

# Provisional report on diving-related fatalities in Australian waters 1999

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## Key words

Diving deaths, scuba, breath-hold diving, diving accidents, solo diving, CAGE, case reports

## Abstract

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In 1999 there were eleven diving-associated deaths in Australia for which data, sometimes incomplete, are available. Five deaths were associated with scuba diving and six with use of snorkels. Four scuba divers died from cerebral arterial gas embolism (CAGE) and one from running out of air. Four of the snorkellers were over 65 and three of these died from cardiac causes. One snorkeller was attempting to reach a deeper depth than he had previously achieved and hyperventilated before the dive. The sixth snorkeller was found floating just under the surface in shallow water.

## Introduction

Coronial information is available about 11 diving-related fatalities in 1999, six involving use of snorkels and five the use of scuba equipment. The main facts in these cases are discussed. Unrecognised health problems in older tourists were an important factor in the deaths of four snorkellers. The facts are summarised in Table 1 and the case reports appear below.

## Case reports

### CASE BH 99/1

This woman, her husband and their six-year-old child were day-trip visitors to an island. It is thought they did not attend the talk about the safe use of a snorkel provided on the trip out. After disembarking they went to the beach near the landing jetty. Here there was a notice stating that swimming was prohibited in this area. All three entered the water. The victim had used a snorkel only once before, seven years earlier.

After about 15 minutes of snorkelling alone, the husband returned to his wife and child, who were standing in shallow water about 15 metres from the shore. He suggested that she remain there until he returned from taking his daughter back to the beach. Because the mask he had been using had leaked, he changed his mask before returning to where he had left his wife. He was unable to see her among the others in the water so he quickly returned to the shore and ran down the jetty to ask for help from the crew of the boat which had brought them. A surface check using binoculars was unsuccessful, then he saw her lying in a small boat moored at the jetty with people attempting to resuscitate her.

Some men had seen her floating in the water beneath the jetty. At first they had thought it was a mannequin which

someone had thrown into the water as a joke, then realised it was a real woman. There was a slight delay before they noticed that, although she had a snorkel, she was not coming up for air. One of them walked to a nearby bar and asked the barman to look at her, saying "She doesn't look too healthy". The barman responded quickly, yelling for assistance before jumping in the water. She was pulled into a boat and CPR was immediately instituted. This succeeded in maintaining her alive and she was transferred to the local hospital. She died the next day from near-drowning cerebral anoxic damage.

### Comment

It is probable that this woman would have survived had she stood up. A possible reason for her failure to do so may have been the shock and surprise of breathing in water through her snorkel. Although she was not wearing fins, this need not have necessarily compromised her safety in the shallow water close to the beach. The notice prohibiting swimming near the jetty was probably designed to keep swimmers out of the path of boats approaching the jetty.

A strange feature of this case was the action of the vessel's owners, who instructed their solicitor to prevent the police from taking statements from the crew. Equally strange is the fact that this was legally permissible. As there is no reason to suppose the incident was in any way due to any act or omission of the crew this 'pre-emptive strike' appears to have been the result of a fear lest some error be alleged in their management.

### Summary

SNORKELLING; FIRST USE FOR 7 YEARS; DID NOT ATTEND INSTRUCTION SESSION; NOT WEARING FINNS; SHORT TIME OF SEPARATION; SILENT DEATH BY DROWNING IN CALM SHALLOW WATER CLOSE TO OTHERS; NO KNOWN HEALTH FACTORS.

**Table 1. Summary of diving-related fatalities in Australian waters**

Case	Age	Training and experience	Dive group	Dive purpose	Depth (metres)		Weight belt	
					Dive	Incident	On	Kg
BH 99/1	35	None	Buddy separation before incident	Recreation	< 2 m	< 2 m	None	-
BH 99/2	71	Some experience	Solo	Recreation	?	Surface	None	-
BH 99/3	24	Some experience	Solo	Recreation	22 m	Ascent	On	5
BH 99/4	75	Some experience	Solo	Recreation	2 m	Surface	On	?
BH 99/5	68	None	Buddy separation before incident	Recreation	?	Surface	None	-
BH 99/6	70	Some experience	Buddy separation before incident	Recreation	2 m	Surface	None	-
SC 99/1	31	Some training No experience	Group separation before incident	Class	2 m	2 m	On	?
SC 99/2	29	Trained No experience	Group separation before incident	Recreation	10 m	10 m	On	?
SC 99/3	65	Trained Experienced	Buddy separation before incident	Recreation	15 m	Ascent	On	?
SC 99/4	60	Trained Experienced	Buddy separation during incident	Recreation	?	Ascent	?	?
SC 99/5	31	Trained Some experience	Buddy separation during incident	Recreation	?	18 m	On	6

**CASE BH 99/2**

This man and his wife were making a day trip to the Barrier Reef. During the outward journey there was a talk on snorkelling techniques and the passengers were required to complete a medical questionnaire. On this form he declared himself as having none of the listed conditions as he had been in good health since two "minor heart attacks" in 1982. During the morning snorkelling, wearing a wetsuit and fins supplied by the company, and using his own mask and snorkel, he had no problems. After lunch the vessel moved to another location, and while his wife watched he snorkelled in the prescribed area. She saw him rest at a float station to adjust his mask, then swim back to the vessel and cling onto the bottom step of the snorkelling platform. He

spoke to his wife, who noticed that he had a "ghastly pallor", then he lost consciousness and floated away. She screamed for help and a diving instructor quickly entered the water and brought him to the dive platform at the vessel's stern, as this was at water level. The crew gave CPR and only ceased after medical advice by radio to do so.

*Autopsy findings*

At the autopsy there was noted to be emphysema involving the outer two thirds of both lungs, and carbon deposits on their surfaces. There were pericardial adhesions and proximal blockage of the inter-ventricular coronary artery. The lower abdominal aorta and the iliac arteries were described as "egg shell" calcified. Death was ascribed to a myocardial infarction.

**in 1999 (BH – breath-hold, SC – scuba, ? – unknown)**

<b>Bouyancy vest</b>	<b>Contents gauge</b>	<b>Remaining air</b>	<b>Equipment Tested</b>	<b>Whose</b>	<b>Comments</b>
No	n/a	n/a	n/a	Own	Second use of snorkel. Solo. Shallow water. Drowned.
No	n/a	n/a	n/a	Hired	Mild myocardial infarct 17 years ago. Appeared healthy. Acute myocardial infarction.
No	n/a	n/a	n/a	Borrowed weights and fins	Attempting deep dive. Hyperventilated. Unused to weight belt. Lost fin.
No	n/a	n/a	n/a	Hired	Childhood polio. Hypertension. Recent medical check. Acute myocardial infarction.
No	n/a	n/a	n/a	Hired	Last snorkelled four years before. Aortic valve replaced two years before. Surface swim separation. Probably acute cardiac arrhythmia.
No	n/a	n/a	n/a	Hired	Silent death in calm water. Hypertensive myocardial changes. Cardiac death.
Not stated	Not stated	Adequate	No fault	Hired	First open water dive with class. Rapid ascent after separation. CAGE.
Not stated	Not stated	None	No fault	Hired	Separation underwater. Drowned.
Partly inflated	Not stated	Adequate	No fault	Hired	No dives for four years. Recent refresher dive. Separation underwater. CAGE
Not stated	Not stated	Not stated	Not checked	Own	Possible underwater avalanche panic caused ascent. CAGE. Delayed death.
Not stated	Not stated	Adequate	Not stated	Hired	Sudden panic ascent. CAGE. Brain dead next day.

*Comment*

This myocardial infarction could have occurred anytime, anywhere, and was not predictable from his health history.

*Summary*

CONSIDERED HIMSELF HEALTHY; SNORKELLING IN CALM WATER BEFORE LUNCH; AFTER LUNCH SUDDEN CARDIAC DEATH IN CALM WATER; HISTORY OF TWO “MINOR” HEART ATTACKS 17 YEARS EARLIER; ACUTE MYOCARDIAL INFARCTION.

CASE BH 99/3

This youth was the son of one of the crew of the dive boat,

and a guest rather than a paying passenger. There were two groups of scuba divers aboard, under the supervision of two divemasters, and a crew of three. The club divers managed their own affairs, with one divemaster organising the scuba divers, the other and the skipper keeping a surface lookout watch on the divers. In response to his mother’s request they also maintained a watch on the youth as he snorkelled. He appeared to be making ‘duck dives’. At one time the skipper judged that the youth was getting too distant from the boat for safe observation and asked his mother to tell him to come closer, which he did. He was seen to be wearing board shorts and a T-shirt, a mask and snorkel, with strap-on fins, borrowed from his mother, on his bare feet.

After some time spent making shallow dives he apparently

told his mother that he intended to try to dive deeper, to beat his previous best of 17 metres' sea water (msw), and donned one of the weight belts lying on the deck close to the stern boarding board. His mother instructed him in how to release the belt. He asked about the depth and was told it was 22 msw. The skipper denied having any knowledge that he had donned a weight belt but had noticed that he hyperventilated to some degree before his descent. He had suggested that it was safer to have a buddy, and also that he had one arm raised as he ascended so as to know when to blow the water from his snorkel as he broke the surface. This advice was not followed.

The alarm was raised when a single fin floated to the surface close to the dive boat. One of the scuba divers, having a post-dive swim, looked down and saw a body lying face up on the sea bed 22 metres below. The divemaster who had been acting as safety lookout immediately donned the scuba set kept ready for any emergency and jumped into the water. He noted that the mask was in position, some 'facial squeeze' was present and the snorkel was out of his mouth. He released the weight belt, said to be five kilograms or less, and carefully brought him back to the surface. Once back on board the boat, CPR was commenced.

#### *Autopsy findings*

The autopsy confirmed that drowning was the cause of death, and a post-hyperventilation dilution hypoxia blackout was given as the reason. In the autopsy report it was mentioned that the brain was retained and not returned with the body, a procedural matter the subject of recent intense public interest following a New South Wales investigation into the management of bodies and body parts by forensic departments.

#### *Inquest statements*

At the subsequent inquest the divemaster stated he had initially thought the victim was one of the crew and was unaware anyone would be snorkelling. He also said that he had directly asked to be informed whenever the youth entered the water so as to know to look for him and that this was not done. There was some criticism concerning the absence of a reservoir bag on the OxyViva resuscitation equipment but this would not have affected the outcome as he was certainly dead when found. Although there was a statement in the government regulations that the emergency equipment should deliver 100% oxygen, expert opinion was presented that this was an impossible requirement.

There was much discussion concerning whether the dive-boat owner or the hirer was responsible for checking the safety equipment before a chartered dive boat left harbour. It was decided that the dive-group organiser was probably the one to have this legal responsibility. As the victim was a guest of a crew member it was decided, after some discussion, that this was not a 'workplace' death so did not

require an official investigation. If he had been a member of the scuba diver group or had performed any crew duties this would have been required.

#### *Comment*

That his mother had to show him how to release the weight belt suggests that he had no experience of diving with one. Although there was no direct description of the sea conditions, the fact that he was diving without a wetsuit and could be seen from the surface 22 metres above would imply water conditions were good. It is evident that he was far from being an experienced breath-hold diver.

The loss of one fin, possibly because of a slack strap, would have compromised his ability to swim to the surface had he become aware of an urgent need to do so before blacking out. The fins were intended to be worn over booties, and were not his own but borrowed from his mother. His clothing would produce drag and prevent his achieving a rapid descent or ascent, and therefore could have had some effect on the tragic course of events.

After this episode his mother could never bear to sail on the boat. She considered that she had a degree of responsibility for his death because she had failed to warn him of the risks of post-hyperventilation blackouts. However, her past scuba training had not left her with any awareness of this risk.

#### *Summary*

EXPERIENCED SNORKELLER; NOT USED TO DIVING WITH WEIGHT BELT; HYPERVENTILATED BEFORE DIVE; ATTEMPT TO EXCEED HIS PREVIOUS BEST DEPTH; BARE FEET; LOST STRAP-ON FIN; FAILED TO DITCH WEIGHTS; PROBABLE POST-HYPERVENTILATION BLACKOUT; DROWNING.

#### CASE BH 99/4

This man was a member of a group of 'senior citizens' from overseas taking a trip with the intention of making a reef walk. However, on their arrival it was decided that the tide was too high for this and they were offered the option of snorkelling as an alternative. They had previously been given advice regarding snorkelling. Six of them decided to snorkel. Like all of the other members of the group, he had completed a medical questionnaire. In this he stated there were no medical restrictions to his fitness to undertake the trip and noted that he was taking some medication for hypertension.

The snorkel group was taken in a rubber dinghy to a small lagoon about two metres deep, about 150 metres from the vessel. After snorkelling for about 15 minutes they were all called back to the dinghy and it was then noticed that one person, the deceased, was floating face down about 100 metres from the dinghy. The dinghy stopped a short distance

away from him as it was returning to the cruise boat, and when its presence evoked no response a crew member jumped into the water and turned him face up. His mask and snorkel were noted to be correctly in position. He was quickly pulled into the dinghy and brought back to the cruise boat where it was decided there would be no purpose in attempting CPR as he was obviously dead.

#### *Autopsy findings*

At the autopsy a scar was noted over and anterior to his left shoulder and that there was some atrophy of the left arm muscles, findings relating to childhood polio. The left ventricular wall was hypertrophied and the mitral valve showed moderate deformity, while there was moderate coronary artery disease. The cause of death was acute myocardial infarction in association with hypertension.

#### *Comment*

The fact that he was found in the water between the dinghy and the cruise boat may indicate that he felt unwell and was swimming back to it for this reason. The post-polio atrophy of one arm would not have influenced this outcome.

#### *Summary*

APPEARED TO BE HEALTHY; TAKING MEDICATION FOR HYPERTENSION; SNORKELLING IN CALM WATER NEAR OTHERS; MODERATE CORONARY ATHEROMA; ACUTE MYOCARDIAL INFARCTION.

#### CASE BH 99/5

This man and his wife were staying at an island on the Barrier Reef when they saw a snorkel dive advertised as "being for those with snorkelling experience". Their actual experience was not stated but it was probably rather less than was intended in the notice, as the man had not snorkelled since 1995. He had had an aortic valve replaced in 1997. Since then he had undergone cardiac checks every five months. These had apparently been satisfactory and his wife was unaware of any recent ill health. Although she judged the water conditions to be too rough for them she said nothing as she knew that he would have gone without her if she had refused to go and she believed he would be safer if she came to buddy him. Otherwise, she knew, he would be a solo swimmer in a crowd of other snorkellers.

There were 20 people on the 11-metre dive boat, both snorkel and scuba divers. The snorkel divers had a safety lecture during the trip out to the anchorage at a 'bommie'. The skipper and deckhand remained on board as surface safety cover for the snorkellers, while another staff member accompanied the scuba group. After swimming for a time the wife touched her husband and indicated it was too rough and they should return to the boat. Their normal practice

was to swim side by side but after they turned to start their return she lost sight of him because of the waves. She decided it was wiser to continue her return swim alone rather than try to locate him. The skipper observed him lagging behind her as they swam along the reef edge 50–60 metres from the boat as they began their return. They would have the advantage of the wind during their return. He noticed the man stop swimming and shout to his wife, who did not hear him and continued swimming. He therefore signalled to him 'Are you all right?' and received an 'OK' signal in return. The skipper was still not satisfied "as he did not seem comfortable" although showed no signs of distress or of struggling. He ordered the mooring to be cast off and motored to make a close check of his condition. The boat passed close to the victim's wife, although she did not notice it, and when they reached him they found he was now face down and unresponsive.

He was quickly brought aboard and expired air resuscitation commenced after checking his carotid pulse was present. His mask was in position, the snorkel attached but not in his mouth. The recall horn was sounded, a radio call was made for the resort's medical assistance to meet them on their return, and CPR was instituted.

#### *Autopsy findings*

The autopsy showed only minimal atherosclerotic changes in the major vessels, the prosthetic aortic valve in situ, apical adhesions to the right parietal pleura, and a 1 cm bulla on the postero-apical surface of the left lung. Vomit was present in the oesophagus and both lungs. There were also fractured ribs – parasternal right 2nd and 3rd, left 2nd to 5th, and left mid-clavicular 4th and 5th ribs. These resulted from the very desperate and vigorous resuscitation attempts. Both kidneys showed signs of infection, with pus present on the cut surfaces, and cortical scarring especially of the right kidney. The weight of the heart was 548 gm. Cardiac arrhythmia was given as cause of death.

#### *Comment*

Another senior citizen, this time with a mistaken belief that he was fit for anything. Just because ordinary exercise is within a person's effort tolerance it does not mean that harder work can be tolerated without problems. Buddies who are out of sight or who cannot see you are no help in an emergency.

#### *Summary*

LAST SNORKELLED IN 1995; AORTIC PROSTHESIS INSERTED 1997; EXCESS BELIEF IN HIS ABILITY TO COPE WITH THE WATER CONDITIONS; SURFACE SEPARATION FROM BUDDY IN ROUGH SEA; RENAL INFECTION; PATENT CORONARY ARTERIES; DEATH PROBABLY DUE TO ACUTE CARDIAC ARRHYTHMIA.



## CASE BH 99/6

This man and his wife were members of a group travelling to visit the Barrier Reef. They received a talk on snorkelling and general safety matters translated into their language by their tour guide during their outward trip. This included a requirement to report any medical problems. On arrival at the cay the passengers were transferred to the beach and snorkelling equipment was distributed, with buoyancy vests offered to anyone who wished for one. The victim had brought his own gear as he was concerned about the hygiene of company equipment. However, he was reassured as to this company's practices and used the offered equipment. There was a designated snorkelling area watched over both from the vessel and by a crew member on the beach, who could radio for a replacement if he had to enter the water to assist a swimmer. The sea was calm and the weather fine.

The victim had swimming and snorkelling experience and no significant medical history, so while four passengers were receiving instruction in snorkel use and others waded in the water, he was among the three or four experienced snorkellers who headed off to view the highlights of the safety zone. His wife remained on the beach. He returned to her after a short time to leave his fins as they were annoying him and he usually wore none, then he returned to the water. She later noticed he was stationary, floating face down. She was not initially concerned as she assumed he was taking photos. He was about 20 metres from the beach, not swimming, and then started to float away from the shore. Next there was a shout from some people in another boat who were pointing to a floating body. The shore safety watcher immediately informed the dive boat and then took his tender to give assistance.

First to reach the victim were two people who had swum out from the beach. They rolled him face up and noted that his face was cyanosed and he was unconscious and not breathing. They were towed back to the beach holding onto the tender and there CPR was commenced after removing his false teeth. However, the facial change this created resulted in the pocket mask not sealing properly. They continued CPR, changing places, until the oxygen respirator arrived from the boat. They initially experienced problems from regurgitation of food and water after nearly every breath they gave him. He was transported back to the boat on a stretcher and resuscitation efforts were continued until advised to cease by an emergency doctor by radio from a hospital.

*Autopsy findings*

The autopsy showed the heart weighed 529 gms and there was up to 40% narrowing within the left anterior descending coronary artery. The left ventricle was 2.1 cm in thickness. The diagnosis was death due to hypertensive heart disease and coronary heart disease. His only medication was "Xatral" (alfuzosin hydrochloride) for his prostate.

*Comment*

Again the victim was a senior citizen. Many elderly people live unaware of their hypertension until they see the doctor about something else, such as prostate problems. Many over the age of 65 have difficulty accepting that their effort tolerance is no longer that of a fit 40-year-old.

*Summary*

APPARENTLY FIT AND ACTIVE MAN ON PROSTATE MEDICATION; SILENT DEATH SNORKELLING IN CALM WATER; UNDIAGNOSED HYPERTENSIVE MYOCARDIAL CHANGES; CARDIAC DEATH.

## CASE SC 99/1

This death occurred during the first open water dive of a basic scuba course. The sea was calm, with only a slight swell and tidal current. The visibility was 5 to 8 metres. The dive boat landed the class on a beach then took some scuba divers to another location. The instructor chose to lead his class of four in a 'V' formation from the beach. The victim was the second student on the instructor's left. The party descended slowly and after 1 to 2 minutes, at about 2.5 to 3 msw, the victim was missing. The instructor immediately brought the three other divers to the surface and told them to look around for bubbles coming to the surface. The dive boat returned at this time and a surface search was made from it and another nearby boat.

The body was found sitting on the sea bed by the instructor during his underwater search, less than 20 metres from the shore, depth two metres, about 25 minutes after his absence was noticed. CPR was unavailing.

During the inquest the victim's sister, who was in the same scuba class, said that both of them had experienced problems with the class work because of language difficulties. They had required the instructor's help to pass the second exam of the course.

A child witness described seeing a distressed diver come to the surface, then rapidly submerge. The witness also mentioned seeing the "whole top part" of the diver's body, that he probably did not have the regulator in his mouth, and that there was a "pretty loud noise like he was taking a very big breath, like gasping" before he went straight back under the water.

*Comment*

The child witness's statement is very suggestive of cerebral arterial gas embolism (CAGE) but the autopsy report is not yet available (July 2005). Panic induced by losing sight of the other divers may have precipitated a dash for the surface and breath-holding made this dash fatal. Buddies, or instructors, who are out of sight or who cannot see you are

no help in an emergency. Unfortunately to lead a dive an instructor needs to be in front and to watch over a group he needs to be behind it. As long as instructors take more than two students with them underwater, separation of the group can occur and separation may lead to incidents and death.

This death occurred during the first open water dive of a basic scuba course; it demonstrates the narrow safety margin between a safe or a fatal course of events.

#### *Summary*

LANGUAGE PROBLEM IMPAIRED TRAINING; FIRST OPEN WATER DIVE OF COURSE; ENTRY FROM BEACH; SHALLOW CALM WATER; SCUBA INSTRUCTOR LEADING FOUR STUDENTS; SEPARATION; WITNESS SAW DIVER COME TO SURFACE "LIKE A ROCKET"; CLINICAL VERDICT WAS PROBABLE CAGE.

#### CASE SC 99/2

This overseas visitor had been trained to dive 21 months earlier. Apparently the course provided only four dives in an indoor pool. She had not dived since then. She signed up at a dive shop for some guided dives under the direction of an instructor who was a compatriot of hers. There was to be a third member of the dive group, another compatriot of similarly limited diving experience (nine dives). She, however, had taken a short 'refresher' dive with the instructor a few days before this dive so was better prepared to make the open water dive. The victim's first open water experience was an uneventful morning dive in a small sheltered bay with good visibility and a variety of marine life. This bay was considered so safe that it was used for training by local dive schools.

The instructor said that he showed the area to them and described the dive plan before they kitted up. He stated he checked that they had correct weights, and assisted the victim to assemble her gear as she had largely forgotten what her course should have taught her. He included instruction on how to inflate the BCD. It is uncertain whether he reminded them of the buddy system or of the rule to ascend to the surface if separation occurred. It is clear that he was treating her like a pupil rather than a certified diver. They moved slowly to enable him to assess their skill levels during the first dive, with a maximum depth of 10 msw.

For the surface swim out from the beach, they were told to partly inflate their BCDs. During their first dive she experienced some problems equalising her ears so before their second dive the instructor made her practise equalising them five times. Their second dive was to be a little longer and deeper than the first. The plan was for him to lead, the other two to follow, but it is thought that the buddy was alongside him and the victim was behind them. On the first dive she had used less air than her more practised buddy.

Fresh cylinders were used for the second dive. She had no equalising problems on this dive. The instructor pointed out marine life on the reef, looked without success for a Weedy Sea Dragon, then checked their air. The victim still had 130–140 bar but the buddy was down to 100 bar, so the instructor decided to start their return to the beach. He believed that he had signalled his intent but the victim evidently failed to see it and separation occurred, though he claimed they had made eye contact. Visibility was 10 metres but when he looked back "in 30 seconds" she was not in sight. He brought the buddy to the surface and then searched the surface for signs of bubbles but saw none, so dived again to make an underwater search. This proved unsuccessful so he surfaced and brought the buddy back to the beach. He then made a further 30–40 minute underwater search till his air supply was exhausted. It was his hope that she had joined some other divers, but this was not the case.

An intensive search was instituted but was unsuccessful. This was concentrated on the area where the separation had occurred. She was found three days later by local divers who used two underwater scooters and a careful search pattern in an area further from the shore than the original search area. All her equipment was in place and her air cylinder was empty. She was said to be short-sighted but did not wear glasses for everyday activities so this was not considered to be a factor significant in her death.

#### *Comment*

What occurred can never be known but it is probable that when the victim found herself alone she panicked and did not think about such basic actions as ascending to the surface or dropping her weight belt, and then drowned when she ran out of air, still focused on trying to find the other two. It was only her second open water dive. As the coroner said, it is one thing to listen to what may have been spoken about in general terms 21 months before, but quite another to know what to do when panic comes after finding oneself alone underwater. Indeed, the instructor himself stated about his compatriots, "they are more used to being guided underwater rather than diving by themselves". Unfortunately he did not let this acute observation govern his actions in the management of these two divers. Overseas-trained divers have not necessarily been trained in, let alone have experienced, diving conditions similar to those they find in Australia, but this may not be taken into account when they present a certificate of training. Such was the situation here.

#### *Summary*

OVERSEAS TRAINED; SECOND OPEN WATER DIVE; TRIO GROUP LED BY INSTRUCTOR; SEPARATION; CALM WATER; FAILED TO DITCH WEIGHTS OR INFLATE BCD OR ASCEND TO SURFACE; MILD SHORT-SIGHTEDNESS; CULTURAL FACTORS SIGNIFICANT; DROWNED.

## CASE SC 99/3

The victim and her husband had dived for many years in a range of locations. However, because they had not dived for about four years before this incident they took a refresher dive before coming to the resort island. Although she suffered some mild seasickness on the trip out to the island this had resolved by the next day when they joined 18 others for a guided dive. The instructor gave them a talk on the trip to the mooring. Here the four photographers in the group chose to dive independently while the remaining 14 divers continued with the instructor, who was acting as a divemaster.

This couple were aware they were likely to have ear equalisation problems so they spoke to the instructor and they were among the first to enter the water and descend. On the seabed, 10 to 15 metres down, they adjusted their buoyancy and joined the group around the instructor. After a short time the husband found he was experiencing a problem with water in his mask and turned away from his wife while clearing it. When he turned back he was unable to see her but presumed she was among the other divers. When the instructor next checked the group he noticed that one diver was missing and followed protocol by looking around for about two minutes, then rounded up the group and brought them slowly up the mooring line, making a safety stop for three minutes at five msw. Earlier in the dive one buddy pair had left the group after notifying him. When they reached the surface he saw another dive boat was now alongside his dive boat. When he came aboard he saw that CPR was being given to a diver. During the dive he had kept all of the group within about 10 metres of himself, visibility being about 15 metres.

The skipper of the other dive boat reported how they had seen a diver at the surface close to the reef edge, who had descended again. They later saw the deceased come to the surface gently, apparently face up. There was no movement and their first impression was that this was a turtle. There was no response to an 'Are you OK' signal so the decision was taken to go and investigate. She was about 40 metres off the reef edge, unresponsive, mask on, regulator floating free, with blue lips and dilated pupils, and her eyes looking cloudy or foggy. Her BCD had a little air in it but was not full. The weight belt was in place and one fin was off. CPR was commenced as soon as her backpack was taken off. Oxygen was given and a radio call made to alert the resort nurse. A trauma physician who was staying at the resort assisted the resuscitation efforts. Radio contact was made with a mainland medical emergency service before CPR was discontinued. A check of the contents gauge showed 120 bar pressure remained – the initial pressure had been 200–210 bar.

*Autopsy findings*

A CT scan was performed of the head, neck, chest and abdomen before the autopsy was commenced. This showed extensive intra-arterial gas throughout the cranium, neck, thorax, abdomen and pelvis. Pockets of gas were seen anteriorly within the chambers of the heart but there is no description of which chambers were involved. There was a moderate-sized left pneumothorax, and there was some calcification in the right lobe of the liver that may indicate a history of previous granuloma. The coronary vessels were widely patent and showed only mild atheroma, while histology of the lung showed alveolar spaces apparently distended, with occasional alveolar haemorrhage. Some alveolar spaces contained a small amount of gastric contents. Also mild nephrosclerosis and nephrocalcinosis were noted.

Her health history was of a mild, non-medicated hypertension, hormone replacement therapy, and vitamins. She had an annual health check and, like her husband, took regular exercise. The equipment check, which did not record the weight of the belt, revealed no significant faults. The regulator mouthpiece had excessive perishing and a hole, but there was no water entry when it was tested. The air contained no contamination. There was a comment that the equipment required some maintenance but was functional. She was wearing a prescription mask.

*Comment*

It is difficult to imagine a reason for this experienced, though 'rusty', diver to leave her buddy without warning, particularly as there were others close by, the visibility was good, water calm, she had plenty of air remaining, and her equipment was working correctly. No reason for her to have been 'spooked' has been identified, and even had she experienced a spray of water through the regulator this should not have caused her to panic. The skipper's report suggests she did not surface violently, and the BCD was apparently only partially inflated, which suggests she made a swimming ascent but omitted to breath regularly, or exhale adequately, during her ascent. The severity of the pulmonary barotraumas and of the CAGE was remarkable. The missing fin probably came off during her recovery. Once again, separation was the first step on the path to disaster.

*Summary*

TRAINED, EXPERIENCED DIVER; NO DIVES FOR FOUR YEARS; RECENT REFRESHER DIVE; WELL-ORGANISED DIVE; GOOD WATER CONDITIONS; UNEXPLAINED SUDDEN SEPARATION FROM BUDDY; SOME AIR IN BCD; PRESCRIPTION MASK; SOME HYPERTENSION; MASSIVE CAGE.



## CASE SC 99/4

Although this incident occurred outside Australian territorial waters it is included as the victim was evacuated by air and died in Australia, so was investigated on behalf of the local coroner. He was an experienced diver who was making his 23rd annual live-aboard trip with friends of long standing. He and his buddy were at an unstated depth when they were enveloped in material from either an underwater avalanche or the collapse of the rock shelf above them. They apparently made an ascent together until about three metres from the surface, at which time the victim reportedly removed his mask and made a rapid ascent to the surface. He was unconscious when reached. CPR was quickly initiated aboard the yacht and this was continued until he was evacuated by air to Australia for specialist treatment. He died in hospital from a cardiac arrest.

*Autopsy findings*

The autopsy showed minimal atherosclerosis in his heart. He had had a left-sided thoracotomy some years before for a "non-malignant condition" and a few pleural adhesions were noted. Inflation of the lungs was performed and an air leak was demonstrated into the pulmonary circulation from the posterior aspect of the left lung. This led to the pathologist's diagnosis of CAGE, which was supported by the typical history of a CAGE diving incident, though the period of treatment since the accident had removed the possibility of gross intravascular air being found.

*Comment*

Unfortunately there is no record of any examination of his equipment being performed, so there are no details as to whether he had adequate remaining air, inflated his BCD, dropped his weight belt, or was using his regulator during the final stage of his ascent.

The diver fitted the definition of a senior citizen in the State of Victoria, being over 60 years old. There was no evidence that he had been diving since his last annual diving holiday. Being involved in a rock fall could well have overwhelmed his years of experience.

*Summary*

EXPERIENCED DIVER; ENGULFED BY UNDERWATER AVALANCHE; ASCENT WITH BUDDY; SEPARATION; RAPID MASK-OFF ASCENT LAST THREE METRES; UNCONSCIOUS AT SURFACE; DIED IN HOSPITAL AFTER AIR EVACUATION; CAGE; TERMINAL ACUTE CARDIAC FAILURE.

## CASE SC 99/5

The victim was an overseas visitor of limited experience who joined a three-day live-aboard trip to dive on the Barrier Reef. He had been trained two years previously. The boat carried a group of dive pupils with their two instructors, and another diver who had an Advanced Diver certificate. This man's experience was about 30 dives greater than the victim's. One of the instructors got them to fill out a form to detail their dive experience, and a liability-release form, then issued them their equipment. This instructor also gave them a talk covering good diving practices. Although the company manual stated that all divers should be taken on an assessment dive before they were allowed to dive unaccompanied by an instructor, this was not thought necessary as he had recently made a dive with the company and performed in a correct manner.

Their first dive was rapidly aborted when the victim's personal mask leaked due to separation of the face plate. An instructor assisted their return. Following the return of the trainee divers the boat was driven to another area close to a reef wall and the skipper took the two trained divers in the outboard tender to a place where they could descend and drift back to the dive boat along the wall. The skipper noticed that the victim was having great difficulty in descending headfirst, so advised him to descend upright and hold the deflator hose above his head. He appeared to be normal in his demeanour and followed the advice successfully. The skipper told them he would remain and drift around as their surface supervisor. The visibility was good, 20 metres or so, and he remained still and watched their bubbles ascending. Then he noticed there were a lot more bubbles, rather like shaken soda water, and the victim shot up through the surface right to his waist. His mask was off his face and he made a sound like a shout, then flopped face down in the water. He was only about 10 metres from the tender so was rapidly reached and taken aboard. The buddy surfaced very soon afterwards.

The buddy first met the victim on the dive boat when the equipment was being handed out. He thought the victim appeared to be anxious about his mask, taking a second one as a spare. They were briefed by one of the diving instructors to follow behind the students for their first dive of the trip and reminded of the good diving practices they should follow. He thought the victim was still anxious as they started their first dive, as shown by his quick movements, heavy breathing, and difficulty at the surface until the instructor ascended and took him back to the dive tender because of the separation of the mask's skirt from the face-plate frame. The buddy joined the instructor and continued with the dive.

After this dive, the boat was moved to another location and the next dive was arranged after checking that a sufficient surface interval had elapsed. The buddy was surprised that when he suggested they prepare for this dive the victim

asked for time to have a few minutes' sleep, which he took to indicate nervousness, a need to collect himself. After they had checked each other's equipment they got into the tender with the skipper. The victim was slow to descend but did so after advice from the skipper of making a feet-first descent. The buddy kept a close watch on him as they descended and they exchanged frequent OK signals. They descended quickly to 18 msw then gradually swam back up to 14 msw, their planned dive depth. The victim showed his inexperience by jerky movements "like a diver in training". They swam along the reef wall for a few minutes, the buddy keeping him in constant view, though unable to establish eye contact. The victim continued to give the impression to his buddy that he was anxious, then he suddenly began to swim horizontally away from his buddy very fast. There was no apparent reason for his action. His buddy followed, assuming that he would look round and accept a 'slow down' signal. Suddenly he became vertical, began to fiddle with his mask, his rapid movements indicating extreme anxiety and his breathing rapid and heavy. He then started kicking hard towards the surface holding his mask. The buddy was able to watch his ascent, which was faster than his bubbles, and his recovery by the skipper. He was not able to see whether he breathed out during his ascent but saw him go limp before he reached the surface. He then made his own ascent. Frothy blood was coming from the victim's mouth, his eyes were open, and "he looked bad".

Once back on the dive boat, CPR was commenced. CAGE was diagnosed and a radio call for assistance was made. Instructions were received to go to a helicopter pontoon 13 miles away, which they did at maximum speed, and from there he was taken to a hospital that had a recompression chamber. At the hospital, bilateral intercostal catheters were inserted and a chest X-ray showed gas in the mediastinal, pericardial, and subcutaneous tissues across his chest. CT scan of his brain showed gross oedema and presence of some cerebral perfusion. Hyperbaric treatment to 18 metres with 100% oxygen proved unavailing and he remained deeply unconscious. He developed high-output renal failure, a suspected centrally mediated diabetes insipidus, and other metabolic derangements. Brain death was confirmed by two independent specialists the next day.

#### *Autopsy findings*

At autopsy pin-point air leaks were noted on inflation of the lungs and multiple scattered air blebs were present over the surfaces of both lungs. The diagnosis of CAGE was confirmed. Examination of the equipment showed it functioned adequately in a static situation and met the manufacturers' performance specifications. However, the regulator was noted to be in poor mechanical condition from lack of regular maintenance, and unhygienic due to the lack of, or poor, cleaning. It was not tested to establish how it would satisfy the demands of a panicking diver. The mask had some splits and holes in the skirt that allowed

ingress of a small amount of water initially but more when the mask was moved or pressure was reduced by the wearer inhaling from it. Although the remaining air was not recorded there is every reason to believe the tank contained more than sufficient air had the victim remained still and regained his composure.

#### *Comments*

While the matter is not noted, it is probable the BCD was not inflated. Water inflow into the mask may have exacerbated the victim's anxiety level during the dive. Once panic occurs the diver is at extreme risk of dying even though well supplied with air and close to his buddy. Such was the case here.

#### *Summary*

TRAINED BUT INEXPERIENCED; LACKED CONFIDENCE; PROBABLE MASK PROBLEM WITH WATER ENTRY; POSSIBLY INADEQUATE AIR SUPPLY FOR A PANIC BREATHING SITUATION; PANIC ASCENT; FAILED TO DROP WEIGHT BELT; CLASSIC CAGE SYMPTOMS; BUDDY ACTIONS COMMENDABLE.

#### **Discussion**

The rationale for the existence of the medical sub-specialty of diving medicine is to reduce to a minimum morbidity and mortality among those who 'dive' or enter an environment of significantly changed ambient pressure or breathing medium. The basis of advice is theory soundly based on case studies and experiments. In the case of diving-related fatalities, the most complete and comprehensive body of information is the investigations into such fatalities made on behalf of coroners. This is particularly so in Australia where such data are available far more readily than in other countries. Such form the basis of this and previous reports.<sup>1,2</sup> However, one of the difficulties in properly assessing diving-related deaths is the time it takes to obtain all the various reports.

Examination of the data from cases in which a snorkel was being used confirms yet again the findings of previous reports that show clearly that hyperventilation to increase depth and duration of a dive can be fatal (BH 99/3). This is a lesson that appears to require successive generations of divers to learn anew. Case BH 99/1 is a reminder that a person inexperienced in the use of a snorkel can drown in water so shallow that they would have saved themselves by placing their feet on the sea bed and standing up. It possibly demonstrates the fatal 'tunnel vision' effect on the thought processes of a person faced with an unexpected problem while in the process of concentrating on trying to perform a new skill.

Four of the dead snorkellers were over 65 years old. Health problems are more frequent in older people. In the four

senior citizens, a cardiac factor was the most probable critical factor. None of these persons regarded themselves as being unhealthy, and it is unlikely a routine medical check would have raised warnings of their risk of death. It may be necessary to regard such deaths as an unavoidable fact of life, though asking about health histories is certainly appropriate and of potential value. However, determination to snorkel or scuba dive has long been known to lead to suppression of the answers that would bar the person from such activities.

There are significant lessons to be learnt from the cases reviewed here for those who organise scuba dives involving inexperienced divers from overseas, or who teach persons in other than their first language. There is also the confirmation of the fact that an instructor leading others cannot perfectly monitor them constantly. This is sadly demonstrated in cases SC 99/1 and SC 99/2. It is of particular importance to be aware of the different expectations vested in the dive leader by some overseas cultures. Instructors have great responsibilities and it is difficult for them to adequately cover every eventuality, particularly where a dependent diver fails to follow reasonably expected responses to becoming separated. Perhaps it is time to encourage groups to have two safety divers, one the dive leader and the other the rearguard. Self-interest should ensure all those involved with inexperienced scuba divers are aware that proof of training is no guarantee of a diver's competence in an open water environment.

### Conclusions

Once again the 1999 fatalities in Australia highlight both the avoidable risks of snorkelling and the risks to elderly, apparently fit, people in the age group where sudden death is an unavoidable reality. The efforts made by watchers and others to resuscitate the victims are commendable.

Four of the scuba divers died from CAGE. Only one of these was an inexperienced diver. One diver, in a class doing

its first sea dive, died with an empty tank after losing the group.

A constant problem for dive-group leaders is having to both lead a group and simultaneously closely watch over its members. Leading requires being in front and watching over a group requires being behind it.

When welcoming visitors to the Great Barrier Reef there is the problem of adequately imparting vital safety information to those for whom English is not their first language. Some of the scuba divers have little, if any, experience and may expect to be nannied by their dive leaders. When planning dives these facts should be considered in order to increase the safety of those involved.

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