUPILS PROBLEM OF INADEQUATE AIR SUPPLY. STRONG CURRENT FACTOR SAVED PUPILS. LEFT HIS STUDENTS. ANOXIA THEN DROWNED.

Discussion

Information is available on seven persons who died while using snorkels. Of these three were experienced users and the critical factors were post hyperventilation blackout, a shark attack, and probable conjunction of rough water and drugs. Experienced spear fishers will always risk blackout when they allow their endeavours to over-ride their body's warning signals. The additional factors in this case of asthma and back problems do not appear to have been critical. Although shark attacks are rare and unpredictable, they are most likely in areas where seals and sea lions are present, as in this case. The third experienced diver who drowned had an unwise diving behaviour pattern, a liking for solo diving and rough water. Whether or not the drug level critically effected his behaviour cannot be known, but

it undoubtedly cannot have been beneficial. The reason for his death on this occasion on this dive can never be known.

All the remaining snorkel users were very inexperienced, and two were sufficiently anxious to wear a buoyancy jacket, while a third was thought to need one. Unfortunately these floated their wearers face down. Cardiac factors were the probable critical event in three cases, with panic in shallow water the likely factor in one. Three of the scuba users were significantly inexperienced, but apparently all were confident of their diving ability. The story of SC 98/4 is particularly tragic, as she made a water entry from a jetty with her husband standing behind her ready to follow. There were several factors conspiring to her drowning, an uninflated BCD, loss of regulator from her mouth and her replacing it with her snorkel in error, and the possible respiratory shock of change from the hot jetty into water cold by comparison. In SC 98/6 the sudden change to rapid shallow breathing and then death while ascending accompanied by his diving instructor is difficult to explain in the absence of significant autopsy findings. Case SC 98/9 illustrates the problem of those who believe their certification is proof they are expert divers, even though they fail to use their training after their course. Additional adverse factors were being solo, running out of air, unwillingness to use a snorkel and tying the catch bag around his waist. Avoidance of any one of these factors might have saved his life.

There were five instances where the victims were experienced, the best publicised being the double fatality where a couple were not only left at sea but their absence went unadmitted for two days. One of the victims was described as being a poor swimmer with poor eyesight, factors reducing their chance of survival. This incident shows a clear breach of basic supervision responsibilities. It is suspected that similar "left at sea" events have happened previously but, fortunately, the divers involved were recovered unharmed by other dive boats. In case SC 98/5 the diver was experienced in deep diving and had indeed brought a small tank of nitrox mix with him to allow him a slightly increased time on the wreck and reduce his deco stop time. He informed his buddy of his plan and the buddy in consequence commenced his ascent without him. This broke a buddy pair into two solo divers at depth. The buddy became worried by the failure of his friend to join him or surface. A search recovered the missing man, whose air tanks were empty. His gauge showed he had ascended 4 m then sunk back to the sea bed. In his out-of-air state he never thought to drop his weight belt or to use his nitrox supply so had no chance of survival.

In case SC 98/7 the victim similarly allowed a low-air situation to develop, then attempted to save his air by making a buddy breathing ascent. During this he was head down so unable to vent his BCD, and unfortunately his buddy's dump valve lanyard was without a ball to grasp, so was unable to be operated. They recognised the danger of

too rapid an ascent so separated. The victim reached the surface and appeared well initially, then lost consciousness. This was clinically a cerebral gas embolism scenario, though not confirmed at autopsy. Dive discipline does not appeal to all but may nevertheless have survival benefits, as in case SC 98/8. Here the dive organiser was safety conscious and checked the recent dive experience of those on the live aboard dive boat. However no "warning bells" rang when the victim's first buddy refused to dive again with her because she ignored her buddy, did not check her contents gauge and used excessive air. On the fatal dive she failed to wait for her allotted buddy, whose later descent was aborted through sinus squeeze. Remarkably she rejoined her buddy and they surfaced together to find themselves in a current. Their "safety sausages" were faulty and dive boat slow to recognise and respond to their signals. She apparently became impatient and dived again, leaving her buddy. Her body was later found floating, tank empty and some air in her BCD. There was evidence of a past myocardial infarction but no evidence of either a gas embolism or further cardiac event.

The experience of the diver in SC 98/3 is unknown. He and his two buddies ascended when he was low on air during their return swim. The dive leader, an instructor, suggested they snorkel back the remaining distance, but he aspirated some water and resumed using his scuba regulator. The instructor had begun to tow him but before reaching the dive boat he said "no air" and lost consciousness. In the absence of apparent cardiac disease, the pathologist suggested the cause of death was cardiac arrhythmia.

It is clear that running out of air remains a potentially fatal event, as also is overconfidence in one's diving ability, and that being solo is arguably unwise. The responsibility to perform a correct head count remains a responsibility dive masters neglect at risk to their divers' safety. The old basic rules for safer diving still remain valid.

Acknowledgements

This investigation would not be possible without the understanding and support of the Law, Justice or Attorney General's Department in each State, the Coroners and police when they are approached for assistance.

PROJECT STICKYBEAK

Readers are asked to assist this safety project by contacting the author with information, however tenuous, of serious or fatal incidents involving persons using a snorkel, scuba, hose supply or any form of rebreather apparatus. All communications are treated as being medically confidential. The information is essential if such incidents are to be identified and the causes brought to the attention of those involved in diving safety and diving training. **See back cover for address to write to.**

Dr D G Walker is a foundation member of SPUMS. He has been gathering statistics about diving accidents and deaths since the early 1970s. He is the author of REPORT ON AUSTRALIAN DIVING-RELATED DEATHS 1972-1993 which was published in 1998. His address is P.O. Box 120, Narrabeen, New South Wales 2101, Australia. Fax + 61-(0)2-9970-6004. E-mail <dougwalker@ausdoctors.net>.

ABALONE DIVING IN WESTERN AUSTRALIA DIVING PRACTICES IN 1999

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Key Words

Abalone, occupational diving.

Introduction

Abalone divers are only one group of Australian diving fishermen. They work in New South Wales, South Australia, Tasmania, Victoria and Western Australia, diving mostly in shallow water. This is not always possible because of overfishing in past years and the activities of poachers who do not have abalone licences. Other groups of diving fishermen include pearl divers, who have been working in Western Australia, the Northern Territory and Queensland for over 100 years; divers on Tasmanian salmon farms, where the salmon are fattened in moored nets, since the 1980s; divers doing the same sort of work and more for the tuna farms in South Australia since the 1990s; and other divers who collect tropical fish, periwinkles, and other shellfish.

Abalone diving

In the early years of Australian abalone diving (1960s-1970s) there was no regulation of abalone fishing and as a result divers went deeper and deeper as enthusiastic collecting stripped the shallower waters. In this era there were many diving accidents (decompression sickness and cerebral arterial gas embolism after emergency ascents when the compressor stopped) and a number of deaths from the bends. The most horrific were in 1972 in Mallacoota, Victoria, where two poachers from New South Wales, where divers were not licensed, died in the chamber after days under pressure. Shortly afterwards the Victorian Government refused to renew single abalone diver licences, requiring the applicant to purchase an extra licence from another diver who would then have to leave the industry. This and the introduction of quotas reduced the need for divers to take as many risks as they had done and, with an