ORIGINAL PAPERS

AUSTRALIAN DIVING–RELATED DEATHS IN 1996

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Key Words
Accidents, deaths.

Summary

This review discusses 11 snorkel-using swimmers and 11 divers using scuba. Only one of the snorkel users was experienced (BH 96/4) and the true reason for his death is unknown. The remainder fall into the category of almost total inexperience, calm sea, separation from others and silent death. By a strange chance there were two with an epileptic history in this group, BH 96/3 and BH 96/7, the former having also a history of previous myocardial infarct and the epilepsy being incidental rather than causative. Those having a duty of care as responsible for the safety of a group of persons swimming, some of whom are using a snorkel with minimal, or no experience, have an extremely difficult task in attempting to identify the sub group of such swimmers who show no outward signs of being in distress before silently dying. The scuba divers show a wide range of factors, inexperience, water power, excessive depth (perhaps by error), tight wet suit neck, and air embolism type symptoms.

Four of the inexperienced scuba divers ran out of air but none of the experienced divers actually ran out of air, indeed four of the five in this group had fully adequate remaining air. In contrast to the snorkel user group, health was less of a factor, with angina as a possible factor in one and psychological factors involved in another.

Breath-hold divers and snorkel users

BH 96/1

An overseas family visiting a popular island hired some masks and snorkels. One showed three others how to use the equipment and then he left them for 10-15 minutes to snorkel, by himself, a short distance away.

When he returned two of them were in shallow water and pointed to where the third person could be seen floating about 7 m from the beach in only 1 m of water. She was fit and a good swimmer but, as the end of her snorkel was at the surface of the water, he waded out to her, though not alarmed at that stage. When he lifted her head, blood and water came from her nose and mouth. He quickly dragged her ashore but resuscitation was unavailing. When he had last seen her she had been snorkelling in a normal manner, about 5 m off the beach, and he had watched her for about 5 minutes.

The cause of death was drowning and there were no adverse health factors. It is most likely that she got water down her snorkel and, because this was the first time she had used a snorkel, she failed to respond by blowing it clear, or by tearing off her mask and raising her head, and forgot the water was so shallow she could simply stand up.

FIRST USE SNORKEL. GOOD SWIMMER. HEALTHY. SILENT DROWNING AT SURFACE IN CALM, SHALLOW WATER CLOSE TO OTHERS.

BH 96/2

This group of overseas visitors had an interpreter with them but it is probable that they failed to pay attention to the information given to the passengers during the trip out to the Barrier Reef pontoon from which they were to view the reef. As the victim was a poor swimmer he chose to accept and wear a life vest but did not add fins to the mask and snorkel he used. There were crew members watching over the designated swimming area but their task was made very difficult because there were about 50 people in the water at any one time, with a constant flow of persons entering and leaving the water. The victim, floating 15-20 m from the pontoon with the end of his snorkel above the surface, was thought to be rather too still so the lifeguard entered the water and to check. He turned the victim face up and saw that he was unconscious. The snorkel was still in his mouth. Resuscitation was commenced as soon as he was lifted onto the pontoon and an initial response was obtained but not maintained. Some difficulty was experienced when lifting him from the water because he was liberally coated in sun tan lotion.

The autopsy showed there was almost complete occlusion of the left circumflex coronary artery and 60% narrowing of the left anterior descending coronary artery. However there was no histological evidence of myocardial ischaemic changes. He had suffered a stroke 2 years before and was taking medication for hypertension and to lower his cholesterol. No details of his recent health are known beyond the statement that he had some residual deficit from his stroke. From the history it is believed his death was due to a cardiac cause.

SNORKELLING WEARING A LIFE JACKET. SILENT SURFACE DEATH. IN CROWD. FLOATED FACE DOWN. SNORKEL STILL IN MOUTH. HISTORY OF STROKE, HYPERTENSION AND HYPER-CHOLESTEROLAEMIA. CORONARY ARTERY DISEASE. PRESUMED CARDIAC DEATH.

BH 96/3

Two overseas visitors, a man and his wife, went on a day trip to the Barrier Reef. After she had snorkelled she returned to the pontoon and gave him the mask and snorkel. One of the crew advised him to reposition the mask strap, advice he did not appreciate. He was watched for 3-5 minutes in the water by the lookout. His wife also watched him for a time, then both were distracted. A short time later the lookout saw him drifting at the surface with his head dipping from time to time. As the victim did not react to the end of the snorkel becoming submerged the alarm was raised. When he was reached he was unconscious. He failed to show any response to resuscitation.

It was later established that he had a history of epilepsy, starting in 1976. His last fit was in 1991 when he was taken to a hospital where myocardial ischaemia and possible evidence of a past (silent) myocardial infarction was noted. More recently, he had suffered an episode of mild left ventricular failure due to mitral regurgitation, thought to be a consequence of the previous myocardial infarct. Autopsy revealed a scar in the inter-ventricular septum but only mild coronary atheroma with patent vessels. There was marked atheroma in the aorta, iliac and cerebral vessels and cardiomegaly was reported. The left pleural space was obliterated. Although clinically acceptable, the official cause of death, acute myocardial infarct in association with marked coronary artery disease, was not supported by the recorded findings. While it is probable that he suffered a fatal cardiac event, it is possible his epilepsy had recurred. He wore dentures (upper and lower) but these were removed before the resuscitation efforts and were not an adverse factor.

SNORKELLING IN GROUP. SILENT DEATH. HISTORY OF EPILEPSY AND PAST MYOCARDIAL INFARCT. CARDIAC DECOMPENSATION EPISODE. SCARRING LEFT PLEURAL SPACE. PROBABLY ACUTE CARDIAC DEATH.

BH 96/4

Despite being unwell for 7 months with Chronic Fatigue Syndrome symptoms which followed a probable infection from Ross River Fever, he had been sufficiently fit to spear fish with his buddy. Both of them were experienced and capable of diving to 24 m (80 ft). The sea conditions were described a being ideal for diving and while two friends remained in the boat, ready to respond to any requests for assistance, the victim and his buddy began spearfishing about 200 m from the boat. They kept apart from each other for reasons of courtesy and safety. Each had a float with a line to his spear gun and placed fish on a line when caught. They were about 10 m apart until the buddy returned to the boat to have some lunch. The victim was seen from time to time at the surface, his fins being visible as he commenced each dive.

They heard a boat approach and saw it circle the diver's float, then it came close to their boat. It was the victim's habit to talk to any boat which came near and they had not seen him at the surface for some time, so they quickly motored over to the float and pulled it up. It was heavy. This was because the victim's body was caught on the (discharged) spear gun. He was not entangled nor tied to it in any way. His mask was half full of water. Not unexpectedly, he failed to respond to resuscitation. It is assumed that he drowned after suffering a post-hyperventilation blackout.

EXPERIENCED SPEARFISHERMAN. DELAY BEFORE ABSENCE NOTED. HAD FIRED SPEARGUN. FOUND WHEN SPEARGUN PULLED UP. POST-HYPERVENTILATION BLACKOUT.

BH 96/5

The members of a trade mission were taken to see the Barrier Reef. The visibility was poor so the glass bottomed boat trip was cancelled and they were offered the chance to go snorkelling. It is not known whether the victim and others in the party were in the saloon when a short talk on snorkelling was given to the passengers during the trip out to the island, but it is believed that one of the four heard the talk and passed on some information to the other three later, while they were on the beach. There were notices about the availability of instruction but their boat schedule prevented them from taking up the offer.

The water was shallow off this beach. The victim soon became separated from the others, who found that the wind made their return to the beach difficult. Probably at least 30 minutes passed before they saw him floating 10-15 m from the beach in waist deep water. They pulled him ashore but he did not respond to resuscitation. Autopsy failed to reveal any medical condition which could be implicated. No information is available concerning his swimming ability nor whether he had ever snorkelled previously. It is likely he had never previously used a snorkel and failed to respond correctly when he got water down his snorkel.

SNORKELLING. PROBABLY FIRST TIME. SHALLOW WATER. SOME CURRENT. SEPARATION FROM OTHERS. AFTER 30 MINUTES SEEN FLOATING UNCONSCIOUS. SILENT DROWNING. SWIMMERS NEARBY UNAWARE OF TROUBLE.

BH 96/6

This day trip brought its passengers to a cay among the reefs. During the trip out a talk on the basic safety rules on the boat was given and passengers were asked to fill in a medical questionnaire if they intended to join one of the "scuba experience" (Resort) dives. Then a diving instructor gave a talk about snorkelling and scuba diving.

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and Experience Victim	Training and Experience Buddy	Dive group	Dive purpose	Depth in metres Water	Depth in metres Incident	Weights On	Weights kg
BH 96/1	72	No training No experience	No buddy	Solo	Recreation	1	Surface	None	None
BH 96/2	51	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 96/3	79	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 96/4	33	No training Experienced	No training Experienced	Buddy Separation before incident	Spear fishing	18	Not stated	On	Not stated
BH 96/5	42	No training No experience	No training No experience	Group Separation before incident	Recreation	1.5	Surface	None	None
BH 96/6	19	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 96/7	20	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 96/8	24	No training No experience	No training No experience	Buddy Separation before incident	Recreation	1	Surface	None	None
BH 96/9	57	No training No experience	No training No experience	Buddy Separation before incident	Recreation	Not stated	Surface	None	None
BH 96/10	25	Training and Experience not stated	Training and Experience not stated	Buddy Separation during incident	Recreation	2	Surface	None	None
BH 96/11	55	No training Experienced	No Buddy	Solo	Hunting octopus	Not stated	Surface	On	16
SC 96/1	41	Trained Some experience	Trained Experienced	Buddy Separation before incident	Recreation	8	Surface	On	Not stated
SC 96/2	37	Trained Experienced	Trained Experienced	Group Separation before incident	Recreation	33 (Planned 27 m)	4.5	Off	Not stated
SC 96/3	45	Trained Very experienced	Trained Very experienced	Group Separation before incident	Recreation	76	Surface	On	Not stated

DIVING-RELATED DEATHS IN 1996

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Equipment Owner	Comments
None	Not applicable	Not applicable	Not applicable	Hired	1st use of snorkel. Good swimmer. Shallow calm water. Silent drowning.
None	Not applicable	Not applicable	Not applicable	Hired	Solo in group. Poor swimmer. Valiant rescue attempts. Cardiac type death. Previous CVA.
None	Not applicable	Not applicable	Not applicable	Borrowed	Silent death in crowd. Epileptic. Previous myocardial infarction. Cardiac death.
None	Not applicable	Not applicable	Not applicable	Hired	Solo. Post-hyperventilation blackout. Recent chronic fatigue syndrome.
None	Not applicable	Not applicable	Not applicable	Hired	1st use of snorkel. Group separation. Silent surface drowning. Shallow water.
None	Not applicable	Not applicable	Not applicable	Hired	Inexperienced. Separation from others. Calm sea. Found drowned.
None	Not applicable	Not applicable	Not applicable	Hired	Silent death in group after resort scuba dive. Undeclared epilepsy.
None	Not applicable	Not applicable	Not applicable	Hired	1st use of snorkel. Buddy close. Poor health? Fatigue. Shallow water. Silent death
None	Not applicable	Not applicable	Not applicable	Hired	2nd use of snorkel. Separation from group. Cause of death uncertain.
None	Not applicable	Not applicable	Not applicable	Hired	Buddy went ashore but other swimmers were nearby. Silent drowning at surface.
None	Not applicable	Not applicable	Not applicable	Owned	History of significant ill health. Cardiac death.
Not inflated	Yes	Adequate	Some adverse	Owned	No dives for 5 years. Tight hood. Mask filled with water. Died during surface swim back to boat.
Inflated	Yes	Low	Adequate	Owned	Psychological and psychiatric problems. Possible asthma history. Ill health? Separation, then solo. CAGE.
Not inflated	Yes	Not stated	Equipment lost	Owned	Heavy equipment. Rough surface. Tried to swim into current, sank. Tight neck seal.

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and Experience Victim	Buddy	Dive group	Dive purpose	Depth in metres Water	Incident	Weights On	kg
SC 96/4	40	Trained Some experience	Trained Some experience	Buddy Separation before incident	Recreation	30	Ascent	On	6
SC 96/5	46	Trained Inexperienced	Trained Very experienced	Group No separation	Pupil Advanced Diver	30	30	On	Not stated
SC 96/6	36	No traininng Experienced	No buddy	Solo	Cray fishing	3.5	3.5	On	15
SC 96/7	19	Trained Some experience	Trained Very experienced	Group Separation before incident	Work	9	Ascent	On	10
SC 96/8	38	Trained Experienced	Trained Experienced	Buddy Separation before incident	Recreation	10	Surface	On	Not stated
SC 96/9	32	Trained Experienced	Trained Experienced	Group Separation before incident	Recreation	32	22	On	8
SC 96/10	42	Trained Some experience	Trained Some experience	Buddy Separation during incident	Recreation	32	15	On	12
Sc 96/11	28	No traininng Some hookah experience	Trained Experienced	Buddy Separation during incident	Tuna farming in cage	20	20	On	7

Those who signed up for the scuba dive were ferried to the cay with the equipment. Those who were intending only to snorkel swam to the beach, a distance of about 150 m. There was at least one other boat with its passengers on the cay at this time. The victim told her friend she had used a snorkel previously. Her friend was making her first snorkel swim and experienced difficulties, so chose to wait to be taken ashore in the ship's dinghy when it had serviced the scuba diving passengers. She last saw the victim when the victim had swum about half way to the beach. Although they had signed up for the scuba they were not in the first group so were to snorkel first. The buddy joined those listening to the instructor, on the beach, about use of scuba and expected to be joined there by her friend. It was here that she was told her friend had been found floating, unconscious and had died.

The skipper of the other boat saw a person floating at the surface. He became alarmed when he saw there was no response when his boat's wake passed over the snorkeller, so he took his dinghy and investigated. She was unconscious and he bumped her head while pulling her limp body into the dinghy. CPR was unsuccessful. The pathologist maintained that the head injury occurred before her death, the skipper equally certain that his boat never hit her and that the injury occurred during retrieval. The skipper's version was accepted, but the pathologist described the blow as having been forceful and, he thought, significant. She was using her own mask, snorkel and fins but was wearing a wet suit provided by the boat. Her experience using a snorkel is not known but possibly was not great. She was described as being "an average swimmer". There was no adequate safety watch on those

DIVING-RELATED DEATHS IN 1996 (Continued)

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Equipment Owner	Comments
Not inflated	Yes	None	Adequate	Owned	12th dive. Dived with buddy without instructor. Low air ascent. Separation. CAGE.
Not inflated	Yes	Adequate	Adequate	Dive shop	5th dive, on advanced course. Panic ? From cardiac pain? CAGE.
Not inflated	Yes	Adequate	Adequate	Owned	Solo. Cray fishing. Experienced. Tired. Possibly lost regulator from mouth.
Inflation failed	Yes	None	Some adverse comments	Work	Altered dive log to falsify experience. Out of air panic ascent. CAGE. History of cold water asthma.
Part inflated	Yes	Adequate	Adequate	Owned	Wrong underwater direction led to surfacing in surf zone. No dives in previous 12 months.
Not inflated	Yes	Adequate	Adequate	Owned	Trio separated during descent and failed to reascend together. Shot line incorrectly placed. Deep so nitrogen narcosis. Tight wet suit? Tired by surface swim.
Not inflated	Yes	None	Adequate	Hired	‘Advanced diver’ after 9 dives in 2 months. Over confident. Out of air. Deep dive. failed buddy breath as different BCD. CAGE death as boarding boat. Twice ran out of air during training.
Not inflated	Yes	None	Some adverse	Employer	Working inside 20 m deep fish pen. 1st scuba dive . Untrained. Some hookah experience. Strong current, poor visibility. Heavy air use. Out of air ascent. CAGE.

swimming to the beach from the boat. The cause of death was drowning, the only identified reason for this being the (possible) head injury.

SEPARATED. PROBABLY INEXPERIENCED WITH SNORKEL. NEAR OTHERS. SCALP INJURY OF UNCERTAIN SIGNIFICANCE. DROWNED.

BH 96/7

The two overseas visitors had met recently and, being from the same country, had decided to take a trip to see the Barrier Reef together. One of them had a history of frequent epileptic fits, as her companion knew. Indeed she had a fit the evening before they made the fatal trip. The passengers received the regular talk on shipboard safety. On the outward trip a medical history form was given to those showing an interest in taking the opportunity to make a supervised scuba dive. The victim asked her companion whether she should write down about her epilepsy, a question which he said was for her to decide. There is a difference of opinion as to whether she discussed the matter with the instructor. Her experience during her first “resort dive” was such that she signed up for a second one, the same group of passengers undertaking both trouble free dives. Strictly speaking the instructor had too many in his group, because his assistants lacked the necessary training and certification. His instructor organisation would not have supported his actions had any incident occurred. The victim’s group was given an introductory talk on scuba diving while those who had chosen to limit themselves to snorkelling were given a talk on this subject.

When they returned from the second scuba dive they were told they could, if they hurried, join the snorkel group. This was led by the skipper. They were taken in the ship's dinghy to join the snorkel group off the beach. This escorted tour of snorkel using swimmers ended about 100 m from the boat and they were left to make their own way back from there. There was no crew member tasked with the sole duty of watching over the swimmers and it was only after a roll call was made of passengers and a search of the boat failed to find her that her absence was noted. One of the crew climbed the mast and he saw her body floating at the surface. Examination of her snorkel showed that one lug of her mouthpiece had been bitten off (it was in her mouth) so it was believed that she had suffered an epileptic fit and drowned. The diving instructor was noted to be using unpaid divers as assistants on the understanding that their work time would contribute to qualifying towards qualification to become dive masters, but he was not covered for this by the organisation he claimed would give the desired certification, though an "active" instructor in another.

The details of this case are incomplete as the skipper and the instructor claimed "privilege" and elected not to give any statements. The skipper had led the snorkel group on its tour to view the corals but his official terms of employment prohibited him from leaving the boat. Although those who chose to snorkel and not scuba were given a talk, the latter group received no instruction. It is not known whether the victim had any previous experience in the use of a snorkel but she apparently experienced no problems with its use. Her lack of concern about the implications to her safety of fits in the water is very difficult to understand but possibly reflected a desire to ignore (as far as possible) the reality of her medical problem. Her companion stated that she had a short warning of the onset of her fits and may have relied on this if she gave any thought to the possible risks. Being alone when the fit occurred removed the last possible safety factor. The passengers were not, apparently, advised to swim with another person as a buddy.

EPILEPTIC. FAILED TO DECLARE HEALTH RECORD. RECENT FITS. 2 RESORT DIVES, THEN JOINED SNORKEL GROUP. SEPARATION. SILENT, SURFACE DROWNING. INADEQUATE SAFETY WATCH OF PASSENGERS. INSTRUCTOR USED UNQUALIFIED ASSISTANTS.

BH 96/8

Here again two visitors from the same overseas country met by chance and decided to join one of the day trips to one of the Barrier Reef resort islands in order to go snorkelling there. They hired masks, snorkels and fins once they arrived and were given some instructions by the attendant in the shop. Because the victim understood English better than her companion she translated this advice to her, thereby giving her the impression she was knowledgeable about snorkelling. There was a long walk from the shop to the chosen beach and the victim was noted to become easily tired, though she did not mention having any ill health. When they came to don the equipment it became obvious that the victim was ignorant of its use.

After they entered the water they remained in the shallows, though moving away from others who were in the water because the victim found herself bumping into them. About half an hour later others saw the victim's companion walking along the beach and looking out to sea as if trying to find someone, then heard her scream for assistance. The victim was then seen floating face down in shallow water near some rocks. The water had been calm, the wash from boats entering the bay had not been troublesome and none of the boats came near the swimmers at the beach. It is not known how or why the two became separated but it is apparent the victim drowned silently at the surface and was probably fairly close to her buddy. Although there were guided snorkel tours they had just missed one and the time for return to the boat made the next tour too late. The autopsy revealed no reason for her becoming tired too easily and it is assumed that she drowned following inhalation of water down her snorkel, despite it having a purge valve.

FIRST EXPERIENCE WITH SNORKEL. SILENT, SURFACE DROWNING IN CALM SHALLOW WATER. MAY HAVE BEEN UNFIT. NO DISEASE FOUND.

BH 96/9

This group from overseas joined a trip to the Barrier Reef in the afternoon, after a morning spent "white water" rafting. At the island, they hired snorkelling equipment and swam off a beach with many other day trip visitors. There was a marker buoy where the water was deeper but most visitors were in waist deep water near to the beach. The victim was initially with his wife and daughter but after a time they returned to the beach to sun bathe. His wife became alarmed when he had not joined her after 20 minutes and she was unable to identify him among the swimmers. The two women started to walk along the beach to look for him and soon came across a group trying to resuscitate someone on the beach. He had been seen, by a tender taking passengers back to another boat, floating motionless, face down, some 500 m off the beach. It is probable he was dead when located. Getting him aboard the tender was difficult because of the sun tan oil on his body. No ill health was found at the autopsy and he had a history of regular health checks. It is possible that his inexperience with use of a snorkel was the reason he drowned as it was only the second time he had used a snorkel. Although a talk on snorkel use was given in his language during the boat trip, and similar instruction given when he hired the equipment on the island, his wife later claimed that no information was given. This illustrated the difficulty of ensuring that information is imparted effectively.

While there was a confirmation by the histologist that the victim had suffered a minor subarachnoid haemorrhage (without brain damage), and the pathologist firmly believed there had been a significant, but unrecorded, head injury at some time prior to death, there is no convincing evidence to show that this was of significance. The coronary arteries were healthy and no myocardial ischaemic changes were found. There was a large warty polypoid vegetation on the anterior pulmonary valve leaflet, thought to have led to the thickening of the left ventricle's wall. It was not thought to be a factor in this death. It is likely that his lack of familiarity with the use of a snorkel was the critical factor. When the head injury occurred was never decided.

SECOND USE OF SNORKEL. SEPARATION FROM FAMILY. IN A CROWD. IN CALM SHALLOW WATER. SILENT DROWNING. FOUND BY CHANCE. FLOATING FACE DOWN. NON-CRITICAL LESION OF PULMONARY VALVE.

BH 96/10

Shortly after she arrived from overseas this visitor met a compatriot and they decided to visit a Barrier Reef island together. On their arrival they hired masks, snorkels, fins and buoyancy vests. However she found her fins were too tight and soon discarded them. There were other swimmers snorkelling off this beach so her new companion had no fears about leaving her to lie on the beach and sunbathe. It was some time later that he became aware that he could not see her among the swimmers and he gradually became worried by her absence. One of the island's staff was sitting on the beach at this time and he noticed a person floating quietly among the swimmers, not reacting when others passed close by. He thought this was strange and decided to check, so swam out to her. He found her floating face down, snorkel out of her mouth and its end underwater. After turning her face up he towed her to the shore and commenced CPR, but there was no response. The buoyancy vest had unfortunately kept her floating face down. No health factor was found at the autopsy and it must be assumed that she had drowned after aspirating water down the snorkel. The water was only waist deep where they had been initially but where she was found it was 2.1 m (7 ft) deep so she could not have stood up when in trouble. Nothing is known about either her swimming ability or whether she had ever previously used a snorkel but gross inexperience seems to have been the critical factor.

SNORKEL EXPERIENCE NOT STATED, BUT POSSIBLY FIRST USE. SEPARATED FROM COMPANION. SILENT, SURFACE DROWNING IN CROWD OF SWIMMERS. NO FINS. VEST FLOATED HER FACE DOWN.

BH 96/11

It was customary in his native country to dive for octopus for food and he had continued this despite his probable awareness that it was not permitted in Australia in the areas where he liked to hunt. His wife had tried to dissuade him from diving alone and he had responded, as on this occasion, by hiding his intentions from her. His failure to return home at the expected time led members of the family to institute a private search of the locations he chiefly favoured but they drew a blank. By the time they notified his absence to the police the latter were trying to identify a body found in the tidal harbour that evening.

The finder was a man who had entered the water for a swim after spending some time relaxing on the beach. He had seen a float when he first arrived but taken no notice of it till he entered the water and then saw there was a body attached and it was slowly drifting with the incoming tide. He pulled it to the shore and hurriedly notified the police. They found that the victim must have entered the water some distance from where he was found, an indication that he was aware his activities were best kept unobserved. He was found to have a plastic bottle with him. This had possibly contained a solution to cause the octopuses to leave their crevices, and he had caught several before he died.

Autopsy showed that he had fibrosis of his lungs, 90% narrowing of the right coronary artery and up to 70% of the left, and the left ventricle showed thinning of the anterior wall and scarring of the lateral. His medical history was of silicosis, a myocardial infarct and prostatic cancer in remission. Despite his ill health history he had persisted to work long after others would have given up. Cause of death was given as atherosclerotic cardiovascular disease.

SOLO BREATH-HOLD DIVING (ILLEGALLY) FOR OCTOPUSES. SIGNIFICANT HISTORY OF ILLNESS. FOUND FLOATING. EVIDENCE OLD MYOCARDIAL DAMAGE. CORONARY ARTERY DISEASE. CARDIAC TYPE DEATH.

Scuba divers

SC 96/1

Although he trained in 1980 and dived frequently for about 8 years, he had rarely dived since his marriage in 1987 and had not dived at all for 5 to 6 years. However he had kept his tank "in test" and had replaced the O rings and obtained new straps for his fins before making this dive. His buddy had made 16 dives since qualifying 2 years before. The chosen dive site was an underwater track popular with local divers. Having gained weight, the victim had some difficulty getting into his wet suit jacket, but managed. The hood was tight, according to later witnesses. They entered the water from a ramp, descending to the chain at about 8 m. After about 5 minutes the victim

indicated that he wished to ascend, which they did without haste. He explained that his mask was filling with water and he did not wish to continue, so they started a surface swim back to shore. He started using his snorkel but soon changed over to scuba. When they were about 10 m from the shore, where the water was rougher, they lost contact with each other.

It was only after the buddy had come ashore, onto some rocks, and removed his equipment that he looked back and saw his friend floating at the surface, face up. A diving instructor, waiting for his class, also noticed the victim floating face up, moving passively with the surge. He quickly motored over to him, dived in and commenced in-water EAR. Others now came to assist and tow the victim to the rocks (his weight belt was probably ditched at this time). The buoyancy vest was noted to be in poor condition but this was not a factor as he floated face up.

The autopsy revealed neither the classical signs of drowning nor any significant coronary artery disease, although the heart was said to show mild cardiomegaly. This was possibly a cardiac death from arrhythmia in association with the effort of swimming in rough water, with possibly some aspiration of water.

SCUBA TRAINED. HAD NOT DIVED FOR 5-6 YEARS. SURFACE SEPARATION IN ROUGH WATER. BUOYANCY VEST IN POOR CONDITION. CAUSE OF DEATH UNCERTAIN. MILD CARDIOMEGALY. HEALTHY CORONARY ARTERIES. POSSIBLY CARDIAC FACTOR OR 'DRY' DROWNING.

SC 96/2

The basic facts are known, but the complete story is unlikely ever to be known because the victim was a very determined and intelligent woman who retailed a different medical history to different friends, whom she managed to keep apart. She claimed to suffer from multiple sclerosis and to have spent time in a wheel chair. She also claimed to have screws in her spine for vertebral changes and was thought to have suffered from depression and possibly asthma symptoms. She claimed to have received her basic training after obtaining a medical clearance, but there is no documentation to either confirm or deny any of these statements. Because she was (de facto) scuba diving, she was given further training to make her activities less dangerous to herself. This instructor was aware, in part, of her personality.

The fatal dive was to be to 27 m but was changed to a deeper one as the instructor had two pupils needing a "deep dive". She agreed to a 35 m dive on a reef. The descent down the anchor line was tiring as there was a strong current. She only descended 5 m before returning to the surface. Although the pupils stated that the instructor took her back to the surface he said he only became aware of her absence when they reached 20 m. He was not worried as there were two experienced crew in the dive boat who could take care of her.

The crew said that she seemed to be rather puffed before her initial descent but had refused their suggestion she wait in the boat. She dived again after a short rest and was not seen by the other three divers during their dive. She surfaced, while they were taking their decompression stop, about 50 m from the dive boat and appeared to be upright as she gave an "OK" signal. After picking up the three divers the boat moved to where she had been seen and found her floating there, dead. The autopsy confirmed that this was a cerebral arterial gas embolism death. Her booking for this dive was accepted without planning for her to be provided with a buddy. There was still 50 bar air remaining in her tank when it was checked.

TRAINING HISTORY IRREGULAR, BUT EXPERIENCED DIVER AND INTELLIGENT. HEALTH HISTORY SIGNIFICANT BUT UNDOCUMENTED. SEPARATION EARLY IN DESCENT. THEN SOLO DIVE. POSSIBLE HISTORY OF ASTHMA. BREATHLESS BEFORE DESCENT. POSSIBLE NEUROLOGICAL AND DEPRESSION HISTORY. X-RAY PROOF OF CAGE. PERSONALITY FACTORS SIGNIFICANT.

SC 96/3

All five of the divers making this deep dive were experienced in use of nitrox and trimix and they had all previously dived with each other. Since the recent death of a friend making a deep dive, the victim had been obsessional over safety, carefully planning his dives in advance and then calculating and making the appropriate gas mixture. Although there was a current they were confident that it would prove to be no problem. They anchored by snagging the anchor on the wreck, at 73 m, then let down two shot lines for their planned decompression stops. The longer one, from the stern of the boat, had a cross line to the anchor line so that after water entry at the stern they would be able to reach the anchor line more easily and so start their descent down it. A mermaid (safety) line was streamed from the stern.

The victim was the second to enter the water and he held onto the mermaid line, moving back along it to allow the third diver room to enter the water and to receive his video camera equipment. Meanwhile the first diver had reached the sea bed. A struggle with the equipment in the current caused the third diver to abort his dive at 54 m. These two divers could see each other but neither ever saw the victim after they left the surface. The anchor pulled free so divers one and three aborted the dive and decompressed on the shot lines. The crew saw the victim drift beyond the end of the mermaid line. He seemed to be attempting to orally inflate his buoyancy vest, then sank.

He was never seen again. His torn dry suit was found on the sea bed two days later but neither his equipment not any part of his body was ever found. It was accepted that the dry suit was savaged by sharks after his death. It is supposed that he may have failed to open the valve supplying air to his buoyancy vest but needed positive buoyancy. As he was negatively weighted, had the regulator out of his mouth while he was trying to inflate his vest, and had lost the "surface anchor" benefit of the mermaid line, he may have died because of a sudden submersion at this time.

EXPERIENCED DEEP DIVER. INTENDED DEEP DIVE WITH TRIMIX. SURFACE LOSS OF GRIP ON MERMAID LINE. NEGATIVELY BUOYANT. ATTEMPTED ORAL INFLATION OF BUOYANCY VEST. SEPARATION FROM BUDDIES AND BOAT. STRONG CURRENT. ANCHOR CAME FREE FROM WRECK. NEW DRY SUIT, POSSIBLY WITH TIGHT NECK SEAL. BODY NEVER RECOVERED.

SC 96/4

The two dive boats carried 15 divers in addition to an instructor and a dive master. The plan was for the more experienced to be guided through a passage in a large rock while the others were escorted to a more scenic, and shallower, adjacent area. The victim and her buddy were in a group of 4 or 5 at the surface with the instructor when one of the "passage" divers surfaced and asked the instructor to descend with him to assess whether he should attempt the deeper dive. The instructor told his group to wait for his return and descended with this diver. When he surfaced the victim and her buddy were no longer at the surface, having apparently decided they were competent to dive without supervision.

The victim had been diving for 3 months and had made possibly 11 scuba dives. Her buddy had been diving for 12 months but no details are available of her diving experience. They made an uneventful dive to 30 m, disregarding the 18 m depth limit of their certification level, and when the buddy noticed that her contents gauge showed 50 bar she indicated that they should ascend. She reported that the victim's gauge showed 150 bar, a degree of nitrogen narcosis probably influencing her acceptance of such a reading at this stage of their dive. First one, then the other, led their ascent, the buddy being in advance as they neared the surface. The victim failed to surface but there was no immediate alarm at this, it being assumed that she had boarded the other boat when she was not seen at the surface. After about 20 minutes delay the instructor decided to make an underwater search and found her lying on the sea bed, weight belt on and her tank empty (so he could not inflate her BCD).

Examination of her equipment showed it to function correctly after the tank was filled. An X-ray of the body taken before commencing the autopsy showed air in both ventricles and right atrium, the neck veins, the bile system and portal system. The autopsy showed also air in the Inferior Vena Cava, a small left sided pneumothorax, surgical emphysema in the neck, and a possible perforated left eardrum. It is assumed that she ran out of air and suffered a massive air embolism before reaching the surface. A friend stated that she had previously shown coolness in a stressful diving situation. The critical factors were failure to monitor her contents gauge, separation and possible nitrogen narcosis impairment in an inexperienced diver.

TRAINED. TWELFTH SCUBA DIVE. IGNORED INSTRUCTOR'S ADVICE TO DIVE WITH HIM. CERTIFIED TO 18 m. DIVED TO 30 m. SEPARATION DURING LOW AIR ASCENT. OUT OF AIR. MASSIVE AIR EMBOLISM. CAGE.

SC 96/5

The diving history of this unfortunate man lasted 8 days. He started an "advanced diver" course immediately he completed his basic course, during which he made four (4) dives. The instructor had four students and each made a giant stride water entry and waited on the mermaid line before they descended as a group. They stopped at 15 m to allow one of the group to equalise, then collected at the anchor while the instructor attached a come-back line to it as the visibility was poor. He then indicated they should follow him to an area 2-3 m away where the visibility was better. On looking back he saw that the victim had remained close to the anchor, though not holding onto it and was holding his regulator in his mouth with one hand. The instructor signed to the other three pupils to remain where they were and returned to the victim. He noticed he looked distressed and wide eyed, so decided he would take him to the surface. Having made the decision to abandon the dive, the instructor signed to the other three to follow him (they did not observe this signal) and started to ascend with the victim, who kept one hand on the line. As they ascended the instructor kept his legs round the line and arms around the victim. When they reached 10 m the victim removed his regulator but retained his grasp on it. He refused to allow it to be replaced in his mouth. At this time he seemed to be conscious. The instructor brought him up to the surface as quickly as possible and there ditched his weight belt while trying to keep his face above the surface. Now the victim was unconscious. In-water EAR was attempted before the victim was pulled into the boat and CPR commenced by the boatman, while the instructor descended to retrieve his three other pupils. Resuscitation efforts were unsuccessful.

Pre-autopsy X-ray films were taken and showed air in both ventricles and right auricle. The autopsy findings confirmed this and also found changes indicative of pulmonary barotrauma. The coronary arteries showed

areas of 70% narrowing and there were left ventricle wall changes probably indicative of a myocardial infarct. It is assumed that he had a pre-training medical check and neither revealed cardiac symptoms nor had any disease discovered. Possibly anxiety led to angina when he reached the sea bed, and his change in behaviour at 10 m was due to a myocardial infarct. The pulmonary barotrauma and arterial gas embolism were the consequence of his ascent the last 10 m while unconscious.

JUST TRAINED. NOW TAKING ADVANCED DIVER COURSE. INEXPERIENCED. MAKING FIFTH SCUBA DIVE. DISTRESS. POSSIBLE ANGINA PAIN. PANIC. CORRECT INSTRUCTOR RESPONSE. ASCENT WITH CLOSE CONTACT. VICTIM REMOVED REGULATOR AND REFUSED TO ALLOW REPLACEMENT. RAPID ASCENT LAST 10 m. EVIDENCE OF AIR EMBOLISM AND PULMONARY BAROTRAUMA WITH CAGE.

SC 96/6

This experienced diver had never received formal training but this did not prevent him obtaining air or buying new equipment. Indeed he intended to try out his new buoyancy vest on this dive and had added some 7 lbs to his weight belt for this reason. His wife helped him carry his diving equipment over the rocks to the water's edge, a walk which left him red faced and sweating. He admitted to a racing heart. Although he claimed to be feeling relaxed his wife was not convinced this was true. He indicated he would return from his solo dive in an hour so his wife sat on the rocks for about hour, then returned. She watched his snorkel for about 15 minutes before she realised that it was floating by itself, not attached to her husband. She raised the alarm and an air search was commenced which located his body in 3.6-4.5 m (12-15 ft) of water. His fins were missing, his legs were under a ledge, and there were crayfish spines in his (remaining) glove. His regulator was floating free so it was thought probable that it had come out of his mouth and he had failed to regain it in time to avoid drowning. He had 2/3 of his air remaining.

EXPERIENCED SCUBA DIVER. NO FORMAL TRAINING. SOLO DIVE. CRAY FISHING. PROBABLY LOST REGULATOR FROM MOUTH AND FAILED TO RECAPTURE AND REPLACE IT IN TIME.

SC 96/7

The critical facts in this tragedy are that this inexperienced diver falsified her log book to indicate a greater degree of experience, and that this led to the dive leader to give insufficient thought to close control of the divers he was leading. She and a friend were travelling around Australia on a working holiday. While staying in a hostel they heard of the chance to join a marine science organisation. Anticipating that there might be an opportunity to dive she and several others obtained an appointment. Before being permitted to dive they had to show proof of training, that they had made a certain number of dives and had satisfied one of the staff they were indeed safe divers. She amended her dive log to appear more experienced than she was and this was not noticed when the book was examined. This is not surprising as there is a common assumption that such evidence is true, and it was hindsight which led others to claim the log was so obviously untrue that this should have been so recognised.

The staff member who took the group on a recreational dive to assess their abilities also assumed they were sufficiently experienced to manage a simple dive situation and were capable of watching their contents gauges. He was remiss, but not without cause, in omitting to check her gauge when he checked the others and decided it was time to ascend to the surface, though he had checked it earlier in the dive, assuming her air use would be similar to that of her buddy. He was surprised by the absence of the victim as he began to bring the group up. When he reached the surface the boatman told him that a diver had surfaced a short time before them, waved an arm and then sank. Her mask was off at this time. An initial search failed to locate her but she was later found drowned on the sea bed.

The autopsy report was grossly inadequate, but fortunately a CT scan, which showed conclusive evidence of air embolisation into the heart, was made before the post mortem. It is assumed that she had suddenly found she was in a critical low-air situation and made an emergency ascent which had resulted in pulmonary barotrauma. It was noted as strange that the admission that she had cold water related asthma caused no questioning of her fitness, even though the water in the area was not cold.

Add barristers (there were 6) to an inquest and the dispassionate search for truth becomes a victim. The blame-shifting operation was successful in causing the organisation to tighten its rules and ensure that a stricter check of documents and more careful dive assessment be instituted. However, there may be need to question training standards where monitoring of the contents gauge is not treated as a top priority by pupils. The staff member deputed to take this dive had no special qualification to assess or lead a group, but had that responsibility.

TRAINED. ALTERED LOG BOOK TO SHOW MORE EXPERIENCE. AIR USE INITIALLY SIMILAR TO OTHERS. BECAME LOW ON AIR MORE RAPIDLY THAN THE OTHERS. SUDDEN ASCENT WITHOUT WARNING TO OTHERS. AIR EMBOLISM DEATH. CAGE.

SC 96/8

Because the visibility was so poor at the planned dive site the divers were offered a credit for a future dive by the

dive organiser. Despite these conditions the victim and his buddy dived, unlike the other divers who had rapidly returned to the dive boat. The second location, a reef area, also presented problems although the visibility was better. The divers were told to swim away from the reef after descending, as there was rough water around it. By accident the victim and his buddy failed to follow this advice so surfaced in the rough water around the reef. The water here was too shallow for the dive boat to reach them and they then made their second critical error. Instead of inflating their buoyancy vests and allowing themselves to be washed over the reef into calmer water they attempted to swim through the surf area to reach the boat. The buddy was successful in reaching an area where the boat could reach him, his friend was not. He was recovered by some of the group and towed to the shore and resuscitation commenced. Although he reached hospital and was intensively treated he died there the next day from cerebral hypoxic damage.

The victim had been trained for 2 years but not dived in the previous 12 months. However he was regarded as being an experienced diver by the dive organiser, the instructor who had trained him. Although the victim had indicated to his buddy about the time of their ascent that he had some leg cramp he had declined any assistance. The buddy inflated his buoyancy vest at the surface but it is not stated whether the victim inflated his. The buddy was very tired when reached and the victim would have been similarly affected. The swim might have been easier underwater rather than at the surface.

TRAINED. EXPERIENCED. SURFACED IN SURF AREA OVER REEF. WATER TOO SHALLOW FOR DIVE BOAT TO REACH. FATIGUE. WATER POWER. NO DIVES FOR 12 MONTHS. MADE MISTAKE IN DIRECTION UNDERWATER SO SURFACED IN SURF ZONE. DELAYED DROWNING DEATH.

SC 96/9

This woman was reasonably experienced, having made 44 dives in a wide variety of places. This was her third time at this location. However she had always previously dived with her husband, an instructor, as her buddy. The planned dive had to be aborted as it was close to a main shipping channel and they were told a large ship was due. The alternative location was a frequently dived area. Because her husband had some pupils she was to dive with two other divers. The plan was for them to descend a shot line to a ledge at 20 m at the mouth of the depression. However unknown to the divers, the line was directly over deeper water, 33 m.

The three divers entered the water before the instructor with his 3 pupils and a divemaster. One buddy descended slowly because he was unfamiliar with his hired equipment and was left behind by the other two. This diver joined the instructor's group when they reached his depth. When the victim and her remaining buddy reached the end of the line they were out of sight of the instructor and his group of divers. They stopped at 22 m, the end of the shot line. The victim was a short distance from her buddy, who was holding the line. When the buddy looked up to try to see if the other buddy was coming visual contact was lost. Finding herself alone, the buddy followed correct procedure and ascended. When all the divers had returned to the boat, the victim's continued absence worried her friends but her husband was so confident of her ability that he remained unworried far longer than anyone else. When he did become worried he made a short dive and then an unsuccessful surface search. Then the alarm was raised and a more organised search initiated. The first, at 20 m, was unsuccessful, but a second one to 30 m located her lying on the sea bed.

Probably there were adverse several factors. She was used to diving buddied with her husband, a diving instructor. She was possibly uncomfortable with the 50 m surface snorkel swim from the boat to the shot line buoy, made necessary by the boat drifting, and her wet suit jacket may have been too tight. She descended without retaining her grip on the line and continued the descent after becoming separated. Other factors were nitrogen narcosis, cold, darkness, and separation. She had adequate air but failed to inflate her buoyancy vest or drop her weight belt. The autopsy showed that at some stage of the dive she had suffered a ruptured right ear drum, which could have caused pain and then cold water induced vertigo. But the full story of what occurred can never be known as she was alone at the time. When last seen she was vertical, a short distance from the line and her buddy, rotating as if checking her situation. She had then continued her descent deeper than the agreed maximum dive depth.

TRAINED. EXPERIENCED. TRIO GROUP. FAILED TO WAIT FOR SLOWEST DURING DESCENT. FATIGUE AFTER SURFACE SNORKEL. POSSIBLY TIGHT WET SUIT. MISPLACED SHOT LINE. FAILED TO HOLD SHOT LINE DURING DESCENT. CONTINUED DESCENT AFTER SEPARATION. NITROGEN NARCOSIS FACTOR. COLD. DARK. SEPARATION. RIGHT EARDRUM RUPTURED. ADEQUATE AIR. FAILED TO INFLATE BUOYANCY VEST OR DROP WEIGHT BELT.

SC 96/10

The dive shop checked their certification when they paid to join the boat dive but omitted to look at their log books to establish their degree of experience. The victim could rightly claim to be an Advanced Diver but he had only made a total of 9 dives in the 2 months since he first started scuba diving. He omitted to tell them that he had run out of air on two of these 9 dives. His friend was open

water trained and had made 13 dives, 6 in the last 6 months, but regarded him as the senior diver because of his additional qualification and his very obvious confidence. There were six divers, plus an instructor, who remained in the boat to act as dive master. The water conditions at the reef were variously described, ranging from "a moderate swell" to "a 2 metre swell", with a minimal current. The visibility was regarded as good for this location. The instructor checked that all had their air turned on before anyone entered the water. The victim and his buddy were the last pair to enter the water. Their descent was slow as they experienced problems equalising their ears.

For this dive the victim was wearing his new buoyancy vest and a hired weight belt (11 kg or 24 lbs). Their contents gauges were showing 50 bar after 10-15 minutes at 32 m and they were approaching the anchor line at about 12 m when the victim suddenly grabbed his buddy's buoyancy vest and tried to suck air from it, then abruptly let go of it and disappeared from the buddy's view. She then decided, correctly, to ascend and reached the surface shortly after him.

The instructor saw a diver surface, followed shortly first by the victim (about 20 m from the boat) and then his buddy. The victim was coughing and failed to answer to calls so the instructor jumped into the water and swam with the Jesus line to these two divers. They grasped the line and were pulled to the boat. The buddy was exhausted when pulled aboard and had lost one fin. Both had positive buoyancy but is it not stated whether either had an inflated buoyancy vest. After the buddy was pulled aboard, the victim, who had been holding onto the boat waiting his turn to board, was noticed to have stopped breathing. He was quickly pulled aboard and resuscitation efforts commenced but he failed to respond. Although he had not spoken after he surfaced he had correctly followed all instructions. It is not stated whether he used either his regulator or snorkel after reaching the surface.

Examination of his equipment explained his action in trying to obtain air from his buddy's BCD as his secondary regulator was fed from his BCD. No faults were found in his equipment except for the fact that the tank was empty. A chest X-ray was performed before commencing the autopsy and this showed the presence of air in both ventricles, the right atrium, the aorta, the portal system, and inferior vena cava. There was no pneumothorax or surgical emphysema but the lung histology showed changes typical of barotrauma. The myocardium showed no ischaemic changes, the most atheroma being in the right coronary artery which had less than 30% occlusion. It is possible that nitrogen narcosis effected his response to monitoring his air supply and led to him becoming out-of-air during his ascent. The mismanaged attempt to buddy breath was a further adverse factor and was due to unfamiliarity with the equipment each diver was using.

"ADVANCED DIVER" AFTER 9 DIVES. OVERCONFIDENCE IN HIS DIVING ABILITY. OUT OF AIR. INAPPROPRIATE ATTEMPT TO BREATH FROM BUDDY'S BCD. THEN SEPARATION AND PANIC ASCENT. FACTOR OF EQUIPMENT DIFFERENCES. POSSIBLE NITROGEN NARCOSIS FACTOR. TWICE OUT-OF-AIR IN NINE DIVES OF TRAINING. OUT-OF-AIR THIS DIVE. INEXPERIENCE. PULMONARY BAROTRAUMA. AIR EMBOLISM. CAGE.

SC 96/11

During the time he was employed at this tuna farm this man received some instruction in the use of hookah (surface supply) diving apparatus. He had no formal training in its use, however. It is probable that he had made 12 dives with this equipment before the day on which the man who had "instructed" him told him to take a scuba set and dive inside the tuna cage with him help to repair the inner net. This was the first time he had ever used scuba. This employee evidently assumed that the victim's hose supply diving was sufficient diving experience for this task.

There was poor visibility inside the net and a "reasonably strong current", so strenuous exertion was required. In addition, the depth (20 m) was the deepest the victim had ever dived. Not surprisingly, his air use was heavy. Unfortunately the equipment gave little advance wanting of the exhaustion of the air until this was nearly complete. The victim approached the other diver, who was using surface supply, who signalled to him to ascend, which he did. However he failed to reach the surface and was found dead on the floor of the cage after an, initially unsuccessful, search.

Examination of his equipment showed there was no remaining air and that there was a leak in the scuba feed inflator button. This would have caused an inflated vest to deflate in about 5 minutes but had no relevance to this death as there was no air available to inflate the vest had this been attempted. The pre-autopsy X-ray clearly demonstrated the presence of air in all the cardiac chambers, and a CT examination showed air in the cerebral vessels, the sub-dural space and jugular veins. There was no pneumothorax. It is probable that he suffered the CAGE during his out-of-air ascent, lost consciousness, then sank back to the net floor of the cage. The buddy, who had told him to dive, was so overcome by what had occurred that he later committed suicide, compounding the tragedy. It is not certain that, had the buddy attempted to buddy breathe, this would have been successful in these circumstances.

FIRST USE OF SCUBA. SOME EXPERIENCE WITH HOOKAH. NO FORMAL TRAINING. WORK DIVE IN POOR VISIBILITY, STRONG CURRENT. HEAVY WORK. OUT OF AIR ASCENT. CAGE.

Discussion

Only two of the snorkel using fatalities (BH 96/4 and BH 96/11) were breath-hold diving, the other nine were swimmers using mask and snorkel, with little if any prior experience. Seven were overseas visitors. The significance of this fact may lie in their lack of swimming experience and hence panic when they experienced some problem. All the victims, except the spear fisherman (BH 96/4), were found floating quietly at the surface, in calm water. Health factors were probably responsible in 4 (BH 96/2, BH 96/3, BH 96/7 and BH 96/11). The only experienced victim suffered a post-hyperventilation blackout resulting in his drowning.

The snorkel should no longer be regarded as a totally safe piece of equipment and its use incapable of placing its user in danger. It must be recognised that in a crisis a person's mind may become so focussed on the immediate problem that it fails to allow any consideration of the alternative options for managing the situation. In respect to these fatalities it may be postulated that the unfortunate victims were so consumed with their problem of managing the entry of water through the snorkel that they never thought to remove it and face the situation by becoming simple swimmers once more. It is doubly tragic that, in at least 3 cases, the victims could have simply stood up in the shallow water.

There were 11 scuba diver fatalities identified and CAGE was identified as the critical terminal factor in 6 of them. There were several adverse factors which appeared to influence scuba fatalities, among them inexperience (Table 1), a tight wet or dry suit and strong currents. As usual, running short of air was critical in some cases. In one case an instructor was unfortunate enough to lose a pupil while in close contact and managing his ascent, this indicates the difficulty of even a trained person controlling the actions of others underwater. Inexperience, or lack of recent diving experience, was noted in seven (SC 96/1, SC 96/4, SC 96/5, SC 96/7, SC 96/8, SC 96/10 and SC 96/11). In case SC 96/9 the victim had experience of a range of diving situations but always was dependent on an extensively experienced buddy. In the fatal dive there were several new experiences, a trio group with unknown partners, a tiring surface swim to reach the shot line buoy, descent beyond the end of the line into featureless water, then isolation and nitrogen narcosis. A lethal cocktail of factors.

"Advanced Diver" is a much misunderstood term which does not mean what it suggests. It does not indicate an experienced (advanced) diver, for the Advanced Diver Certificate only means the diver has completed 9 dives under supervision. In case SC 96/5 the diver was taking an "advanced diver" course after only 4 previous scuba dives. He apparently panicked on reaching the sea bed and

TABLE 1
SCUBA DIVING DEATHS AND EXPERIENCE

Inexperienced

Case	Cause of death	Other factors
SC 96/1	Drowned	Adequate air. No dives for 5 years. Dive abandoned due to water filling mask. Rough water. Died during surface swim after separation.
SC 96/4	CAGE	Out of air during low air ascent. 12th dive. Separation during ascent.
SC 96/5	CAGE	5th dive. 1st dive on "advanced diver" course. Distress, possibly due to angina, led instructor to commence ascent with victim who removed his regulator during the ascent and would not replace it. Panic ?
SC 96/7	CAGE	Faked log book entries. Out of air solo ascent.
SC 96/10	CAGE	Advanced diver certification. On 10th dive. Deep dive. Out of air during ascent. Attempted buddy breathing.
SC 96/11	CAGE	Work dive. Some hookah experience. 1st scuba dive. Out of air solo ascent.

Experienced

Case	Cause of death	Other factors
SC 96/2	CAGE	Psychological and psychiatric problems. Deep dive aborted at 5 m. Solo dive after that. Low remaining air.
SC 96/3	Drowned	Negatively buoyant on surface. Strong current. Technical dive. Seemed to be orally inflating buoyancy compensator when he lost his grip and sank.
SC 96/6	Drowned	Solo dive, cray fishing. Legs under a ledge when found. Regulator out of mouth. Adequate air remaining.
SC 96/8	Drowned	No dives for 12 months. Navigational error underwater so surfaced in rough water too shallow for the dive boat. Adequate air remaining.
SC 96/9	Drowned	Trio separated during descent. Shot line incorrectly placed. Solo dive. Adequate air remaining.

suffered a fatal CAGE during a controlled ascent. In case SC 96/10 the victim, certified as an "advanced diver" had managed to run out of air twice during nine training dives. This warning of incompetent air management was not schooled out of him. On the fatal dive he made the same mistake again and this time unfortunately failed to survive. His attempt to "buddy breath" from his buddy's BCD implies that during training he had heard of this unusual procedure, one likely to be of little practical value compared with closer attention to his contents gauge.

There were 3 experienced divers in this series of fatalities. In case SC 96/3 it was the apparent failure to connect his BCD inflation system before entering the water which led to the need for him to attempt (unsuccessfully) to inflate his vest orally. This, combined with the strong surface current, negative surface buoyancy from wearing excessive weights, a possibly tight neck seal to his dry suit and losing of his hold on the mermaid line led to his death. In case SC 96/6 the victim was solo and the presumption is that he was concentrating so much on catching a crayfish that when he lost his regulator from his mouth he was in a position which prevented him from putting it back in his mouth and from making an immediate ascent. Case SC 96/9 is discussed above.

Health factors noted were temporary (fatigue SC 96/9, leg cramp SC 96/8), potential (the cold water asthma history in SC 96/7, personality factors in SC 96/2), or actual but unknown to the victim (myopathy SC 96/1). Depths of 30 m or greater bring nitrogen narcosis into consideration as a factor affecting the responses of the diver to his or her situation, while strong currents affected the course of the dives in cases SC 96/2 and SC 96/3.

Acknowledgments

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 the police when they are approached for assistance.

Readers are asked to assist this safety project (PROJECT STICKYBEAK) 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 avoided in future. Please write to Dr D G Walker, PO Box 120 Narrabeen, NSW 2101.

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 PO Box 120, Narrabeen, New South Wales 2101, Australia. Fax + 61-02-9970-6004

SNORKEL DIVING A REVIEW

Carl Edmonds

Key Words

Barotrauma, breathhold, deaths, decompression illness, hyperventilation, hypoxia, recreational diving, unconscious.

Introduction

Snorkel diving is related to breath-hold diving and free diving.

The earliest evidence of breath-hold diving is attributed to shell divers, around 4500 B.C.

Traditional breath-hold divers include: the female shell divers of Japan (Ama) and Korea (Hae-Nyo); the sea-men (Katsugi) of Japan; sponge divers of Greece; pearl divers of the Tuamotu archipelago and Bahrain, and the underwater warriors of Xerxes.[1,2]

The abalone and paua divers of the USA and New Zealand and spear fishermen world wide use snorkels to simplify the surface phase of breath-hold diving. Submarine escape tank operators of USA, Europe and Australia have adapted breath-hold diving to modern applications.

The number of professional breath-hold divers of Korea and Japan have remained steady at about 20,000. The pearl divers of the Tuamotu archipelago, the Middle East and the Torres Strait, as well as the sponge divers of Greece, no longer have a viable industry. The abalone and paua divers have remained fairly constant, probably only a few hundred, because of the dwindling supply of this natural resource in shallow, accessible waters.

Compressed air diving, including scuba and hookah (surface supply from a compressor), have eroded the occupational activities associated in the past with breath-hold diving.