

## ORIGINAL PAPERS

### AUSTRALIAN DIVING-RELATED DEATHS IN 1997

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#### Key Words

Accidents, deaths.

#### Summary

This report records the details of deaths referred to Coroners as having occurred while the deceased had been either swimming or diving using a snorkel or was diving using compressed air. It is highly probable that not all fatalities occurring during such activities have been identified but the information provides a factual basis for discussion of how to reduce such fatalities. The data for 1997 is unusual in the number of snorkel users who died and the fact that all save one occurred in visitors to the Great Barrier Reef region. The presumed reason is that only there is a commercial interest in providing facilities for snorkelling and a corresponding Governmental interest in any fatalities which occur. There were seventeen (17) snorkel deaths identified and eleven (11) of these were overseas visitors. Only one death (BH 97/6) was outside the Great Barrier Reef area. Ill health (cardiac) was the critical factor in many instances. Only four (4) deaths were identified among scuba divers and two (2) using surface supply.

#### Snorkel swimmers and breath-hold divers

Of the seventeen fatalities identified, a cardiac factor was either a probable or certain critical factor in nine.

#### Case BH 97/1

This man had a history of an episode of tachycardia some five years before and was taking medication to prevent a recurrence. However he had reported no ill health since this episode. As his wife destroyed all his tablets after his death it is not known what he was taking. He went snorkelling alone after booking to join a conducted snorkel swim in the afternoon. The morning swim which he had intended to join had been cancelled because of expected rough water. Later his wife and daughter walked along the beach and found his clothing, so they assumed he was still swimming and would return later. When he failed to join them at the midday meal they became worried, the more so when they heard an announcement calling for a doctor. Shortly after this they were informed that one of the staff had noticed something in the water about 100 m off the

beach. He thought it was a turtle caught in a mooring rope but when he swam out he discovered it was a body. Although his left arm was apparently tangled in the rope this had not apparently been the reason he drowned. It is assumed that he probably suffered an episode of cardiac tachycardia and the resulting incapacity led to his drowning, though this cannot be proved.

SOLO SWIM USING SNORKEL. HISTORY OF TACHYCARDIA FOR WHICH HE TOOK MEDICATION. PROBABLE CAUSE DEATH WAS CARDIAC ARRHYTHMIA LEADING TO DROWNING.

#### BH 98/2

The sudden death of this apparently healthy young woman without warning was particularly unexpected because she had recently passed a "diving medical" check and just completed a scuba diving course. A bonus scuba dive was offered to them on completing the course but she decided to snorkel swim instead. This decision may have been because she wished to take some underwater photographs without any interruptions. She was with the group of scuba divers but no special attention was paid to her while two of the group were being towed closer to the reef where they were to dive, following which another diver requested attention. She was seen floating upright, head and shoulders out of the water, near the channel marker. She appeared to be signalling to be picked up. It was then slack tide and there was no significant current running. When the dive boat reached her she was floating as if snorkelling, then rolled over and her head became submerged but she failed to react. She was pulled aboard and CPR commenced but failed to show any response. Histology evidence of idiopathic lymphocytic myocarditis was found following the autopsy.

SOLO SNORKEL. CALM WATER. SILENT SURFACE DEATH. RECENT DIVING MEDICAL. JUST COMPLETED SCUBA COURSE. MYOCARDITIS.

#### BH 97/3

While on holiday in Australia this man visited one of the island resorts. There he met other visitors, some of whom asked him to join them snorkelling, but he declined as he had no equipment. However he decided to follow their example the next day but did not join them as they were intending to scuba dive. He hired a mask and snorkel, but no fins, and went to a beach and there teamed with two others. He was not as strong swimmer as they were. After 20 to 30 minutes travelling with the current he decided to return to their starting point but the other two chose to continue longer over a reef. When they last saw him he appeared to be snorkelling in a confident manner, but shortly

afterwards they heard a cry for help and saw him waving his arms above his head. He was unconscious and sinking by the time they reached him. They brought him ashore as quickly as possible, a difficult task as here the shore was sharp rocks. The drowning was thought to be due to fatigue, with his poor physical condition, poor swimming ability and lack of fins all contributing.

NOT USING FINNS. SEPARATED. THEN SURFACE SNORKEL SWIM AGAINST CURRENT. POOR SWIMMER. EXPERIENCE UNKNOWN.

#### **BH 97/4**

Although he had had a triple coronary bypass in 1990 he did not seek medical during his visit to Australia when he experienced an episode of faintness, loss of vision and pain in the back of his head while hiking in the Blue Mountains three weeks before he and his wife visited the Barrier Reef on a live-aboard boat. Although there were other passengers swimming and snorkelling in the water, he chose to snorkel with his wife away from the others. The safety boat came and offered to take them back to the main group but this offer was declined. However, the boat returned a short time later and he then suggested that his wife be towed, then he was seen floating face down and apparently lifeless a short distance from her. Resuscitation efforts were unsuccessful.

SURFACE SNORKEL CLOSE TO WIFE. CALM WATER. SILENT RAPID DEATH. SAFETY BOAT CLOSE BY. HISTORY OF CORONARY ARTERY BYPASS 7 YEARS BEFORE. EPISODE OF ILL HEALTH WHILE WALKING 3 WEEKS BEFORE DEATH. ACUTE CARDIAC DEATH.

#### **BH 97/5**

Two couples from overseas were on holiday on a reef island and decided to snorkel off a beaches. It was calm and shallow and there were already about twelve others on the beach and five in the water when they arrived. As they had brought only two sets of equipment with them it was decided the two men would use it first, then the two women. However one of them had persistent trouble with water entering her mask so returned to shore, telling her friend she would get one of the men to take her place. As they could see her swimming strongly from where they were sitting on the beach there was no hurry in the hand over. It was about five minutes before they looked again and then they were unable to see her so decided to walk along the beach, expecting to find that she had come ashore further up the beach. They came across a group giving CPR to a person who had been found floating face down in the shallow water near the beach. Although she responded to resuscitation she died in hospital the next day from the effects of the cerebral anoxic damage. No health factors were found to explain why she drowned. Possibly she

inhaled some water and panicked, failing to stand up in the waist deep water. There is no information as to whether she had any snorkelling experience but she had appeared to have no trouble snorkelling when last seen.

SEPARATION. THEN SOLO SNORKEL. CALM SHALLOW WATER. CLOSE TO OTHERS. SILENT INCIDENT. DELAYED DROWNING DEATH.

#### **BH 97/6**

Two divers were spear fishing near the harbour entrance. After about an hour and fifteen minutes the buddy left the water but the other diver continued. About 15 minutes later the buddy saw two fishing boats enter the shipping channel and then saw his friend surface in their path and fail to reappear after they had passed. He realised his friend must have been hit so rushed to the harbour to ask the fishermen to return, then entered the choppy water to search for him. The body was not recovered for a further 1.5 hours, with two head wounds.

SPEARFISHING. SEPARATED SO SOLO. SURFACED IN BOAT CHANNEL IMMEDIATELY IN FRONT OF TWO FISHING BOATS. NO DIVERS FLAG. FATAL HEAD INJURIES FROM PROPELLER.

#### **BH 97/7**

An optional extra for passengers on this cruise ship was a day trip to visit the Barrier Reef and this couple were among the large group which signed up. They were taken out to a pontoon, permanently moored at one of the reefs, and each given mask, fins, a snorkel and a talk on the use of this equipment. The victim admitted to being a poor swimmer and was provided with a life jacket before he entered the water. There were two crew deputed to watch over those in the water as they swam around using their snorkels. One noticed that the victim was floating motionless, face down, and raised the alarm before swimming out to check what was wrong. He was soon joined by the safety dinghy. Their resuscitation efforts were unavailing. Although there was no history of ill health the autopsy showed the presence of severe coronary atheroma and evidence of an area of myocardial scarring. This probably indicates that his history of recent "indigestion" may have been unrecognised angina. The circumstances indicate that this should be regarded as death from cardiac causes.

SNORKELLING IN GROUP. SILENT RAPID DEATH. EFFICIENT SUPERVISION. NO HISTORY OF ILL HEALTH. CORONARY ARTERY ATHEROMA. CARDIAC DEATH.

#### **BH 97/8**

Among the passengers on this trip out to the Barrier

## PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and Experience Victim	Experience Buddy	Dive Group	Dive purpose	Depth in metres Water	Incident	Weights On	kg
BH 97/1	73	Training and experience not stated	No buddy	Solo	Recreation	Not stated	Surface	None	None
BH 97/2	29	Training and experience not stated	No buddy	Solo	Recreation	Not stated	Surface	None	None
BH 97/3	28	Training and experience not stated	Training and experience not stated	Group Separation before incident	Recreation	3 m	Surface	None	None
BH 97/4	67	Some training No experience	Training and experience not stated	Buddy Separation before incident	Recreation	Not stated	Surface	None	None
BH 97/5	56	No training No experience	No training No experience	Buddy Separation before incident	Recreation	1 m	Surface	None	None
BH 97/6	32	No training Experienced	No training Experienced	Buddy Separation before incident	Spear fishing	9 m	Surface	On	Not stated
BH 97/7	75	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 97/8	31	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 97/9	43	No training No experience	Trained Experienced	Group No separation	Recreation	Not stated	Surface	None	None
BH 97/10	72	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 98/11	60	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 97/12	46	No training No experience	No training No experience	Group Separation before incident	Recreation	Not stated	Surface	None	None
BH 97/13	46	No training No experience	No training No experience	Buddy Separation before incident	Recreation	1 m	Surface	None	None
BH 97/14	67	Training and experience not stated	Trained Experienced	Group No separation	Recreation	Not stated	Surface	None	None

**DIVING-RELATED DEATHS IN 1997**

<b>Buoyancy vest</b>	<b>Contents gauge</b>	<b>Remaining air</b>	<b>Equipment Tested</b>	<b>Owner</b>	<b>Comments</b>
None	Not applicable	Not applicable	Not applicable	Hired	Episode of tachycardia 5 years before. Rough sea so not group dive Cardiac death.
None	Not applicable	Not applicable	Not applicable	Hired	Sudden death. Apparently healthy Myocarditis
None	Not applicable	Not applicable	Not applicable	Own	First use of snorkel. No fins. Not strong swimmer. Swam into current, fatigued.
None	Not applicable	Not applicable	Not applicable	Hired	Coronary bypass 7 years before. Acute cardiac death.
None	Not applicable	Not applicable	Not applicable	Not stated	Separation then solo. Calm water. Unknown swimming, and snorkel ability.
None	Not applicable	Not applicable	Not applicable	Own	Surfaced in boat channel. Hit by propeller.
Life jacket	Not applicable	Not applicable	Not applicable	Hired	First use of snorkel? Poor swimmer. Wore life jacket. Silent death in crowd.
None	Not applicable	Not applicable	Not applicable	Hired	First use of snorkel. Calm sea. Silent surface problem. Delayed drowning death.
None	Not applicable	Not applicable	Not applicable	Hired	Obese diabetic became breathless. Towed but died. Acute cardiac failure.
None	Not applicable	Not applicable	Not applicable	Not stated	Parkinsonism. Good swimmer. Asymptomatic coronary disease.
None	Not applicable	Not applicable	Not applicable	Hired	History of previous myocardial infarction. Inadequate surface watch. Current. Cardiac death.
None	Not applicable	Not applicable	Not applicable	Hired	No fins? Poor fit mask, snorkel? Silent surface death. Excess alcohol a factor.
None	Not applicable	Not applicable	Not applicable	Hired	First use of snorkel? Collapsed standing on reef. Renal disease, cardiac factors.
None	Not applicable	Not applicable	Not applicable	Hired	History of coronary artery bypass.

## PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and Experience Victim	Training and Experience Buddy	Dive Group	Dive purpose	Depth in metres Water	Incident	Weights On	kg
BH 97/15	72	Trained Experienced	Trained Experienced	Group Separation before incident	Recreation	18 m	Surface	On	3 kg
BH 97/16	33	No training No experience	No buddy	Solo	Recreation	3 m	Not stated	Not stated	Not stated
BH 97/17	24	Training and experience not stated	Training and experience not stated	Buddy Separation before incident	Spear fishing	27 m	Not stated	Off	4.5 kg
SC 97/1	38	Trained Experienced	Trained Experienced	Buddy Separation during incident	Recreation	40 m	40 m	On	12 kg
SC 97/2	58	Trained Experienced	Trained Experienced	Buddy Separation before incident	Recreation	32 m	Surface	On	Not stated
SC 97/3	43	Trained Some experience	Trained Experienced	Group Separation before incident	Recreation	18 m	Surface	On	9 kg
SC 97/4	47	Trained Some experience	Trained Experienced	Group Separation before incident	Deep dive course	30 m	Ascent	Buddy ditched weights	14 kg
H 97/1	40	Some training Experienced	No training Experienced	Buddy Separation before incident	Cray fish	3 m	Ascent	On	Not stated
H 97/2	30	Trained Experienced	Trained Experienced	Buddy Separation before incident	Spear fishing	36 m	Ascent	On	Not stated

Reef was a group of overseas visitors with their tour guide. He translated to them the talk on snorkel diving which was routinely given during the outward trip. While members of the group, and other passengers, were swimming near the pontoon, one of them noticed the victim floating immobile, face down, about 10 m from the pontoon. The snorkel was out of her mouth and there was some water in her mask. The safety watcher quickly swam out and retrieved the victim and commenced CPR, which was rewarded with a resumption of breathing after 30 minutes. She died in hospital 4 days later from the effects of anoxic brain damage. Nothing is known concerning her swimming ability, personality, or possible previous use of a snorkel. The water was calm and there were 10-20 other swimmers nearby but none were aware she was in trouble.

SNORKEL SWIMMING IN CROWD. CALM

WATER. SILENT INHALATION OF WATER. PROLONGED CPR BEFORE RESPONSE. DELAYED DROWNING DEATH

**BH 97/9**

Two friends, on holiday from overseas, joined a day trip to the Barrier Reef. Although one of them was obese and a diabetic she admitted to no ill health when signing on to go snorkelling. The passengers were shown a video on snorkelling and were given a talk. The two friends had lunch after spending some time snorkelling near the pontoon and then joined a guided tour of an adjacent reef after demonstrating their snorkelling ability to the guide. This was a requirement because the tour passed over deep water and lasted 45 minutes. The victim was noticed to swim slower than the others but declared she was not feeling

**DIVING-RELATED DEATHS IN 1997**

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Equipment Owner	Comments
None	Not applicable	Not applicable	Not applicable	Own	Inadequate safety watch. Rough water. Polycystic kidneys. Coronary atheroma.
None	Not applicable	Not applicable	Not applicable	Borrowed	Solo. No medical history available. Body never recovered.
None	Not applicable	Not applicable	Not applicable	Own	Post-hyperventilation type death.
Not inflated	Yes	None	OK	Own	'Silt out' in wreck.
Not stated	Yes	+++	OK	Own	Surface swim to start dive. Cardiac death?
Not inflated	Yes	+++	OK	Own	Separation on descent. Unexplained drowning.
Not inflated	Yes	+++	OK	Hired	Separation during class ascent. Nitrogen narcosis effect? CAGE.
None	No	None	Faults	Own	Supply hose separated. Out-of-air ascent. Panic ascent. CAGE.
None	No	None	Serious faults	Borrowed	Compressor failed. Lost air. Out-of-air ascent. CAGE.

unwell. However, after 25 minutes she was noted to be very breathless and she accepted an offer to tow her back to the boat. Before this could be done she became unconscious and ceased breathing. She was brought back to the boat quickly. CPR was attempted to be unsuccessful but she was transported by helicopter to the base hospital where some return of vital signs was noted, but not maintained. This was diagnosed as death from acute cardiac failure due to arrhythmia. The pathologist noted the presence of moderate coronary and patchy myocardial fibrosis. It was suggested that she was probably unused to making the strenuous exertion required during this swim against a current. As is often the case in drowning, resuscitation efforts were made more difficult by regurgitation of fluids.

SNORKEL SWIM IN GROUP. BECAME ACUTELY BREATHLESS THEN UNCONSCIOUS.

OBESSE DIABETIC. MODERATE CORONARY ATHEROMA AND PATCHES OF MYOCARDIAL ISCHAEMIC DAMAGE. PROBABLY CARDIAC ARRHYTHMIA CAUSED ACUTE CARDIAC FAILURE.

**BH 97/10**

This man was visiting his son, who had a boat. They decided to take it out to a local reef and go snorkelling. The father made a backward roll entry into the water and then swam back to hold onto the boat. He mentioned that he had swallowed a lot of water but was cheerful and appeared well. When his son entered the water half a minute later he was surprised to see him floating face down near the boat. His CPR was unsuccessful. There was no history of ill health beyond some Parkinsonism symptoms. The autopsy showed marked coronary atheroma with severe stenosis of the right

anterior coronary artery. The cause of death was given as being cardiac arrhythmia combined with inhalation of sea water. There was no history of cardiac symptoms and he was not taking any medications. He was said to be a good swimmer.

**SUDDEN SILENT DEATH AFTER WATER ENTRY FROM BOAT. SOME ASPIRATION OF WATER REPORTED BUT APPEARED UNAFFECTED. SOME PARKINSONISM SYMPTOMS. CORONARY ATHEROMA PRESENT. CAUSE OF DEATH CARDIAC ARRHYTHMIA AND INHALATION OF SEA WATER.**

#### **BH 97/11**

During the trip out to the Reef this couple, both of whom had made 3 or 4 previous snorkel dives, were exposed to a safety talk concerning boat procedures, snorkelling, and swimming abilities. The wife later claimed not to have heard any such talk. Getting the active attention of passengers cannot be guaranteed. Following a trip in the glass bottomed boat the couple went snorkelling away from others who were swimming or snorkelling near the boat while other passengers were scuba diving or on the cay's beach. The couple found they could not swim back to the cay against the current and his wife was pleased to be assisted back to shore by two of the other passengers who responded to her husband's signals. They later said they did not see him when they arrived to assist her. Once ashore she became aware of her husband's absence and he was then seen in the water and appeared to be experiencing some difficulties. When reached by two others of the passengers he was floating face down, limp and probably dead. There was some delay before the skipper was informed that some problem had occurred and brought over the glass bottomed boat. CPR was begun as soon as he was pulled aboard but there was no response. Autopsy revealed that he had suffered a myocardial infarct and there was evidence of a previous one. There was marked coronary atherosclerosis. His wife was unaware of him having any health problems apart from "some blood pressure, for which he occasionally took half a tablet". It is very tempting to assume that the tablet was for angina, but there is no corroboration of this supposition. Although there was no efficient safety watch from the beach, this did not effect the outcome in this instance.

**SILENT SURFACE DEATH SHORTLY AFTER SEPARATION FROM OTHERS. STRONG SURFACE CURRENT. AUTOPSY SHOWED PREVIOUS UNKNOWN MYOCARDIAL INFARCT. FATAL FURTHER INFARCT.**

#### **BH 97/12**

There is uncertainty whether this man was free from the influence of the previous night's drinking when he

boarded the boat on a day to The Reef. Similarly there were differing opinions as to whether passengers were advised to swim in buddy pairs. Although he was issued with mask, snorkel and fins there is no certainty that he was actually wearing these when he was last seen close to the boat after entering the water. His intended buddy decided to abort his swim soon after entering the water and the victim then swam away without his actions being noticed. He was later found floating face down by the crew of another boat who noticed his failure to react to the wash of another boat passing over him. His mask, snorkel and fins were apparently missing when he was reached. No medical reason was found for his drowning in these circumstances, but perhaps this was his first use of a snorkel and he panicked when water entered his snorkel.

**SILENT SURFACE DEATH AFTER SEPARATION FROM GROUP. SNORKEL USE EXPERIENCE UNKNOWN. EQUIPMENT MISSING SO UNCERTAIN WHETHER WORN.**

#### **BH 97/13**

Two women friends, on holiday from overseas, joined a day trip to visit one of the reefs. During the trip out the safety talks were given in several languages though later questioning showed that there was poor recall of mention of health factors. After arriving at a sandy cay they were ferried ashore. Lifejackets were made available to those who desired them, and masks, snorkels and fins were given to those who wished to do more than simply swim. The two women began snorkelling close together but soon increased their separation as they kept bumping into each other. The friend had snorkelled previously and helped the victim get ready, then watched her closely until satisfied that she was managing without any problems. There was some chop but the water was clear, there were others nearby and a safety watch was maintained from the beach. The friend noticed the victim standing unsteadily on the reef in waist deep water, her mask off, waving her arms. The buddy joined her and tried to steady her but failed and she toppled forwards into the water. Several nearby swimmers and a crew member quickly came to help. EAR was commenced while in the water and continued after she was brought back onto the boat but she did not respond. It was later found that she had a history of renal disease and had a poor effort tolerance, becoming breathless while walking except on level ground. Cause of death was given as drowning but the presence of amyloid disease and myocardial fibrosis changes indicates that this was a cardiac death.

**FIRST USE SNORKEL. SHORT SEPARATION. THEN STOOD ON REEF IN SHALLOW WATER WAVING FOR ASSISTANCE. COLLAPSED AND DIED. SEVERE ILL HEALTH. RENAL AND CARDIAC DISEASE. FAILED TO RECOGNISE THE EFFORT DEMANDS OF SWIMMING WITH SNORKEL.**

**BH 97/14**

This day trip to the reef was run in the regular manner, with talks on the boat's emergency procedures and giving basic instruction on snorkelling to those intending this activity. The victim, a visitor from overseas, declared his history of a myocardial infarct in 1984 and that he had suffered no subsequent ill health. His only medication was a daily dose of aspirin. The reasonable decision was taken that he could join the guided snorkel tour of the reef. There were two groups, one of the younger passengers, the second of the more elderly. He was included in the latter group. The group leader made frequent stops and swam slowly in appreciation of this group's probable abilities. After about 15 minutes the victim was noticed to be tired, though he made no complaint, so the leader decided to tow him back to the dinghy which would return him to the boat. He was too breathless by the time they reached the dinghy to climb into it without assistance, so the OxyViva was used, then he lost consciousness and CPR was initiated. He was airlifted to hospital but died later that day. Autopsy revealed a fresh myocardial infarct and evidence of his previous one. At no time did he mention pain, only tiredness and breathlessness.

RAPID DEVELOPMENT OF BREATHLESSNESS DURING SUPERVISED SLOW SNORKEL SWIM. HISTORY OF PAST MYOCARDIAL INFARCT (1984). FATAL FURTHER MYOCARDIAL INFARCT. DIVE LEADER GAVE CORRECT AND RAPID MANAGEMENT OF THE SITUATION.

**BH 97/15**

The investigation of this fatality was deliberately, but perfectly legally, degraded by the natural desire of those most involved to avoid possible self-incrimination, and although their response may have been excessive it was effective in reducing the availability of important data and has made it impossible to clarify some inconsistencies in the evidence which is available. It is agreed that adverse sea conditions had caused the cancellation of several previously arranged snorkel and scuba dives in the days preceding this dive, and that the conditions were such that only those who claimed to be experienced snorkel divers were to be taken out on the boat. The dive boat carried a skipper and a diving instructor, who had two pupils among the 15 or so snorkel divers aboard. Two smaller boats followed, one with an additional 5 snorkel divers, the other with several scuba divers. There was no apparent check on the real experience of the snorkel divers, several of whom appear to have considered that their scuba diving experience placed them in this category. They were instructed after entering the water to swim to the reef edge and then the current would take them to a bommie and where the dive boat would pick them up 40 minutes later. No instructions were reportedly given concerning the dive location (one witness contradicted this) or advice to follow buddy system practices and no adequate surface safety watch

was arranged. The sea conditions differed from those expected, a strong current being present, a fact not noticed by the skipper until it was observed that the members of the group were scattered and being carried away from their intended destination and were signalling to be picked up. One of them later claimed to have drawn attention to a diver in need of assistance, the victim, but the boatman insisted in picking up another pair before going to him, and other witnesses confirmed this.

They had entered the water about 50 m from the reef and to reach the bommie they were intending to drift some 200-300 m. The water was 20 m deep where they entered the water. They had been advised to attract assistance by raising one or both arms and waving them, an action which often results in the person becoming submerged. There is some uncertainty concerning the sea conditions, variously described as half a metre to 6 foot swell. But the current was certainly contrary in direction to that they had been expecting, and rated as being strong by most of them.

When the boat reached the victim he was face down, "vertical in the water with the top of his head 10-20 cm below the surface". He was quickly pulled into the boat and EAR commenced, although he appeared to be dead. One witness described the divemaster as panicking and performing inefficient EAR, but this is unlikely to have affected the outcome. As so frequently occurs in drowning accidents, regurgitation of stomach contents complicated the resuscitation efforts. There is no information concerning the victim beyond the fact that he lived in Australia but was heard "talking in another language", and held a scuba diving certificate dated 1969 "not from a recognised organisation". It is perhaps surprising that the available records contain no more information concerning the victim, his health, and swimming/snorkelling, the minimal desirable data. The autopsy showed the presence of diffuse coronary atheroma, but no myocardial infarction. The mitral valve was abnormal with probable insufficiency, and the kidney contained numerous cysts. While the cause of death was drowning there may be significance in the coronary atheroma and mitral valve changes. One witness thought the victim had been wearing special fins but his equipment was not formally described in the depositions.

GROUP SNORKEL DIVE. CURRENT STRONGER AND DIFFERENT DIRECTION TO EXPECTED. SURFACE SAFETY WATCH SLOW TO RECOGNISE DIVERS IN DIFFICULTY. DELAY IN RESPONDING TO OBSERVED NEED FOR ASSISTANCE. POSSIBLY EXPERIENCED SCUBA AND SNORKEL USER. SOME CARDIAC INSUFFICIENCY PROBABLE BUT NO MEDICAL HISTORY.

**BH 97/16**

The course of events in this case is unlikely to ever

be known. This man was loaned equipment, wet suit, mask, snorkel and weight belt, to enable him to accompany two of his friends when they went to catch fish on a reef, for which they had a license. There is no information concerning either his swimming or snorkelling experience and ability, but as he was able to dive and net some fish at their initial location, depth 3 m (10 ft), he most probably had significant experience. After this they took their boat to their intended location, another dive boat having left the area by this time. He was left in the boat when his two friends commenced their hookah (surface supply) dive and it is probable they did not expect him to remain in the boat to watch their compressor. When one of them returned after about 90 minutes he was surprised to find the victim present neither in the boat nor on the surface nearby. A visual search of the surface was unsuccessful and he then signalled to tell the other diver to surface. They notified the loss of their companion and continued their search until deteriorating weather forced them to stop. The water here was 15 m (50 ft) deep but only 1.5-3 m (5-10 ft) over the nearby bommie. The visibility was good and current minimal. Later official searches were equally unsuccessful, neither body nor any of the equipment ever being found. It is assumed, from the failure of the body to float, that he failed to ditch his weight belt. No reason can be given for him to drown but it is possible he drifted too far from the boat to be able to return, suffered a medical emergency, or possibly suffered a fatal post-hyperventilation blackout. If he was an experienced spear fisherman (there is no evidence of his breath hold diving ability) the last would be a likely scenario.

SOLO BREATH HOLD DIVING WHILE BUDDIES HOOKAH DIVED. ABILITY UNKNOWN. NO ADVERSE WEATHER OR KNOWN HEALTH FACTORS. BODY NEVER RECOVERED.

#### **BH 97/17**

On the second day of this live-aboard reef dive trip the victim and his friend were noted to be free diving to 15 m (50 ft) with their spear guns, an indication of their ability. The next day the boat moored at another reef, water depth 25.5 m. While most of the other passengers, snorkel and scuba diver were taken by the boat's tender, the victim and his friend were spear fishing from the stern of the boat, their activities aided by getting one of the passengers to burley the water using pieces of fish. No sharks were seen at this time. A witness described how the victim failed to surface after being underwater for 5 minutes and his float had not moved. Then he realised there was a speargun floating at the end of the line and no sign of the victim, its owner.

The initial was to make a quick surface check using the boat's dinghy. This being unrewarded, the skipper and another person searched for the victim using scuba. They found the spear embedded in coral and surrounded by small sharks attracted by the fish on it. There was nothing in their

behaviour to suggest they had attacked anyone. A weight belt was on the line with the spear gun but no trace of the missing man was ever found. It is believed that he must have been negatively buoyant even after ditching his weight belt and that the current had washed the body away over the sandy bottom. He was an experienced spearfisherman, capable of reaching 36 m (120 ft) and was diving to 27 m (90 ft). Possibly he overextended his underwater capability while attempting to free his spear, suffering a post-hyperventilation blackout. Unfortunately ditching his weight belt, an accepted safety measure, failed to save him. He was reportedly a healthy man.

EXPERIENCED SPEARFISHERMAN. SOLO DIVES IN 90 m. CAPABLE OF DIVING TO 36 m. SPEAR FOUND IN CORAL WITH WEIGHT BELT ON LINE. SMALL SHARKS INNOCENTLY PRESENT. BODY NEVER FOUND. PROBABLE POST-HYPERVENTILATION BLACKOUT DROWNING.

#### **Scuba divers**

##### **SC 97/1**

Although the victim was trained and experienced she was less so than her buddy as she had only dived in summer months while he had continued during the winter. He was taking a course to become an instructor but there was a free day so took the opportunity to join his wife on a wreck dive. She was well trained, having taken deep dive, rescue and rescue courses, but not wreck penetration. The dive plan had to be changed because a large tanker was expected to pass close to the intended location, a wreck, and this would have limited their time there. The nearest suitable alternative at a similar (slightly lesser) depth was a wrecked submarine. Although the divers were given a general briefing there was no specific warning against entering the wreck through its broken hull. The two entered the hull and swam along inside it, meeting at least one other couple similarly occupied. It was close to their ascent time when a silt-out occurred, and despite the buddy's efforts they became separated. The buddy was able to exit the submarine but the victim failed, her body being recovered the next day by police divers using surface supply equipment for safety. She had unfortunately swum into the blind end of the submarine, 35 m from their entry point. There is always a risk of fine silt collecting in any enclosed space underwater and visibility will be treacherously excellent until it is disturbed and a sudden complete loss of visibility occurs, and with it loss of orientation. As direct ascent from such roofed situations is not possible, lack of a line or clear knowledge of the locality can easily result in disoriented swimming until the diver runs out of air.

SCUBA BUDDY PAIR. SEPARATED INSIDE SUBMARINE DURING SILT OUT. DROWNED. DANGERS OF ENTERING ENCLOSED SPACE WITHOUT A LINE.

**SC 97/2**

During a business visit to Australia, this man and his wife, both trained and apparently experienced divers, chose to join a three day trip to the Barrier Reef. He had made only one dive in the previous 12 months and was taking anti-hypertensive medications (type unknown), but was apparently fit. An instructor was aboard and she gave the passengers a talk during the trip out, mentioning that a personal dive guide could be provided for a small supplement. Although one couple chose to request this option it did not eventuate. The boat was moored about 50 m from the dive site, some bommies. The divers were required to snorkel swim with their guide to where their dive was to commence. The victim and his wife were the last to enter the water but were with the others during this swim. The guide, an instructor, said this couple were checked before the group descended, and when she noted they had not descended with the other 8 divers she surfaced to look for them. She saw them swimming back to the dive boat and that they were being watched from the dive boat.

His wife described how she was surprised when her husband said he was tired and wanted to return to the dive boat as he had not previously mentioned any problem. She swam as fast as possible to avoid delaying her husband. She was about 10 m ahead of him when she looked back and saw he appeared to be drifting. Believing that he might be in need of some assistance she signalled to the boat. There was some delay before she could get a response as the captain thought she was giving an OK signal, then noticed the victim making arm swimming motions and realised he was in trouble. The wife continued her return swim when she saw the tender dinghy start towards her husband, unaware of the seriousness of his condition. When reached, he was unresponsive and very probably dead, but resuscitation efforts were commenced and continued for a time in part to give his wife time to come to terms with his sudden illness. Clinically this was a cardiac death but it was officially recorded as a drowning death because the autopsy did not reveal any significant coronary artery disease, though there was some left ventricle concentric hypertrophy. There is no information available concerning his past health status, and certainly his wife was unaware that he had any heart problem.

EXPERIENCED SCUBA DIVER. SURFACE SNORKEL SWIM. BECAME EXCESSIVELY TIRED. DIED ON RETURN SWIM. BUOYANCY VEST NOT INFLATED. WEIGHT BELT NOT DITCHED. ANTI-HYPERTENSION TREATMENT HISTORY. CARDIAC TYPE DEATH BUT ABSENCE CORONARY ARTERY PATHOLOGY.

**SC 97/3**

Growing tired of painting and renovating his boat this man, a diving instructor, accepted the suggestion of two of his work mates to go scuba diving from it. Their first

dive was successful so they moved to an artificial reef for a second dive. The three men entered the water, two waiting while the third descended. He had strained his knee during the first dive, awakening an old knee problem, so decided to check whether he was fit to make the second dive. After reaching 10 m he decided to abort his attempt. He passed the second buddy, waiting at 7 m to be joined by the victim, during his ascent. The failure of the victim to descend the anchor line puzzled this buddy so he returned to the surface to find out what was causing the delay. To his surprise there was no sign of the missing man, and a descent to the sea bed failed to discover him.

They tried to contact another dive boat which was nearby, but neither radio nor shouting was effective so the first buddy swam across, despite his painful knee, to enlist their assistance. Their searches were unsuccessful and it was only on the third drift dive the next day that his body was seen on the artificial reef. There was a strong current over the reef and this made recovery difficult. The autopsy failed to explain why he drowned as the coronary arteries showed a maximum of 20% narrowing. He was regarded as a careful "do it by the book" workman and diver so it is surprising that he neither inflated his buoyancy vest nor dropped his weight belt. This suggests that death was rapid and unexpected.

TRAINED. SOME EXPERIENCE. DISAPPEARED FROM SURFACE DURING SHORT TIME BUDDIES WERE ABSENT UNDERWATER AWAITING HIS DESCENT. FAILED TO INFLATE BUOYANCY VEST. FAILED TO DITCH WEIGHTS. SUDDEN DEATH. NO CARDIAC CAUSE FOUND. UNEXPLAINED DROWNING

**SC 97/4**

This was his 17th scuba dive, the 4th on the deep dive course, and the water conditions were good. There were five making this training dive under the care of the instructor and they formed a group of three buddy pairs. They first descended to a ledge at 11m, then continued down to 28 m where they performed tests to demonstrate the presence of nitrogen narcosis before swimming around at 20 m depth until the first one's contents gauge read 100 bar, the arranged indication to start their ascent. It was the victim who reached this cut off first. They ascended as a group to the 5 m deco stop. However the victim continued to ascend, slowly finning till he reached the surface. At no time did he show signs of being in any difficulty.

It was his failure to redescend to the deco stop which led the instructor, and then the others, to surface to find out the reason. They found he had the regulator out of his mouth so the instructor replaced it and inflated his buoyancy vest, then offered to tow him back to the boat. He accepted this offer but made no complaint of having any problem. A short time later the instructor looked back, when he obtained no

response to a question, and saw he was grey and unresponsive. He signalled for the boat to collect them and commenced in-water EAR. Once back on the boat CPR was commenced, but there was no response. There was still 7 bar shown on his contents gauge.

The pre-autopsy X-ray showed the presence of gas in all chambers of the heart, aorta, main limb arteries and in the mediastinum. There was evidence of hypertensive cardiomegaly although the doctor who had performed his pre-training diving medical found his blood pressure only 130/80 supine, 115/95 sitting. It had been 140/90 when checked 10 months previously. He was overweight but was dieting. There was a history of anxiety and he had a script to take half a Xanax (alprazolam) tablet if needed. Lymphocytic thyroiditis was also present. There was clear witness confirmation that he appeared to ascend normally, not rapidly or showing signs of anxiety or urgency.

DEEP DIVE COURSE. HIS 17th SCUBA DIVE. GROUP ASCENT. NO APPARENT PROBLEM TILL HE CONTINUED HIS ASCENT PAST DECO STOP. DELAY BEFORE RAPID DEATH. HYPERTENSIVE CARDIOMEGALY BUT HAD NORMAL RANGE BP. LYMPHOCYTIC THYROIDITIS. MASSIVE CAGE.

### Surface supplied diving

#### H 97/1

Although, according to his father, he never successfully completed any of the courses he attended, this man is reported to have held a commercial diver license, owned a dive store and trained others. The truth or otherwise of these comments is not documented in the official records. He was reportedly always careful with the state of his equipment, but when it was examined following his death it was found to have several significant faults, water in the compressor's reservoir, the demand valve allowed in water, the hose couplings were not secured by tape and easily disengaged, and the air intake was unsecured and lacked an air filter. There were three friends in the boat, one being a commercial diver and the other an untrained diver who was experienced by diving with the victim. The former regarded the victim as being reasonably experienced. They were, unsuccessfully, hunting for crayfish among thick kelp, two being down at a time. The buddy became tired and returned to the boat and while he was removing his equipment the hose came off the compressor. He jumped back into the water to retrieve the hose and pulled it and the victim, who had now surfaced, back to the boat where the third diver reattached the hose. The victim was shouting for help and thrashing his arms about at this time, but submerged again after the hose was reattached, which surprised the other two. The thick kelp made it difficult to pull him back to the surface and get him into the boat. Their CPR efforts were unsuccessful.

The pre-autopsy X-ray showed the presence of air within the heart, clear evidence of CAGE. It is thought he probably failed to exhale adequately during his no-air ascent and the thick kelp would have restricted his free ascent to the surface. The comments of the state of his equipment showed that it was in an unsafe condition despite his reputation for safety consciousness. When the equipment was officially examined it was noticed that the bail out bottle was not connected, but it is not known whether this was due to the victim releasing it in his attempt to activate it, occurred during his retrieval, or occurred during its transport and storage before it was checked. Although there was a family history of heart trouble and he was overweight at 108.2 kg (17 stone or 238 lb) there was no evidence of hypertension or coronary artery disease.

HOSE SUPPLY DIVING IN KELP. EXPERIENCED BUT TRAINING UNCERTAIN. HOSE SEPARATED FROM COMPRESSOR. DELAYED ASCENT. ADVERSE COMMENTS CONCERNING EQUIPMENT. BUDDY ALSO EXPERIENCED BUT UNTRAINED. DELAYED ONSET SYMPTOMS OF CAGE.

#### H 97/2

The importance of never using faulty equipment, and of ensuring that it is competently maintained, was tragically demonstrated in this incident. One of the three friends collected cowrie shells for his personal collection, strictly not for sale as he was not licensed. His two friends helped him and the previous day had found that the compressor they used was unable to maintain an adequate air supply for two at 36 m depth. They had replaced the reed valve on the middle cylinder and expected this would be sufficient. However they soon found it would still only supply one diver at the desired depth.

It was the victim's turn to dive. Although he did not like it he was wearing a bail-out bottle on his harness. After he had been underwater a short time the two who remained in the boat noticed the pressure was falling and increased the engine to full throttle. This improved the pressure for a short time, then it again began to fall and this became increasingly rapid. They decided to warn the diver to ascend by two pulls on the hose. They are uncertain whether there was any response. They began to pull up the hose slack, taking in 10 m and indicating the diver was ascending, then it began to run out and it felt as if there was a dead weight at the end of the hose. This led them to decide to pull their friend up using the hose, which to their surprise now ran under the boat. When they had pulled him to 4-5 metres below the surface they could see his regulator was free flowing and one of them dived down to find whether he wished to make a deco stop. He found him hanging limp, the regulator hanging free. They pulled him into the boat and performed CPR but this was unavailing. As there was

no response to their radio calls for assistance, they returned to shore and transported the body to the nearest hospital.

The pre-autopsy X-ray showed the presence of not only a left pneumothorax and surgical emphysema but air in the heart. While these findings may have been modified by their CPR efforts, this was clearly a severe case of pulmonary barotrauma with CAGE. He was reputedly a calm, conscientious, safety conscious and experienced diver, very probably scuba trained, who had frequently used hookah apparatus. However these three divers had apparently dived using a compressor they knew was working below its correct efficiency. The report on the examination of the compressor found numerous faults. The reed valve in the central cylinder had snapped (they heard this occur but did not realise the significance of the sound), there was a major leak from the central metal filter of the compressor, all the delivery fittings had leaks, and the intake hose was plastic and had melted and fused. This last problem could have led to the creation of carbon monoxide. He was reported to enjoy the feeling of nitrogen narcosis, a somewhat unsafe addiction.

EXPERIENCED HOOKAH DIVER. DEEP DIVE FOR COWRIE SHELLS. MALFUNCTIONING COMPRESSOR MINIMALLY REPAIRED. LOSS OF AIR PRESSURE THROUGH COMPRESSOR LEAKS. ASCENDED ABOUT 10 m THEN APPARENTLY LOST CONSCIOUSNESS. LEFT PNEUMOTHORAX. AIR IN HEART. SURGICAL EMPHYSEMA. CAGE.

## Discussion

It is highly probable that two factors explain the rarity of reports of snorkel user/breath-hold other than in Queensland. First there is the factor that the Great Barrier Reef is known world wide and attracts large numbers of visitors from overseas and other States, many of mature age and with little or no previous experience of snorkel use, which weights the numbers who are at risk. Second, this is so important to the local economy that Government and press show particular interest in such incidents as occur. This media and Government interest does not exist in other States and it is therefore probable that such fatalities as occur fail to receive more than local public notice. It is noted that only one of the cases recorded here occurred outside Queensland and that was an experienced diver who surfaced in the path of two fishing boats and was hit by the propeller of one. Given the bias to age in Reef visitors it is perhaps not surprising that a cardiac factor has been considered the critical element in ten (10) of the fatalities. In one a post-hyperventilation blackout, followed by drowning, is believed to have occurred. However there is no clear explanation for three cases, but it is possible that the critical factor was unfamiliarity with use of a snorkel. Certainly water conditions, and even water depth, do not appear to have been factors. It is noticeable how silently death can come,

the victim giving no sign of experiencing any problem to persons nearby. In one case (BH 98/16) the body was never recovered and insufficient is known concerning the victim's abilities to suggest a possible cause for his death, while in the other case where the body was never recovered (BH97/17) the victim's health and ability were documented.

There were four (4) identified scuba diving deaths. The tragic death due to a silt-out while exploring inside a sunken and broken submarine underlines the warning that any enclosed space is likely to contain fine silt which changes temptingly crystal clear water into impenetrable fog in an instant once disturbed. Cases SC 97/2 and 97/3 are difficult to explain other than supposing a sudden cardiac event of which there was no hard evidence at autopsy. Case SC 97/4 illustrates the maxim "Man proposes, God disposes" as this was a normal ascent in a group during which, apparently, the diver suffered a massive air embolism and pulmonary barotrauma. While it possible to invoke stress due to his relative inexperience, and nitrogen narcosis at depth causing him to omit correct breathing, nothing untoward was observed in his behaviour by his more experienced companions.

Surface supply is, in the well-ordered world, a marvellous way to dive as there is an unlimited duration of air supply. Unfortunately in the real world surface supply provided by a compressor (hookah) can cease with minimal warning, with tragic results for an unprepared diver. In the first case the unsatisfactory functioning of the compressor was warning of possible trouble, though naturally none expected the sudden critical failure of the air compressor. The thick kelp complicated the recovery of the victim. Whether or not the victim attempted to use his bail-out bottle cannot now be known but he certainly suffered air embolism, though this was not immediately fatal as he was able to shout and thrash about at the surface before sinking again. A similar catastrophic loss of air occurred in the second case and here there was a depth factor and the embolism appears to have been fatal well before he reached the surface.

To summarise, inexperienced snorkel users appear to be at some risk even in shallow, calm water, and there is a significant risk of critical cardiac events in the older group of users. The cardiac risk should also be remembered in relation to scuba divers. The danger of entering areas from which direct ascent to the surface is impossible is very real if fine silt has accumulated, so should always be remembered. Surface supply users must be aware of their dependence for survival on a guaranteed air supply and hose line. Acceptance of less than this standard can be fatal.

## Acknowledgments

This investigation would not be possible without the understanding and support of the Law, Justice or Attorney

General's Department in each State, the Coroners, and police when they are approached for assistance.

### PROJECT STICKYBEAK

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

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### ARE SOME JELLYFISH TOXINS HEAT LABILE?

Geoff Taylor

#### Key Words

Injury, marine animals, toxins, treatment.

#### Abstract

The author reports four episodes of stings from the Jellyfish *Tamoya gigantua*, two of which are his personal experiences. On the second occasion the sting was successfully treated with local heat. This raises the question as to whether other jellyfish toxins are heat labile and could be treated in the same way.

#### Introduction

Jellyfish stings of varying severity are a very common problem for Australians pursuing water sports around our coasts. They vary from the relatively innocuous sting of the Jimble (*Carybdea rastoni*) to the more serious Irukanj syndrome and Box Jellyfish stingers. Local first aid measures that have been recommended for the less severe stings include the use of vinegar, aluminium sulphate (Stingose), lignocaine jelly, papain meat tenderiser and ice.<sup>1,2</sup>

*Tamoya gigantua* is a little known jellyfish that frequents the tropical waters of northern Australia. It is a large box-jellyfish with an elongated box structure and has only four, very short, thick tentacles at each corner. There is commonly a small fish (species unknown) that resides in the bell of the jellyfish. In appearance it superficially resembles a large innocuous comb jelly and does not look like a stinging species. However, the whole body of the animal is covered in nematocysts that pack a powerful punch and can penetrate protective clothing.

#### Case reports

The first case was a bather who had been swimming near the Navy Jetty at North-West Cape, near Exmouth (latitude 21° S) and suffered a powerful sting. A local diver was despatched to investigate any species likely to have caused this injury. He returned with a huge specimen of *Tamoya* whose bell was 22 cm long. No one was game to experiment with this giant and we remained unsure if it was the culprit.

It was several years later that a diving companion recounted his own experience of being stung in 1987 by the same species, on the hand, while diving at Point Cloates on the Ningaloo Reef. He had suffered intense local pain, which spread to his axilla. He felt tightness in the chest making him short of breath. The pain lasted for several hours causing considerable fear and distress. His diving trip was curtailed and the dive boat returned many miles to base-camp.

The next two cases are my own experiences of being stung on two occasions and the successful use of heat to treat the pain of envenomation.

The first occasion occurred on Ningaloo reef in 1994. While swimming in deep water awaiting pick-up by a boat, my left knee struck a sizeable *Tamoya*. The sting penetrated through a lycra bodysuit, causing instantaneous severe burning pain. The pain soon spread to regional lymph glands in the groin, but there were no systemic symptoms. The intense pain lasted for about two hours, and then slowly subsided over the ensuing three hours.

The second event occurred in the same locality, a year later. On this occasion, while snorkelling, my head struck the *Tamoya*, the stingers penetrating my hair (which is surprisingly thick), with extensive stinging over the scalp. At the same time I lifted my hand in a reflex action to fend off the "attacker", and was stung on the back of the hand.

On this occasion it was decided, as an experiment, to try treating the sting with heat. My hand was immersed in a bowl of hot water as hot as I could stand. This brought almost immediate relief of the pain, but initially the pain recurred after removal from the heat. After 20 minutes the