

# Original article

## Provisional report on diving-related fatalities in Australian waters 2000

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### Key words

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

### Abstract

(Walker D. Provisional report on diving-related fatalities in Australian waters 2000. *Diving and Hyperbaric Medicine*. 2006; 36: 62-71.)

A total of 16 fatalities were identified from official sources as having occurred during 2000. Nine deaths were in association with freediving or snorkelling and five with scuba. There was also one death where surface-supply air was involved, and one where the equipment used was not clearly identified. The investigation of many of the first group did not, in fact, proceed to a coroner's inquest but the investigation documentation is available. The case summaries are presented with attention to the diver performance, equipment and medical factors. Important adverse factors are identified and discussed for each of these groups, with comments on possibilities for reducing the number of fatalities that occur. Many of the factors involved in these tragedies have recurred time and time again in the case histories reported over many years from Project Stickybeak.

### Introduction

Project Stickybeak is an ongoing investigation into Australian deaths associated with freediving, snorkelling and diving using scuba or surface-supply equipment, and has been running since 1972.<sup>1-3</sup> The case histories of 16 deaths associated with freediving, snorkelling, scuba and hookah diving in the year 2000 are reported here and summarised in Table 1.

The National Coroners Information System (NCIS) was searched and details of identified cases made available for this investigation by the State Coroners and NCIS. Not all deaths associated with snorkelling are notified to coroners for investigation by the police. Therefore, several additional sources of information needed to be interrogated including the media. Fortunately the Queensland Workplace Health and Safety (diving) department provides information on such events in the Great Barrier Reef area even when they do not fall within its area of responsibility. A few cases are known only through notification by the police, private investigators, the Divers Alert Network Southeast Asia-Pacific (DAN SEAP), or through the media.

The basic purpose of coroners' enquiries is to determine who died and why, and to make comment on the lessons to be drawn from such tragedies. Access to the information resulting from police investigations on behalf of the local coroner is an essential element of investigations such as Project Stickybeak. This documentation often contains the only reliable information, as police 'incident' investigations now elicit most of the details needed to understand the factors involved in diving-related deaths. Despite this, data are frequently missing and autopsy reports are not always as

detailed as would be expected. The evidence often contains a range of estimates on depths, distances, and the experience of those involved, while the available health history of the deceased is usually minimal at best. However, Australia is fortunate in having this official support for diving fatalities research. Therefore, Project Stickybeak reports inevitably contain an element of bias in determining the most likely course of events in an accident where the documentary data reflect variation in witness recall.

### Case reports

#### CASE BH 00/1

This 80-year-old lady, described as mentally alert and active despite some pain from past right hip and bilateral knee replacements, was with a group of retirees from overseas. She had met none of them previously. They were on a day trip to view the Barrier Reef and received the regular talk on snorkelling during the trip out to their destination, a pontoon at a reef. She wore a buoyancy vest for her first snorkel swim but, after making a trip in the glass-bottomed boat, did not wear one for her second swim. Although there were sometimes up to 200 people in the water under the watch of a crew member in a high chair, at this time there were only about 20 in the water. Her absence was not noticed till a count was taken before the boat left the pontoon. A determined search did not find her body. There is no information concerning her past health or whether she had ever previously used a snorkel, but she was said to have been a good swimmer. The safety watcher had not observed any unusual behaviour in any of those in the water and it is unknown whether she silently sank or drifted away. The cause of death is unknown.

*Summary*

ELDERLY; APPARENTLY FIT; HISTORY PAIN FOLLOWING BILATERAL KNEE REPLACEMENTS AND RIGHT HIP REPLACEMENT; SNORKELLING; NO BUOYANCY VEST; SILENT DEATH IN WATCHED, CALM SEA; BODY NEVER RECOVERED.

## CASE BH 00/2

This 79-year-old man was also an overseas visitor making a day trip to the Barrier Reef. He appeared to be fit and after the instruction talk on snorkelling he did not declare any medical conditions. There was no indication that anything was wrong till the safety lookout saw a group of three snorkellers waving to catch his attention. When he reached them he found two were supporting the third, who was now unconscious. Attempts to resuscitate him were unsuccessful.

*Autopsy*

The autopsy showed an acute myocardial infarction.

*Summary*

APPARENTLY FIT; SNORKELLING IN CALM SEA NEAR OTHERS; SUDDEN DEATH; ACUTE MYOCARDIAL INFARCTION.

## CASE BH 00/3

This 30-year-old man had been spear fishing for 15 years and was known to be capable of diving to a depth of 30 metres' sea water (msw). He was with a friend but they were about 60 metres apart to avoid interfering with each other's hunting. The buddy became cold and left the water after a time to sit on the beach. Although he could not see his friend this did not worry him, as the latter was wearing a black wetsuit and his float was black. It was only after about three hours that he became concerned and persuaded a man to take him out in a boat to search, which was not successful so the police were notified. The float was found but the line could not be pulled up as it was entangled in the kelp. It was now getting dark so it was not until the next day that the police divers could search for the body. The spear gun was recovered but the spear was not found. The body was never recovered.

*Comment*

This is a typical scenario for a post-hyperventilation ascent hypoxia drowning. There was a history of him having survived such an episode in the past, being fortunate to regain consciousness on the surface on that occasion.

*Summary*

BREATH-HOLD, EXPERIENCED SPEAR FISHERMAN; SOLO; PROBABLE POST-HYPERVENTILATION ASCENT HYPOXIA; BODY NEVER RECOVERED.

## CASE BH 00/4

This 31-year-old man had no admitted ill health and, like his friend, was an overseas visitor. While the friend was an experienced breath-hold spear fisherman, he himself was described as 'not confident enough to [scuba] dive'. Indeed, his friend checked his ability to swim using a snorkel for about two hours before feeling satisfied it was safe to leave him and go ashore for a shower. When he returned an hour later he could not see his friend, then he was alerted to a dive boat which had found him floating unconscious. The victim failed to respond to resuscitation efforts.

*Autopsy*

The autopsy revealed the presence of significant coronary atheroma with vessel narrowing, the left anterior descending showing 80% narrowing at one place, which may have been a significant factor leading to his drowning. There was no evidence of a myocardial infarction.

*Summary*

INEXPERIENCED SNORKELLER; APPARENTLY FIT; SOLO; CALM SEA; SILENT DEATH; SIGNIFICANT CORONARY ATHEROMA; PROBABLE CARDIAC DEATH.

## CASE BH 00/5

A 75-year-old woman and her husband were amongst the passengers on a day trip to view the Barrier Reef. There was a talk on safe snorkelling during the outward trip and there was a request for anyone with a health problem to discuss the matter with a crew member. Neither reported a health problem and the available records fail to provide any details. On arrival at the cay there was a further briefing and instruction in snorkelling offered, but it is not known whether this couple accepted this instruction. There were two safety lookouts watching over the 40 persons in the water off the beach, one on the boat and the other on the beach. When the latter decided to take the small tender out to assist some swimmers he first arranged for another to replace him on the beach. The water was calm but there was some current. He noticed one person, who was wearing a buoyancy vest, drifting face down among the other swimmers and snorkellers and went to investigate. The unconscious woman was quickly brought to shore but could not be resuscitated. It was suggested that she may have been floating unconscious for 15 minutes before this was noticed.

*Autopsy*

Unfortunately no autopsy report is available. However, the pathologist decided this was a case of drowning but offered no reason for it to have occurred in calm water in a person wearing a buoyancy vest and close to others, so it is not possible to evaluate whether there was a cardiac cause for her death.

**Table 1. Summary of diving-related fatalities**  
(BH – breath-hold, BSB – buddy separation before incident, GNS – group not separated,

Case	Age	Training	Experience	Dive group	Dive purpose	Depth (metres)		Weight belt On	Kg
						Dive	Incident		
BH 00/1	80	Nil	Some	Solo	Recreation	Not stated	Surface	None	n/a
BH 00/2	79	Not stated	Not stated	GNS	Recreation	Not stated	Surface	None	n/a
BH 00/3	30	Not stated	Experienced +	BSB	Spear fishing	25	Ascent	On	6
BH 00/4	31	Nil	Some	BSB	Recreation	9	Surface	None	n/a
BH 00/5	75	Not stated	Not stated	GNS	Recreation	Not stated	Surface	None	n/a
BH 00/6	27	Nil	Not stated	Solo	Recreation	Not stated	Surface	None	n/a
BH 00/7	60	Not stated	Not stated	GNS	Recreation	Not stated	Surface	None	n/a
BH 00/8	28	Not stated	Not stated	GNS	Recreation	Not stated	Surface	None	n/a
BH 00/9	55	Not stated	Not stated	Solo	Recreation	Not stated	Surface	None	n/a
SC 00/1	24	Trained	Nil	BSB	Recreation	21	17	Ditched by buddy	7
SC 00/2	30	Trained	Experienced	BSB	Cray fishing	20	Not stated	Not stated	?
SC 00/3	27	Trained	Experienced	Solo	Work	9	9	On	6
SC 00/4	30	Trained	Experienced	GNS	Recreation	54	54	Ditched by buddy	?
SC 00/5	29	Trained	Experienced	BSB	Recreation	10	10	On	10
H 00/1	20	Scuba	Experienced	Solo	Work	9	12	On	?
X 00/1	31	Scuba	Nil	Seprn	Work	Not stated	Not stated	On	Not stated

### Summary

SNORKELLING; NO HEALTH HISTORY; POSSIBLY NIL SNORKEL EXPERIENCE; WEARING BUOYANCY VEST; SILENT DEATH CLOSE TO OTHERS IN CALM SEA; GOOD LOOKOUTS SAW NO DISTURBANCE TO SUGGEST ANYONE IN TROUBLE; NO AUTOPSY REPORT BUT REPORTED AS DROWNING; POSSIBLE CARDIAC DEATH.

### CASE BH 00/6

This 27-year-old man was a member of an overseas group of employees visiting Australia. The record is very limited

concerning the lead-up to this fatality beyond the statement that he was snorkelling off a beach when he cried out for assistance. He was apparently alone at the time. His cry was heard by a witness who was mooring an empty dive tender 30 to 50 metres from him. She saw someone waving their arms and initially thought it was to people on the beach, then realised he might be in trouble and alerted the lifeguard on the beach. Each then swam out to him to give assistance. As he was swimming out, the lifeguard observed the person appear to have a convulsion and his body come half out of the water. When reached, the person was unconscious, cyanosed, and floating face down. They placed him on a surf ski and brought him back to the beach. He failed to respond to resuscitation.

**in Australian waters in 2000**

**GSB – group separation before incident, H – hookah, SC – scuba, ? – unknown, )**

<b>Bouyancy vest</b>	<b>Remaining air</b>	<b>Equipment Tested</b>	<b>Whose</b>	<b>Comments</b>
Off	n/a	n/a	Dive boat	Possible cardiac death. Body never recovered.
Nil	n/a	n/a	Dive boat	Cardiac death.
Nil	n/a	n/a	Own	Probable post-hyperventilation blackout. Body never recovered.
Nil	n/a	n/a	Hired	Cardiac death.
On	n/a	n/a	Dive boat	Drowned. Possible cardiac death.
Nil	n/a	n/a	Hired	Drowned.
Nil	n/a	n/a	Dive boat	Acute heart failure.
Off	n/a	n/a	Dive boat	Drowned. Epilepsy.
Nil	n/a	n/a	Not stated	Drowned. Possible cardiac death.
Not stated	Nil	Fault	Dive shop	Drowned. Inexperienced. Fatigue. Cold. Buddy breathing failed. Out of air.
Not stated	Not stated	Fault	Own	Body never recovered.
Nil	Not stated	Nil to test	Employer	Drowned. Commercial diver. No wetsuit. No lifeline. Fatigue. Body never recovered.
Not stated	++	NAD	Borrowed twin set	Cerebral arterial gas embolism (CAGE).
Not stated	+	NAD	Hired	Drowned. Aborted dive as “felt uncomfortable”. Health?
Nil	n/a	Fault	Employer	Drowned. Wave swamped boat. Regulator separated from hose.
Not stated	n/a	Fault	Employer	Possible seizure condition.

*Autopsy*

At autopsy, his heart and coronaries were healthy, and the cause of death was given as drowning. The pathologist offered no comment concerning the cause of the ‘convulsion’.

*Comment*

There is a total absence of any information concerning his swimming and snorkelling experience or where the other members of his group were at this time. The sea conditions were described as far from inviting as it was raining, overcast, windy, with a 0.8 metre swell, so his decision to enter the water alone is strange.

*Summary*

SNORKELLING; UNKNOWN HEALTH AND SNORKEL HISTORY; SOLO; ADVERSE SEA CONDITIONS; SUDDEN CRY FOR HELP; CONVULSION THEN UNCONSCIOUS; DROWNED.

CASE BH 00/7

While visiting a Great Barrier Reef island with her daughter, this 60-year-old lady joined a snorkelling trip to a reef pontoon. There was no history of ill health according to her daughter and she appeared to be behaving in a normal manner till she stood up on some coral and said she was

feeling short of breath. She was noticed to have lost most of her normal colour so those nearby called the glass-bottomed boat to collect her. Arrangements were made to transport her by a float plane to the nearby resort island but during transfer she stopped breathing and expired-air breathing was started. Circulatory arrest ensued and cardio-pulmonary resuscitation was commenced, but she failed to respond. There is an alternative report of the incident which describes the onset of her symptoms being as she rested on the pontoon after her swim.

#### *Autopsy*

The autopsy showed there was 60% narrowing of the left anterior descending coronary artery but no evidence of thrombus. There was histological evidence suggestive of chronic myocardial ischaemia. There was marked thickening of both cusps of the mitral valve with ballooning of the anterior cusp. The lungs were moderately congested and oedematous.

#### *Comment*

This being regarded as a 'death from natural causes' there was no coronial involvement, and no further investigation took place. Death appears to have been due to acute cardiac failure. It is possible that immersion pulmonary oedema was a factor, initiating the fatal conclusion, but this was not recorded as having been considered.

#### *Summary*

SNORKELLING; APPARENTLY HEALTHY WOMAN; ONSET BREATHLESSNESS LEADING TO CARDIAC ARREST; ACUTE CARDIAC FAILURE; CORONARY ATHEROMA AND MYOCARDIAL ISCHAEMIA.

#### CASE BH 00/8

This 28-year-old man had a history of epilepsy, which he claimed was well controlled by his medication. He had declared this condition when booking his 'adventure holiday' trip. He was in a group which had gone white-water rafting, mountain biking, and backpacking before commencing this 'scuba and snorkel' trip to visit the Great Barrier Reef. They were on a motor schooner and received the regular safety talks. The diving instructor on the boat refused his request to undertake a 'resort dive' but found nothing in the rules which required him to be prohibited from snorkelling. He claimed to have made a number of scuba dives previously, but this did not dissuade the instructor from his decision concerning the 'resort dive'. He was not wearing a buoyancy vest, a decision permitted because it would have prevented him from leaving the surface. Although all had been told to dive or swim with a buddy he had separated from his. He had been in a group of others but none had noticed any disturbance, though one noticed his stillness 'but was reassured when he saw him start kicking'. There was a safety watch of those

swimming near the boat and when he was first noticed to be too still in the water it was thought he was taking underwater photographs. Then he was seen to be drifting with his arms and legs hanging down. The instructor quickly entered the water to check the situation and the skipper brought the safety tender. They found he was unconscious, face down, with his snorkel still in his mouth. It was difficult to get him into the tender as he was described as 'a large man' and it was necessary for them to use a harness to pull him into the tender. Resuscitation attempts were unsuccessful.

#### *Autopsy*

The autopsy showed drowning in a healthy person, assumed to be as a result of an epileptic episode.

#### *Comment*

Wearing a buoyancy vest would not have prevented him from drowning as it would have floated him face down. The safety watchers cannot be faulted as there was no disturbance apparent to draw attention to him. Although his full medical history is not known there was a holiday history of recent strenuous physical exertion without problems so his acceptance as a snorkeller can be defended.

#### *Summary*

SNORKELLING; EPILEPTIC WELL CONTROLLED ON MEDICATIONS; KNOWN GOOD EXERCISE TOLERANCE; SILENT DROWNING AMONG OTHERS DESPITE GOOD SAFETY WATCHERS; PROBABLE EPILEPTIC FIT.

#### CASE BH 00/9

This 55-year-old man had an unfortunate family medical history, his father and brother having both died from heart disease. He had recently been started on anticoagulants for his hypertension but he appeared to be healthy. No details are available about his experience or ability as a swimmer or snorkeller. His family were sitting on the beach watching him snorkel round a wreck and occasionally waving to them. Then they noticed he was floating without moving and became alarmed. His son paddled out on an inflatable raft but was unable to drag him onto it. The police were notified and the rescue helicopter arrived about 35 minutes later and dropped a diver who brought him back to the beach. Resuscitation efforts were unsuccessful. His mask was up on his forehead when he was reached.

#### *Autopsy*

The autopsy showed mild atheroma in the right coronary artery but 70–80% narrowing in the left, with patchy myocardial fibrosis lesions. However, there was no evidence of acute myocardial infarction so his death was attributed to drowning, although possibly from an initial cardiac factor.

*Comment*

The fact that his mask was on his forehead when first found is a possible marker for a panic reaction or awareness that he was in some kind of trouble.

*Summary*

SNORKELLING; SOLO; SUDDEN SILENT DEATH; SIGNIFICANT CORONARY ARTERY NARROWING; DROWNING; POSSIBLE CARDIAC FACTOR.

## CASE SC 00/1

It is particularly tragic and ironic that this 24-year-old woman was making an escorted dive intended to help her improve her confidence and ability, a present from her boyfriend. She had trained overseas in warm waters and made two subsequent dives, during one of which she had experienced problems. The dive leader was a divemaster and was aware of her inexperience. Her assigned buddy was a slightly more experienced diver, a person who had taken an advanced diver course. The dive shop supplied all their equipment and they were told about the proposed dive, water entry to be from a rock ledge followed by a snorkel out with inflated BCDs before descending. The area was described as being shallow and protected. This would be her first 'rock entry' dive. The weight on the belt was an estimate made in the shop and no buoyancy check was made. They were told to indicate when their contents gauge reading fell to 100 bar pressure.

There were nine customers with a divemaster as dive leader, and a trainee divemaster as support. The dive leader, who was buddying a diver known to be liable to stray, was in the lead and the others followed in buddy pairs in line behind him, with the trainee divemaster acting as a back marker. The water was described as rough at the entry point, visibility 'not good', and cold. A police witness later said he believed the water conditions were too rough for snorkel swimming. There was a current against them during their outward underwater swim and this, in combination with her inexperience, led her to use her air faster than her buddy and most of the other divers. The dive leader split the group when she showed him that her remaining air was down to 100 bar. She and one other were to return to shore with the 'back marker', then her buddy decided it was the correct thing for him to remain with her although still having about 160 bar. They were slowly ascending on their return swim and were at about 12–13 msw when her 'low air' situation became acute. Her buddy offered his 'octopus' regulator to her and they began to buddy breath, sinking down to the sea bed at 21 msw as they did so.

After a short time the buddy's contents gauge beeped, warning of a critically low state. They were holding onto each other while he was attempting to drop her weight belt when his contents gauge beeped a warning he was about

to run out of air. He dropped his own weights and started a low air/out-of-air ascent, the two becoming separated at this time. His ascent technique was fortunately successful and he suffered no serious ill effects, though required treatment for salt-water aspiration. His friend failed to surface and her body was not found for three days. The weight belt was off when she was found. It is apparent that he had managed to ditch her weight belt, but her wetsuit was older than the one he was wearing and provided less buoyancy so she remained on the sea bed. The reason he had not recognised his seriously low air situation was because his gauge was reading 25 bar too high, a fact only discovered later.

*Autopsy*

The cause of death was given as drowning. It should be noted that the body was not recovered for three days.

*Summary*

SCUBA DIVING; TRAINED; INEXPERIENCED; CURRENT AND ROUGH WATER AFFECTED RATE OF AIR USE; OLDER WETSUIT LESS BUOYANT, NO BUOYANCY CHECK BY DIVE SHOP; LOW-AIR STATE THEN OUT OF AIR SO BUDDY BREATHING; SEPARATION WHEN BUDDY OUT OF AIR; BUDDY'S CONTENTS GAUGE INACCURATE.

## CASE SC 00/2

Both this 30-year-old man and his brother were trained and experienced scuba divers, and on this occasion were diving for crayfish off a small island. The sea was calm, there was some tide flow, and the visibility was poor, only two metres. They anchored in 20-metre deep water and started hunting separately in the rock crevices. These were filled with kelp. After about half an hour of separation the buddy began to worry about his brother's failure to return to their boat and made a search for him. Both this and all subsequent searches were unsuccessful and his body was never found, so the reasons for his death are unknown.

*Summary*

SCUBA DIVING; EXPERIENCED DIVER; DIVING IN KELP FOR CRAYFISH; BUDDY SEPARATION; BODY NEVER FOUND.

## CASE SC 00/3

This 27-year-old professional diver was employed to lead a three-man team tasked with repositioning cyclone moorings. Due to the limited baggage capacity of the plane in which they travelled to join the base ship of this deployment, they were unable to take their wetsuits or other diving equipment except for the Kirby Morgan unit owned by this diver. When they arrived they found that the company's Kirby Morgan unit had been damaged because of poor care and his set was

to be used. There were no wetsuits so they were to wear overalls while diving, the voice communication equipment did not work, and they were limited to one surface-supplied breathing apparatus (SSBA) and only one scuba set as only a reserve compressor was operating at the time. No head protection was available as would have been required for the proposed tasks. Their job was to unshackle the anchor chain from the anchor shanks and attach a lifting cable. It was necessary to uncover the chain from the bottom material and the job was undertaken with each of his two fellow divers in turn singly, using first SSBA then scuba. The victim was using scuba on the fatal dive. The sea had become rough and they had to dive from a dinghy. The line tender became alarmed when he saw the line start to drift away, then he found it had become detached from the diver. After a delay, due to having to return to the support tug to get the SSBA, a search was made. This was supplemented by a surface search for bubbles, but neither the diver nor his equipment was ever located.

#### *Comment*

The reason for this accident is unknown but before his final descent he was noticed to be breathless and showing signs of tiredness. The work depth was insufficient to implicate narcosis but fatigue and possibly hypothermia may have affected his behaviour. Lack of proper equipment for the job was clearly a contributing factor – no wetsuit, unattached lifeline, no buoyancy aid, no protective helmet, no voice communication to the surface, no retention strap on his regulator. All these matters were required to comply with commercial diving regulations. Witnesses considered him unfit before final dive descent. Because neither the diver nor any of his equipment was recovered it is not possible to determine whether the problem was contaminated air, a head injury from the lifting equipment, a health factor, or simple loss of the regulator from his mouth.

#### *Summary*

EXPERIENCED DIVER; SOLO; SUBSTANDARD EQUIPMENT; DISCONNECTED LIFELINE; FATIGUE FACTOR; DIVER ACCEPTED USE OF POOR EQUIPMENT SO EMPLOYER ESCAPED LEGAL LIABILITY FOR THE DEATH; BODY NEVER RECOVERED.

#### CASE SC 00/4

The victim, aged 30, and her husband had trained overseas three to four years previously and subsequently made about 200 dives, over 50 being deeper than 40 msw, their deepest to 46 msw. A friend invited them to make a wreck dive with him and his buddy with whom he had made a number of dives on this wreck. It was a deep dive, 55 msw, and he took care to warn them of the possible dangers of such a depth. He noted they had single tanks so loaned each of them twin 72 cu ft tank sets, with separate regulator on each tank, and

stressed that they should abort the dive at any time they wished to do so. It is not known if they had ever previously used such sets. It was planned for them to ascend before the more experienced divers, though the latter were to descend first. Her descent was delayed by her difficulty in venting air from her drysuit.

When they reached the wreck she appeared to lack her usual composure so their friend, despite the 'OK' sign she gave him, decided to abort the dive and return to the surface with her. He held her wrist, then he checked the position of the anchor line, and when he looked back he saw she had lost consciousness. He immediately inflated her BCD, then found she was tethered by her secondary regulator to the wreck's aerial so he ditched her weight belt and the regulator pulled free, the latter just missing her husband as it did so. A rapid ascent followed and when they were about half way to the surface she had two convulsions and went limp.

The friend attempted to slow their ascent rate by venting her BCD but was unsuccessful, the air expansion rate exceeding the venting. At 15 msw he chose to let her go and make a computer-gauge-regulated decompression stop before continuing his ascent to the surface. There he saw her floating face up. The others helped him to get her into the boat and commence CPR but there was no response.

#### *Autopsy*

A CT scan before the autopsy showed the presence of air in the right side of the heart and also in her thighs. A small tumour of no clinical importance was noted in the liver.

#### *Comment*

The convulsion as she ascended may have been evidence of a cerebral air embolus. The reason for her sudden loss of confidence and then of consciousness at depth is unknown but cold water and narcosis may have played a part.

#### *Summary*

SCUBA DIVING; TRAINED; EXPERIENCED TO 46 MSW; DEEP WRECK DIVE TO 55 MSW; COLD, DARK AND NARCOSIS FACTORS; LOSS OF CONSCIOUSNESS AT DEPTH; EQUIPMENT CAUGHT ON WRECK; UNCONTROLLED ASCENT AFTER BUDDY INFLATED HER BCD AND DITCHED WEIGHT BELT; CONVULSION DURING ASCENT; GOOD ASSISTANCE FROM OTHERS; CEREBRAL ARTERIAL GAS EMBOLISM.

#### CASE SC 00/5

This 29-year-old man had been scuba diving for 13 years, though not in the previous six months, and his buddy had only slightly less experience. The buddy hired the equipment for the day. They made their water entry off a rocky shore

and swam out beyond rough water before they descended, the depth being about 10 msw. A short time later, the victim indicated he wanted to ascend and at the surface, where the water was choppy, he said "I don't feel comfortable". They held onto a cray pot float while his buddy talked to him to help calm him. After a time he said he felt OK and they again descended. At a depth of 3 msw he changed his mind and again surfaced, saying "I can't do it, I have to get out". He was so intent on this that he ignored his buddy's advice to swim to the nearest safe exit area a short distance away, instead swimming to the closest rocky ledge. The water here was a turbulent surge over the rocks but the buddy made a safe exit. When he looked back he saw his friend floating on his back out to sea and imagined he had changed his mind about trying to exit here. After taking off his equipment he went and found a surf lifesaver and asked that a 'rubber ducky' be sent to collect his friend. When he was reached they found he was unconscious and started CPR as soon as they brought him ashore. He did not respond to resuscitation.

#### Autopsy

The autopsy revealed evidence of drowning and the presence of non-significant localised subarachnoid haemorrhage over his left cerebral hemisphere. The latter observation was in keeping with a history of a motorcycle accident at the age of 18, which had caused a left parietal skull fracture complicated by a subdural haemorrhage needing surgical evacuation. A more recent back injury was blamed for his occasional back pain and 'migraine headaches'. His only recent visits to his doctor had concerned a headache and 'sinus symptoms'.

#### Comment

His true swimming and scuba ability is unknown, as is whether he found the sea conditions more severe than he felt competent to meet and for this reason he panicked, failing to inflate his BCD or ditch his weight belt in the process and drowned. His wife reported he had two nocturnal episodes of chest tightness during the previous two weeks, their significance unknown.

#### Summary

SCUBA DIVING; TRAINED AND EXPERIENCED; NIL DIVING FOR SIX MONTHS; ABORTED DIVE; UNSAFE CHOICE OF EXIT AREA; PROBABLE PANIC REACTION TO SEA CONDITIONS; FAILED TO DROP WEIGHTS OR INFLATE BCD; DROWNED.

#### CASE H 00/1

This 20-year-old man was, like many employed in the harvesting of *beche de mer*, untrained in hookah diving and had never had a 'diving medical'. The diving system employed was for the boat to tow three dinghies from each

of which, depending on the depth, a diver would breath-hold dive or use hose supply from a compressor in the dinghy to collect the *beche de mer*. There was doubt concerning the reliability of these compressors such that the skipper had his personal one. It was known that the outboard engine of the dinghy from which the victim was diving was difficult to restart but was reliable once started. There was a second diver with him but when he knew the local depth was 20–25 msw he said it was too hard to breathe at that depth and transferred to another boat to cadge a light for a cigarette. It was a short time later that the accident occurred. A large wave nearly swamped the dinghy and while the crewman was bailing the water out the diver decided to start his dive and jumped out. This made the bow rise and water come in over the stern. The crewman then noticed the hose to the diver was trapped between the transom and the outboard's leg. It was necessary to lift the engine out of the water to free it, but it would first be necessary to stop it as it would run too hot if the inlet for its water cooling was out of the water. Fortunately a diver from another dinghy came and got it free and he was required only to let the engine idle.

While this was happening the boat drifted and suddenly the hose went slack and spun around in the water showing that there was no longer anything connected to it. The crewman checked that the diver had not surfaced, then gave the alarm. The skipper, who had been in one of the other dinghies, checked he had enough fuel for his compressor, then descended to search for him. His first three dives were unsuccessful before he found the victim on the sea bed, his weight belt on and catch bag and regulator lying nearby. He ditched the belt and brought the drowned diver to the surface. Depth here was 10–15 msw.

#### Autopsy

The finding was of drowning without evidence of any medical disease or barotrauma.

#### Comment

The lack of training or experience with hookah, whilst not the critical element leading to this death, may have been contributory. It is apparent that the victim either never thought to ditch his weight belt or was so shocked by the loss of his air supply and contact with the surface that he inhaled water before considering this option. The air compressor had many adverse features but these were not implicated in the tragedy. There were three critical issues in addition to his lack of training: he was not wearing a bailout bottle, he had no lifeline, and there was an insecure coupling between his supply hose and his regulator unit. This last fault made it impossible to treat the hose as a lifeline as it separated when so used in an attempt to pull the diver to the surface. The legal responsibility of the company which ran this particular harvesting of *beche de mer* is a moot point, because the ownership of the compressor was disputed and the divers were described as being self-employed. The absence of

enforcement of workplace safety requirements certainly deserves attention.

#### *Summary*

HOOKAH; UNTRAINED BUT REPORTEDLY EXPERIENCED SSBA DIVER; CONNECTION HOSE TO REGULATOR UNIT INSECURE; HOSE CONNECTION SEPARATED; NO BAILOUT BOTTLE; NO LIFELINE; FAILED TO DITCH WEIGHT BELT; SAFETY REGULATIONS IGNORED BY DIVER'S EMPLOYER AND GOVERNMENT; DROWNED.

#### CASE X 00/1

This 31-year-old diver had completed his basic recreational scuba training course less than three months before he commenced employment with this pearl farming enterprise. He had received no instruction and there was no supervision of him on this his first day at work. There were three divers employed to attach pearl panels to an underwater fence line. He apparently experienced some difficulty with his regulator and entered the water last but appeared to be working in a normal manner when seen from time to time by the other divers. His failure to join the other divers when they completed their tasks led them to check on him and to find him on the sea bed. The incomplete nature of the information available makes it impossible to be certain whether he was using scuba or SSBA equipment.

#### *Autopsy*

The autopsy reportedly noted he had a congenital brain abnormality which may have predisposed him to having a seizure but further details are not available. This was possibly his first use of hookah diving apparatus. The firm was prosecuted, pleaded guilty, and was fined \$10,000.

#### *Summary*

HOOKAH OR SCUBA – UNKNOWN; UNTRAINED; NIL EXPERIENCE OR INSTRUCTION; NEW EMPLOYEE; SEPARATION UNDERWATER; POSSIBLE MEDICAL CAUSE FOR SEIZURE FOUND AT AUTOPSY; DROWNED.

#### **Discussion**

##### SNORKEL USERS AND BREATH-HOLD DIVERS

These fatalities fall into two clearly defined types, either breath-hold dives spear fishing (BH 00/3) or swimming while wearing a mask and snorkel (the remainder). The critical factors in the two groups clearly differentiate them. The cause of death of the spear fisherman was probably post-hyperventilation hypoxic syncope resulting in drowning. The danger of hyperventilation to increase one's underwater duration is well documented, but such

deaths are sufficiently infrequent to be discounted by divers. Unfortunately survival from a non-fatal blackout incident does not appear to be persuasive in teaching avoidance of 'excessive' hyperventilation.

The larger group consisted of swimmers using snorkels, often for the first time, visitors from out-of-State. These deaths occurred, in the majority of recent instances, despite alert safety watchers. These cases indicate both the serious difficulty of recognising a swimmer in trouble in a crowd of others, in particular when there is no outward sign of any problem, and the problem of sudden death in the apparently healthy. Although two of this group had obtained and worn buoyancy vests initially, one had removed her vest before making her last water entry. As these vests tend to float the wearer face down, they have a limited safety function in an unconscious wearer. If they were designed to keep the wearer face up they would be unsuitable for anyone trying to swim and examine the underwater world.

The most common contributing health factor was cardiac with four, possibly five, dying from this cause. It is probable that it was also critical in the fatality where the body was never found. Whether a person with an epileptic history should be permitted to swim, even if accompanied by a conscientious buddy, is a contentious problem and any decision involves consideration of the risk versus quality-of-life factors. It is certainly easier to have a blanket prohibition on all epileptics swimming, but the 'evidence basis' justifying any decision is debatable: even the most healthy can drown. No explanation has been offered for the sequence of events in case BH 00/6 but adverse sea conditions, his possible first use of a snorkel, and being solo, would explain his panic and have resulted in the commotion the witness labeled as 'a convulsion'.

The problem of death among snorkel-swimming visitors to the Great Barrier Reef is a major concern to those involved in taking visitors to view the reef and to tourism authorities generally. It is not clear what action can be taken to effectively reduce these fatalities, as a large proportion are in the age group where unpredictable cardiac events are most common. The majority of victims appeared to be healthy, though a few had failed to reveal their true health history.

The wearing of the type of life jackets suitable for snorkel swimming is of negative benefit should loss of consciousness occur. It is apparent that even the most conscientious safety watch of a group in the water will fail to benefit those who lose consciousness without any outward sign, the only alerting factor being the absence of activity for longer than expected. The safety watchers employed to supervise the safety of swimmers and snorkellers on trips to the Barrier Reef appear to have acted efficiently and are to be commended for the difficult task they perform. The organisations running day trips to the Barrier Reef appear to be taking active steps to ensure efficient safety watch procedures. Whether there is a need to require watchers to hold certificates in life saving is not proven on the evidence

presently available, though boats which carry defibrillators ensure those likely to use them have training. As it would be neither practical nor necessarily effective to require a specialist cardiologist to examine all visitors aged over 45 who intend to snorkel swim on the reef, it may be necessary to accept that such deaths are unavoidable until new predictive tests are developed.

#### SCUBA DIVERS

There were five fatalities identified in association with scuba diving, of which one was due to pulmonary barotrauma/air embolism as indicated by autopsy findings and the clinical history. In one case there was a low-air factor, while the other two divers had adequate remaining air. Inadequate experience and panic are once again apparent.

In case SC 00/3 an unwillingness to risk job loss is the most probable explanation of the number of work-safety violations found in this accident, and indeed helped to protect the employer from the legal consequences of their failure to follow 'best practice' workplace management. In the absence of the victim's body and equipment it is not possible to know the critical factor in this death.

While in case SC 00/4 the diver had shown symptoms suggestive of CAGE during her ascent, she had lost consciousness prior to this for reasons that were never defined but probably included anxiety due to this being her deepest dive, nitrogen narcosis, the cold water, and use of a borrowed twin-cylinder scuba unit. It is probable that this was the first time she had used such equipment, which had a separate regulator for each cylinder.

In the cases where drowning was the given cause of death, the circumstances of each were unique. The dangers of ignoring the 'nanny' advice on safe diving practices is demonstrated, as also the factors of panic, running out of air, and inexperience. The concordance of several adverse factors in these scenarios supports the common belief that the greater the failure to strictly observe advised safe diving procedure the less is the margin of safety.

Scuba diving-related deaths frequently show the presence of multiple risk factors. Rarely does a single adverse factor result in a fatality. Inexperience, absolute or relative, is a predictable factor and this includes those who have not dived recently, as are buddy separation and low-air situations. These breaches of good diving practice are best tackled through training protocols. Buddy breathing cannot be relied on as a safe and sure alternative to monitoring the contents gauge, even assuming the gauge is reading accurately.

#### SURFACE-SUPPLY SYSTEMS

There is no tradition of zero tolerance of unsafe conditions in the pearling industry, indeed from an examination of these two cases it appears workplace safety is ignored at all levels

of the industry. In case X 00/1 complete lack of experience and a possible medical problem leading to a seizure were factors, but unfortunately complete details of this fatality are not at present available. There is clearly an immediate need for a simple 'cross-over' course for those wishing to take up employment in this industry when the only prior training has been recreational scuba diving and not hookah diving.

The examination of the deaths using hookah equipment clearly shows that using faulty equipment can be fatal, and that experience of recreational scuba diving is inadequate preparation for this type of diving. It is a sad fact that no action has been taken to require the completion of a certificated course for divers employed in the pearling, crayfish, and *beche de mer* industries, or enforce the requirement to hold a certificate for employment in this industry.

Permission to access data from the police investigations of these deaths on behalf of the local coroner is a vital element in any investigation into areas where intervention may reduce the occurrence of fatalities. Where such investigations take a particular note of the medical history, training, experience, and equipment factors their value is enhanced. One area of difficulty arises where a snorkeller, independent of a commercial enterprise, is decided to have died 'from natural causes' and, very naturally, the cases are not further investigated. Their omission from later reviews is unavoidable but there is nothing to suggest the critical factors in such cases differ from those here considered. The diving community is greatly indebted to coronial and other sources for their understanding and active support of this ongoing investigation.

#### Acknowledgements

The involvement of the State Coronial Departments, Workplace Health and Safety in Queensland, Queensland and NSW police, the NCIS, and DAN SEAP is essential to this ongoing project.

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