PROVISIONAL REPORT ON AUSTRALIAN DIVING-RELATED DEATHS IN 1993

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Summary

Four snorkelling deaths, thirteen using scuba and four using a compressor supplied hose (hookah) were identified. No claim is made that all the fatalities have been identified. The deaths in the snorkelling group all occurred unobserved, although others were nearby at the critical time. Cardiac factors were implicated in two cases, epilepsy in one and one who drowned for no identified reason was possibly incompletely recovered from a recent viral illness. The causes of death in scuba divers included three possibly cardiovascular deaths, two shark attacks, two disappearances, two drownings with multiple adverse factors in the dive history, one with definite cerebral arterial gas embolism (CAGE), one with possible CAGE and depth related factors, one suicide and an unexplained death. The bodies of three of the victims were never recovered. Two of the hose supplied divers died from carbon monoxide poisoning, the third was victim of a shark attack and the fourth died from either CAGE or surface drowning.

Key words

Breathhold diving, CAGE, carbon monoxide, case reports, deaths, diving accidents, marine animals.

Snorkel user fatalities

BH 93/1

A group of four friends went spearfishing. After a time three of them decided to move to another area but first had to inform the other member of the group. Initially they misidentified him, signalling to a stranger who was diving near where they had last seen him. When they saw a spear gun on the sea bed they became anxious. Later they saw a snorkel at the surface and swam out. He was floating at the surface, face down, with froth coming from his mouth. He was quickly brought to shore but their resuscitation attempts failed. The sea was calm and visibility excellent. Autopsy revealed that his heart showed the changes of a primary cardiomyopathy. He was unobserved for only 10 minutes.

SPEARFISHING. SEPARATION. FOUND FLOATING. CARDIOMYOPATHY.

BH 93/2

Passengers on a cruise liner were offered an excursion to view the Barrier Reef. After a rough trip they reached a pontoon moored at a reef where they could view the reef from a glass bottomed boat and to borrow fins, mask and snorkels to swim in the area bounded by buoyed ropes between the pontoon and the reef. Buoyancy vests were available. The victim was, according to his wife, in good health, a good and confident swimmer and it is probable that he was snorkelling at the surface. He was on metoprolol tartrate (Betaloc) but no details of his medical condition are recorded. When he entered the water there were about 25 others swimming around, though earlier more had been in the designated area. There were two crew members appointed to watch the swimmers, though their task was made difficult because some were making short dives. His wife watched him for a time. When she next looked about 10 minutes later she was unable to see him and a search failed to find any trace of him. It is assumed that, for some unknown reason, he drowned silently and drifted away. His experience with using a snorkel is unknown.

SNORKELLING. SOLO AMONG OTHERS. SILENT DEATH. BODY NEVER RECOVERED. HISTORY HYPERTENSION. ON BETALOC. SUPERVISORS OF AREA SAW NOTHING UNTOWARD. GOOD SEA CONDITIONS.

BH 93/3

Two weeks after being struck by the Influenza A virus girl had recovered sufficiently to holiday at the Great Barrier Reef with her parents. She joined a dozen or so others to make an escorted snorkel viewing of a nearby reef. As they boarded the boat the supervisor counted them and collected their tickets but did not record their names. They were given a brief introduction to the use of a snorkel and fins during their trip to the dive location . Although she was said to be a good swimmer and to have used a snorkel previously, she chose to wear a flotation vest. Its buoyancy kept her on the surface. After reaching the anchoring area they all entered the water and swam, with their dive supervisor, about 20 m to a bommie where he described the corals and fishes they could see there. They were then free to swim about in the area, but first he asked them not to stray too far from him. He made a head count before leading them back to the boat and believed that all were present. The sea was calm with only a slight current. One of the group said that there seemed to be one person missing, so he decided to return to the reef area in case she was there. He saw nobody. After checking that she had not swum back to the beach or returned in another boat, he then conducted a wider search. He found her floating face down, mask in place, about 500 m from the bommie. Resuscitation attempts were unsuccessful. The autopsy showed no other cause for her death than drowning. She was described as having been “a cautious child, one who would never have put herself in danger” so she would not voluntarily have left the group, and the fact that her mask was in place was taken to indicate the absence of panic. The reason for her silent death cannot be known. Possibly

she inhaled water down her snorkel and suffered cardiac inhibition. Other than this occasion her experience with a snorkel is unknown.

RECENT ILL HEALTH. SNORKELLING IN CALM SEA. SILENT DEATH IN GROUP. WEARING BUOYANCY VEST BUT FLOATED FACE DOWN. DELAYED RECOGNITION OF ABSENCE. SUPPOSED GOOD SWIMMER. SNORKEL EXPERIENCE UNCERTAIN.

BH 93/4

Her intention had been to make a Resort Dive but when she filled in the medical history sheet she revealed that she had suffered an epileptic fit after a severe head injury 10 years before. She was told by the diving instructor that she could not be accepted for a dive in case a fit occurred during the dive. She declared that she was on regular medication and had never suffered a fit since this was started, but was still refused. However, as the ticket for the trip to the Barrier Reef included a statement that all passengers could borrow snorkel gear, the staff felt they were unable to refuse to supply her with this. The area for snorkelling was between the two moored boats and the reef. There was supervision by a member of the crew but viewing was difficult because the calm sea reflected the sunlight. The major safety factor was assumed to be the presence of a number of swimmers in the same area. Nobody noticed anything untoward and her absence was not noticed until, 2 hours later, a roll call was made. Six hours after she had entered the water her body was retrieved by a boat several kilometres away. A helicopter observer had seen her fins at the surface, with a dark shadow beneath and guided the boat. Had she failed to reveal her epilepsy history she would have been under the close supervision of the diving instructor on a Resort Dive Experience and her survival chances would have been better. It is assumed she suffered an epileptic fit and drowned.

POST-TRAUMATIC EPILEPSY HISTORY. REFUSED PERMISSION TO MAKE A RESORT DIVE. SILENT DEATH AMONG OTHER SWIMMERS. DELAY BEFORE HER ABSENCE NOTED. PROBLEMS IN SUPERVISION OF GROUP OF SWIMMERS.

Scuba Diver fatalities

SC 93/1

Three friends were snorkelling in a popular diving area. On returning to shore they looked down and saw a still figure on a concrete block below them. They dived down and found it was a scuba diver. There were no bubbles of air coming from his regulator and they found he was attached to the concrete block, which explained the failure of their attempts to bring him to the surface. Police divers had to use bolt cutters on the padlocked chain connecting him to the block. Suicide notes and the padlock's key were later found in the diver's car. He was known to be depressed, was receiving medication and had the support of friends but this proved insufficient to prevent the tragedy. He had made previous suicide attempts but on this occasion, he had taken great care to eliminate all possibilities of failure in his attempt. It is terrible to think of a person's state of mind who has arranged to wait to drown when his tank becomes empty. He had been aware that his body would be found as the area was frequented by divers.

EXPERIENCED DIVER. DEPRESSED. PREVIOUS FAILED SUICIDE ATTEMPTS. SOLO. CHAINED HIMSELF TO BLOCK TO ENSURE DROWNING. SUICIDE.

SC 93/2

Shark attacks on scuba divers are fortunately rare so it may be thought particularly unjust that this attack occurred on a honeymoon couple. They were both experienced scuba divers, the victim more so than his wife. It was a popular and frequently dived area and their first day's dive had been without incident. A large shark they had seen was thought to be a grey nurse and caused no anxiety. On the fatal day there were five divers on the dive boat which was close to some small rocky islets. The other divers formed a trio while the couple dived together. After an uneventful dive for 25 minutes at 21 m in good visibility they saw a large shark about 7 m from them when they were at 10 m. It was swimming away from them. They surfaced about 50 m from the dive boat, then the buddy remembered that they should have made decompression stops, so they descended to 9 m and after 3 minutes rose to 3 m. There the buddy looked round and saw a large shark approaching rapidly. The victim was a little behind and deeper than the buddy. The shark took him in its jaws and swam away. No blood was seen in the water after the attack. The buddy rapidly surfaced and cried out for help. Despite knowing that a shark attack had occurred, one of those in the boat jumped in to assist her while the boat was carefully but quickly brought to pick her up. At this time the other three divers were making a decompression stop. One of the divers, an instructor, made a courageous dive to see whether he could retrieve any part of the victim or his equipment. He saw a large shark in the area and then saw it swim about 3 m in front of him, so surfaced before he developed a need for in-water decompression. A large shark was seen by those in the boat before they left the area. Some fishermen later hooked a shark which vomited out the victim's torso before making its escape.

EXPERIENCED DIVERS IN POPULAR DIVING AREA. SUDDEN MID-WATER SHARK ATTACK DURING DECOMPRESSION STOP.

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and experience		Dive	Dive	Depth m (ft)		Weights	
		Victim	Buddy	group	purpose	Water	Incident	On	kg (lb)
BH 93/1	24	No training Experienced	No training Experienced	Group Separation before incident	Spear fishing	1.2 (4)	Not stated	No	Not applicable
BH 93/2	66	No training Experience not stated	-	Group Separation before incident	Recreation	21 (70)	Surface	No	Not applicable
BH 93/3	16	Some training Experienced	-	Buddy Separation before incident	Recreation	Not stated	Surface	No	Not applicable
BH 93/4	30	No training No experience	-	Group Separation before incident	Recreation	15 (50)	Surface	No	Not applicable
SC 93/1	35	Trained Experienced	-	Solo	Recreation	10 (30)	Surface	On	11 (24)
SC 93/2	31	Trained Experienced	Trained Experienced	Buddy Separation during incident	Recreation	24 (80)	3 (10)	On	Not stated
SC 93/3	29	Trained Experienced	Trained Experienced	Group Separation before incident	Recreation	37 (123)	Ascent	Off	Not stated
SC 93/4	34	Trained No experience	Trained Experienced	Buddy Separation before incident	Recreation	4.8 (16)	4.8 (16)	On	14.5 (32)
SC 93/5	43	No training Some experience	Trained Experienced	Group Separation before incident	Recreation	10 (30)	Surface	Off	Not stated
SC 93/6	34	Trained Experienced	Trained Experienced	Group Not separated	Recreation	75 (250)	75 (250)	On	Not stated
SC 93/7	34	Trained Experienced	Trained Experienced	Group Separation before incident	Recreation	10 (30)	5 (15)	On	9 (20)
SC 93/8	38	Trained Experienced	Training not stated Experienced	Buddy Separation before incident	Cray fishing	6 (20)	Not stated	On	Not stated
SC 93/9	43	Some training No experience	Trained Experienced	Group Separation before incident	Pupil	18 (60)	Not stated	Not stated	8 (18)

DIVING RELATED DEATHS IN 1993

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Equipment Owner	Comments
None	Not applicable	Not applicable	Not applicable	Own	Shallow. Short separation from group. Cardiomyopathy. Silent cardiac death
None	Not applicable	Not applicable	Not applicable	Hired	Silent death in crowd. Drifted away. Never found. Hypertension.
Life jacket	Not applicable	Not applicable	Not applicable	Hired	Silent drowning in group. Drifted away. Recent “flu”.
None	Not applicable	Not applicable	Not applicable	Hired	In crowd. Floated face down. History of post-traumatic epilepsy.
Not inflated	Yes	Yes	Some faults	Own	Depression. Suicide.
Not inflated	Yes	Yes	Not stated	Own	Shark attacked after diver descended to make omitted decompression stop.
Not able to be inflated	Yes	Yes	Serious fault	Hired	Trio. Rapid descent. Rapid ascent hand over hand up anchor line. Buddies continued dive. Vest faulty. Overweighted. CAGE.
Not inflated	Yes	Low	No fault	Own	Asthma history. Just trained. Had had a panic attack during training.
Not inflated	Yes	Yes	No check	Own	No recent experience. Trio. Solo ascent. Coronary artery disease.
Buddy inflated	Yes	Yes	Significant fault	Own	Deep dive. Sudden unconsciouness. Possible nitrogen narcosis, CO_2 retention or O_2 toxicity. Possible CAGE.
Not inflated	Yes	Yes	Not stated	Own	Shark attack during descent, mid-water near seals.
Inflated	Yes	Yes	Some faults	Borrowed	No dives for 6 years. Separation. Found floating. Possible angina.
Not inflated	Yes	Not stated	Equipment lost	Borrowed	2nd open water dive. Drift dive. Separation. Body found 2 months later.

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and experience Victim	Buddy	Dive group	Dive purpose	Depth m (ft) Water	Incident	Weights On	kg (lb)
SC 93/10	22	Trained Experienced	-	Solo	Recreation	15 (50)	Not stated	On	Not stated
SC 93/11	61	No training No experience	Trained Experienced	Group Not separated	Recreation	10 (30)	10 (30)	On	Not stated
SC 93/12	44	Trained Inexperienced	Trained Experienced	Group Separation before incident	Recreation	18 (60)	Surface	On	Not stated
SC 93/13	34	Trained Experienced	Trained Experienced	Group Separation before incident	Recreation	Not stated	Surface	Not stated	6 (14)
H 93/1	32	No training Some experience	Trained Some experience	Buddy Not separated	Cray fishing	7.5 (25)	7.5 (25)	On	Not stated
-Double fatality									
H 93/2	27	Trained Some experience	No training Some experience	Buddy Not separated	Cray fishing	7.5 (25)	7.5 (25)	On	Not stated
H 93/3	27	Training not stated Experienced	Training not stated Experienced	Buddy Separation before incident	Work	12 (40)	12 (40)	On	Not stated
H 93/4	29	Trained Some experienced	Trained Some experience	Buddy Separation before incident	Netting fish	5.5 (18)	Ascent	On	Not stated

SC 93/3

A diving holiday package was arranged by a dive shop in another State. The victim had trained elsewhere but was a member of the club and had dived with its members, though not with those making this trip. The local dive shop checked that they had certification, but not their experience level. It was a boat dive and although the boat owner held a dive master qualification he did not assume the responsibilities. There were seven divers and he left it to them to decide their dive groups, merely advising them not to exceed 33 m. The victim, being a stranger to the others, joined a buddy pair. He entered the water before his buddies, coming rapidly back to the surface because his air was not turned on. He then started his descent without waiting for his buddies. As they descended they could see him close to the sea bed, which was at 37 m, about 5 m from the anchor and swimming towards it. When they reached 22 m they met him ascending rapidly, hand over hand up the anchor line. They signalled to him to slow down. They observed no signs of panic and his breathing appeared normal. They thought he would reach the surface safely so continued their descent and their dive. He had waved his octopus regulator at them as they passed, what he meant by this is unknown.

The man in the boat was surprised to see someone back at the surface less than 5 minutes from the beginning of the dive and became alarmed when the diver floated face up and failed to answer his call. He swam a line to the victim but, by the time he reached him, the victim was unconscious and not breathing. In-water CPR was started and, with the help of two nearby fishermen, he was put aboard the dive boat. Although alive when he reached hospital he never regained consciousness and died there later. He had been wearing his weight belt when he encountered his buddies during his ascent but it was absent when he was

DIVING RELATED DEATHS IN 1993 (CONTINUED)

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Equipment Owner	Comments
Not inflated	Yes	Not stated	Equipment lost	Own	Solo unannounced dive. Sea conditions good. Reputedly cautious diver. Body never recovered.
Buddy inflated	Yes	Not stated	Not stated	Hired	Resort Dive. Requested ascent. Said was OK but acutely ill on pontoon. Acute heart pain. Died next day. Myocardial infarction.
Part inflated	Yes	None	No fault	Hired	At end of dive, solo return to boat on surface. Language problem. Unexplained death. Possible subarachnoid haemorrhage.
Not inflated	Yes	Not stated	Equipment lost	Hired	Advanced certificate after 9 dives. Buoyancy problems. Separation at surface at start of dive. Current. Body never found.
No vest	Not applicable	Not applicable	Some faults	Own	Untrained. Limited experience with hookah. Calm, hot, no wind. Dog knocked intake hose into boat. CO poisoning.
No vest	Not applicable	Not applicable	Some faults	Borrowed	Recent training. Little experience. Calm, hot, no wind. Dog knocked intake hose into boat. CO poisoning.
No vest	Not applicable	Not applicable	No fault	Employer	Shark attack in turbid water. Working on pearl farm, cleaning lines, shells.
No vest	Not applicable	Not applicable	Some faults	Own	Netting fish. Lost fin. Separation. Ascended as replaced fin. Surface cry, then sank. Possible CAGE.

reached at the surface. The rescuer attempted to inflate his buoyancy vest but failed. Subsequent examination showed there was a leak at the attachment of the inflator hose to the vest. An X-ray was performed before autopsy which showed a small left pneumothorax, some air in the left ventricle and some mediastinal emphysema. The autopsy showed that both ear drums were ruptured and that sinus barotrauma had occurred. His weight belt was described as "excessively heavy" but it was not recovered and its actual weight is not known. He probably descended uncontrollably rapidly, due to an inoperative buoyancy vest, suffering severe pain in his ears and sinuses. Failing to drop his weights he had to pull himself up the anchor line to return to the surface. It would be easy in such a situation to forget to breath correctly during the ascent and consequently suffer pulmonary barotrauma and CAGE.

TRAINED. POSSIBLY EXPERIENCED. TRIO. ENTERED WATER WITH AIR OFF. RAPID DESCENT WITHOUT WAITING FOR BUDDIES. THEN MADE RAPID ASCENT. PULLED HIMSELF UP ANCHOR LINE TO SURFACE. BUDDIES FAILED TO ACCOMPANY TO SURFACE. NEW WET SUIT. PROBABLY EXCESSIVE WEIGHTS. FAULTY BUOYANCY VEST. DITCHED WEIGHTS LATE IN ASCENT. UNCONSCIOUS AT SURFACE. PRE-AUTOPSY X-RAY SHOWED LEFT PNEUMOTHORAX, AIR IN LEFT VENTRICLE. CAGE. BAROTRAUMA EARS AND SINUSES.

SC 93/4

He had revealed his asthma history at his diving medical, but possibly played down its severity. On the basis of simple respiratory function tests (no provocation tests were performed) he was passed as fit. This decision

was undoubtedly influenced by his history of managing stress situations and involvement in triathalon competitions. His condition was known to his wife but not to his colleagues at work. In his short diving career he had acted calmly when he became separated during a drift dive and had to manage in a current. In contrast he had suffered an episode of panic hyperventilation at the surface during training which his instructor successfully managed. The victim's buddy was aware of his inexperience and took particular care to keep close to him at all times. They snorkelled out to a shallow reef, depth 3-4 m, and dived for about 33 minutes before the buddy decided it was time for them to return. About 7 minutes later the victim looked at his contents gauge before making a somewhat rapid ascent. The buddy had a 88 cu ft tank, the victim a 63 cu ft one, so the buddy had plenty of air at this time. It is assumed that the victim was down to 50 bar and believed this required surfacing, but the reading is unknown.

The surface conditions had deteriorated while they were under water so the buddy indicated they should return to the beach underwater. His signal was answered but he did not see the victim on the sea bed or when he returned to the surface. He heard a sound like a howl but saw nobody. He called out "Drop your weights. Inflate your vest". The waves limited his range of vision and he soon felt in need of assistance. His calls brought some divers who helped him to shore. A search was unsuccessful, although the victim's mask and snorkel were found. When the body was located next day there was sufficient air remaining to inflate his buoyancy vest and float the body. His weight belt was twisted round but whether this was a significant factor is unknown.

Autopsy showed the presence of thick, blood stained mucus in the trachea but no signs of pulmonary barotrauma or infection. There was evidence of some air trapping in the distal airways, due to plugs of thick brown mucus. He had a nebuliser fitted in his car which he used while driving to dives. Blood assays showed salbutamol (Ventolin) and pseudoephidrine hydrochloride (Sudafed) to be present. He was also reportedly using regular beclomethasone diproprionate (Becotide). The probable sequence of events was inadequate surface buoyancy in rough water, failure to inflate his buoyancy compensator coupled with failure to use his regulator or drop his weights. His respiratory tract changes may well have significantly reduced his capacity to exercise. Asthma was only one of several adverse factors.

TRAINED. INEXPERIENCED. ASTHMA HISTORY REVEALED AT DIVE MEDICAL. RAN IN TRIATHALONS. COLLEAGUES UNAWARE OF HIS ASTHMA. EPISODE OF SURFACE PANIC IN TRAINING. USED NEBULISER BEFORE DIVE. SYMPTOMS OF URTI TREATED BY "SUDAFED" BEFORE DIVE. SEPARATION AT SURFACE IN ROUGH WATER. FAILED TO INFLATE BUOYANCY VEST. FAILED TO DROP WEIGHT BELT. EXPERIENCED BUDDY FOUND SURFACE CONDITIONS SEVERE.

SC 93/5

Four friends decided to go diving, one reason being to provide a refresher dive for the victim who was untrained but had some past experience. He had not dived for some time because of ill-health. He had supposedly recovered from cancer of his spine and a back problem, but no details are recorded. One of the friends decided to fish from the rocks so was given the duty of keeping a watch and to assist them leave the water after the dive if requested. The two who were both trained and experienced took care to watch their friend during the early part of their dive at 5 m. They felt that he was competent so they gradually continued down to 10 m. After about 27 minutes he indicated that he wished to ascend. They were close to the agreed exiting area so continued with their dive while he returned to the surface. He showed no signs of panic or distress. The friend left fishing heard a call for help and then saw the victim holding onto a rock with waves washing over him from time to time. When the friend reached the victim, he was floating at the surface face up. His buoyancy vest was not inflated but his weight belt was off. The others heard the fisherman call out when they surfaced and together they managed to bring the victim onto the rocks. He failed to respond to their resuscitation attempts. At autopsy severe atherosclerotic changes were found in the left anterior coronary artery but no evidence of either old or recent myocardial infarction. The stress of his dangerous situation may have led to a severe angina or sudden arrhythmia, or inhaled water may have caused sudden cardiac inhibition. That he was out of training, separated from his buddies and in rough water in a rocky cleft were all adverse factors. He was described as "a heavy smoker, a bit overweight, but not fat".

UNTRAINED. PAST EXPERIENCE. NO RECENT DIVING BECAUSE OF ILL HEALTH. TRIO. ALLOWED TO MAKE SOLO ASCENT. BUDDIES CONTINUED DIVE. SURFACED SAFELY. ENTERED ROCKY CLEFT WITH ROUGH WATER. UNCONSCIOUS BEFORE REACHED. SEVERE LEFT CORONARY ATHEROSCLEROSIS. WATER POWER. PROBABLY CARDIAC DEATH.

SC 93/6

The six divers were all experienced in deep dives though only two had previously dived to 75 m, one being the victim. This was a dive on a deep wreck. One was to remain in the boat. When the first pair started their dive the others set up decompression bars at 6 and 3 m. As the trio descended they met the first pair ascending. On the wreck they tied a reel line to the anchor and then swam over the wreck. As the three divers began their return to the anchor,

in line ahead the tail ender saw that the middle diver (the victim), though he appeared to be finning, was making no progress. He assumed the victim had become snagged but when he touched him he saw he was unconscious. The regulator fell from the victim's mouth as he was turned over so the buddy replaced it. He appeared to breath shallowly but in a rapid hyperventilation manner. The diver attracted the attention of the leader and held the victim while the leader cut the reel line. Then the tailender let go and started to make his ascent. The leader grabbed the victim and replaced his regulator, but no further efforts to breathe were observed. At 13 m he put some air into the victim's buoyancy vest, ditched his weights and allowed him to ascend to the surface unattended. He then returned to 15 m to start the planned decompression. The man in the boat saw the victim break the surface and immediately jumped into the water. With the assistance of the first pair, who had completed their decompression stops, he got the victim into the boat. Their resuscitation attempts were unsuccessful.

A pre-autopsy X-ray showed a massive air presence intravascularly, with air in the heart and pulmonary vessels and also many other vessels. Some air was post mortem out-gassing but the total amount indicated probable air embolism. There were several adverse factors. Calculations showed that he had used far less air than would have been expected. His regulator was hard to breathe and had a partly inverted exhaust valve which would have caused a spray of water with each inhalation. He was wearing two tanks and the regulator on the second one also was misassembled, however he had not breathed from it. Oxygen toxicity, carbon dioxide retention and nitrogen narcosis could all have affected him and he was using equipment unsuitable for a deep dive because it required too much effort to breathe.

EXPERIENCED DIVER. DEEP DIVES. LOST CONSCIOUSNESS AND SEEN FITTING. TRIO. NITROGEN NARCOSIS POSSIBLE REASON WHY ONE BUDDY ABANDONED VICTIM. REGULATOR HARD TO BREATH. POSSIBLE WATER SPRAY ON INHALATION. LOSS OF CONSCIOUSNESS. PROBABLE NITROGEN NARCOSIS. POSSIBLE CARBON DIOXIDE RETENTION. POSSIBLE OXYGEN CONVULSION. PROBABLE CAGE DURING RAPID UNCONSCIOUS ASCENT.

SC 93/7

On a trip to view an island seal colony there were family members and children in addition to the three experienced divers, only one of whom had previously dived there. The victim had not dived during the past 18 months. The boat anchored more than 30 m from the island and they swam on the surface towards it. They descended, when near the island, to 10 m. Two had reached the sea floor and were watching the victim, who appeared to be equalising her ears at 5 m, when a shark was seen to take her across her body, let go of her, then swim away with her. They remained on the bottom for a time, then decided that it would be safest to exit onto the island. There were now no seals in the water around them and they had difficulty getting through the throng on the rocks. It took a little time to catch the attention of those on the boat, who were unaware of what had occurred. It was later reported that a diver hunting crayfish had encountered a shark here 2 months previously and discouraged it with his spear gun.

THREE DIVERS OFF SEAL COLONY ISLAND. GOOD VISIBILITY. SEPARATION DUE TO DIFFICULTY EQUALISING EARS. MID-WATER SHARK ATTACK. BODY NEVER RECOVERED.

SC 93/8

The employees of a firm had an outing to a resort island, the majority in one boat and three following in the boat owned by one of them. There was some surfing and swimming by all, then the owner of the private boat asked whether the victim would like to scuba dive with him. The owner had spare equipment with him so it is assumed that he was an experienced diver. It is known that the victim had been trained 8 years ago and dived regularly for 2 years but had not dived since. Visibility was good, sea conditions excellent and the water was shallow at the reef close to where the boat was anchored. The owner spent about 5 minutes exploring under a rock shelf at about 4 m, the victim remained outside looking for crayfish. When the owner emerged he was surprised not to see his friend. After a look around underwater he surfaced, but still could not see him. After another underwater check he climbed onto the bommie to obtain a better view. He saw an inflated buoyancy vest at the surface 70 m away, so went over in his boat. He found the victim floating, unconscious, face up and without his mask. After ditching the weight belt he managed to get him into the boat. This was difficult because there was now some breeze and a chop. CPR was unavailing. A check of his equipment showed the tank valve was incompletely open so that breathing would have required extreme effort. A history was later obtained that he had reported chest pains during the previous 3 months, but these had not been regarded as cardiac in origin. At post mortem the left descending anterior coronary artery was affected by atheroma, 60% occluded in places. While there is no evidence that he suffered an anginal attack or that arrhythmia had occurred, and no evidence of air embolism was noted, critical adverse factors were a combination of inexperience, separation and difficulty in obtaining adequate air.

TRAINED. SOME PAST EXPERIENCE. NO DIVING FOR 6 YEARS. BORROWED EQUIPMENT. TANK VALVE ONLY PART OPEN. SEPARATION. POSSIBLE ANGINA HISTORY. 60% NARROWING LEFT CORONARY ARTERY. SUDDEN DEATH.

SC 93/9

The 8 divers were all known to each other at work. One was a diving instructor, three were his pupils and the other four were trained. This was the third open water dive for two of his pupils but only the victim's second as he had aborted one dive because he became too cold. The boat was anchored in 8-9 m close to a drop off. The dive plan was for them to meet on the sea bed and then make a drift dive as a group, never to exceed 18 m. It was not to be considered as a part of the training course. There was no allocation of buddies. There was some current and they all descended at different rates so separation occurred. The instructor gathered four of them in one place and then swam towards the three pupils (two on the sea bed, the third still descending) and signalled them to follow him back to the main group. He thought one started to follow him but soon found he was alone so went back but found no sign of them. He assumed they had decided to dive as a trio and returned to conduct the planned dive with the four trained divers. The victim's absence was noted only after all surfaced and a head count was made. The two surviving pupils described how one had descended quicker, despite having ear equalisation problems, than his under-weighted friend. By the time they were both on the bottom there was no sign of the others and they never identified the drop off, finding themselves at 22 m at one time. They had ascended to the agreed 18 meters and drifted until down to 50 bar. Both groups had assumed the victim was safe with the other. The body was found floating 10 weeks later.

PART TRAINED. 2nd OW DIVE. GROUP DRIFT DIVE. NOT PART OF COURSE. NO BUDDIES ARRANGED. SEPARATION ASSOCIATED WITH INITIAL DESCENT. INSTRUCTOR FAILED TO ACT AS SUCH TO PUPILS. DROWNED.

SC 93/10

As a crew member of a boat taking divers out to the reef and a trained diver it was not against policy for her to go for a dive. Her experience is unknown, but she was described as being an excellent swimmer. An instructor was taking a group of divers on an advanced diver course and there were other divers in the water, but nobody was aware that she intended to dive or saw her enter the water or in the water. Her absence was not noticed until later and no trace of her or her equipment was ever found except for a small piece of her swimsuit. The water was very deep close to where the boat was anchored, too deep for searching. It is unknown why she dived alone or what happened to her. Although a shark attack is possible there is no evidence for this. Water conditions were good for diving when she disappeared.

TRAINED. EXPERIENCE UNKNOWN. SOLO DIVE. BODY NEVER FOUND.

SC 93/11

This was a well-conducted Resort Dive, undertaken off a pontoon moored at a reef. The diver's medical questionnaire revealed no ill health nor medications. The instructor took two divers to a maximum depth of 9 m. After 16 minutes the victim indicated that he wished to ascend, which they did in a normal manner. At the surface he stated he was "all right" but insisted he wished to return to the pontoon. The instructor partly inflated his buoyancy vest and assisted him to swim to the float at the end of the mermaid line attached to the pontoon. The victim part swam, part pulled himself the 20 m to the pontoon where his equipment was removed and he was assisted back on board. It was suggested that he should rest. Very shortly after this he became very pallid, sweaty, felt faint and sick and breathless, with noisy breathing. Some chest pain was also mentioned. He was placed on 100% oxygen. The Diver Emergency Service (DES) and the nearest hospital were contacted. The hospital sent a doctor by helicopter. His condition had so greatly improved with the oxygen that he was evacuated to the hospital for a period of observation and tests rather than because of his condition at the time. He made a good recovery from this episode of acute cardiac decompensation in hospital, but died there the next night from a cardiac arrhythmia due to an acute myocardial infarct. Ischaemic heart disease was noted. It is recorded he had been experiencing some anginal symptoms for about two weeks, indeed had felt an unusual weakness when walking that morning before he dived. It is believed he had a "dive medical" before being allowed to book the reef trip as he had indicated he intended to make a Resort Dive, but no copy of the report is available. It is unknown whether he was aware that his symptoms were due to angina.

RESORT DIVE. NO HISTORY OF ILL HEALTH. WELL CONDUCTED DIVE WITH CLOSE SUPERVISION. ASCENT WHEN ILL-DEFINED SYMPTOMS OF ILL HEALTH. ACUTE CARDIAC DECOMPENSATION AND SHOCK SYMPTOMS AFTER HE LEFT THE WATER. RESPONDED TO OXYGEN. REACHED HOSPITAL. DIED LATER. CARDIAC DEATH.

SC 93/12

Among the divers making a four day dive trip to visit some of the less accessible reefs were three from overseas whose experience was uncertain, though all were trained. The victim had obtained certification on an overseas holiday a year before and not dived since, so the instructor on the boat accompanied him during his first dive to check that he seemed competent. They made four dives on each of the first two days, the sea conditions perfect. However on the third day the visibility was poor. On the second dive of the day they dived as a trio. The two women seem to have managed the current they encountered underwater better than the victim. The dive leader twice left them on

the sea bed and surfaced to check their position. On the second occasion they started to follow her and, so poor was the visibility, collided with her as she was descending. On the third occasion they followed her to the surface as their air was becoming low. They found conditions had worsened and there were rain squalls. The two women signalled to the dive boat they wished to be collected but the victim decided to swim back to the boat rather than wait. By now there were some waves. The dinghy which collected them was on the line the victim took for his return but he was not seen. There was some initial delay due to language problems before they made it clear a diver was missing. An immediate surface search failed to sight him and an underwater search was organised. He was found, lying on the coral, at about 19 m, his mask full of blood, weight belt in position. The autopsy was unsatisfactory, no clear reason being offered for the blood in his mask and lungs, though it was suggested it was a result of aspiration of gastric contents. There was some blood at the base of the brain but its source and significance remains uncertain.

TRAINED. INEXPERIENCED. SURFACE LOW AIR. SEPARATION TO SWIM BACK TO DIVE BOAT. UNEXPLAINED DEATH. POSSIBLY ASPIRATION VOMIT SYNDROME. POSSIBLE SUBARACHNOID HAEMORRHAGE. FAILED TO INFLATE BUOYANCY VEST. FAILED TO DROP WEIGHT BELT. LANGUAGE PROBLEM. CHOPPY SEA DEVELOPED.

SC 93/13

A live-aboard dive boat carried 26 divers among whom there were four from overseas who required the assistance of the interpreter aboard. All held Advanced Diver certification, obtained after making a total of 9 dives, and they had subsequently made respectively 9, 22, 26 and (the victim) 20 dives, although the type of dives is unknown. The instructor gave a talk about the dive conditions and the interpreter was present to translate the talk to this foursome. How completely this was performed is doubtful as some of them believed their dive was to be as a group of four while others believed they were to form buddy pairs. After entering the water they swam in the wrong direction, to the stern rather than the bow, then held onto the mermaid line and adjusted the straps of their equipment. They were slow to leave the surface and the instructor was just about to go to them in the dinghy to offer assistance when the last one was seen to disappear from view. It was not until a subsequent roll call after the divers returned that anyone was aware that a diver was missing. The others described how the first two divers descended easily and watched the third slowly descending. He had waited for the victim, who appeared to be experiencing buoyancy problems, to join him. The visibility was poor, his buddy did not arrive and, hearing the dinghy's outboard motor overhead, he assumed the missing diver had returned to the surface and been retrieved. He therefore continued his descent and joined the others, believing it was intended to be a group dive. They continued the dive as a trio. Although an immediate and determined search was made no trace of either the diver or his equipment was ever found.

TRAINED. CERTIFIED ADVANCED DIVER AFTER 9 DIVES. SOME EXPERIENCE AFTER COURSES. SEPARATION AS DESCENDED. DESCENT DIFFICULTY DUE TO EXCESS BUOYANCY. CAREFUL WATCH ON DIVERS' WATER ENTRY. FAILED TO DITCH WEIGHT BELT. FAILED TO INFLATE BUOYANCY VEST. LANGUAGE COMMUNICATION PROBLEM. BODY NOT RECOVERED.

Hose supply divers

H 93/1, H 93/2

The owner of the compressor was untrained and had only recently bought it. His practice was to go diving, either with any available companion or solo, leaving the boat empty except for his dog. One trained diver, who had dived with him several times, advised him that he needed to make three changes to achieve a safe set up. He should never leave the boat unoccupied while diving, the air intake hose on the compressor should be fixed securely, on a pole, well above the boat, and the compressor's engine exhaust should be extended to reach over the side of the boat. This advice was ignored, a fatal error. The conditions were unusual for the area, with the sea glassy calm, no breeze and excellent visibility. A friend who had recently completed a scuba training course, and had dived a few times with scuba, was found to accompany him. Their failure to return was assumed to be due to their having run out of fuel, but when friends reached their boat it contained only an agitated dog. The compressor was cold as it had run out of fuel. They pulled up the single hose and found the two bodies still attached. They had died by drowning when they lost consciousness from carbon monoxide poisoning. It was the owner's habit to place the air intake hose, unattached, on the side of the boat. In the past it had occasionally been dislodged by the dog. On this occasion there had been no breeze to clear the exhaust fumes from within the boat so they would have been sucked into the compressor and contaminated the air supplied to the divers.

DIVER 1 UNTRAINED. FAILED TO ACT ON ADVICE TO MAKE HOOKAH SAFE. DIVER 2 RECENT SCUBA TRAINED. INEXPERIENCED. ENGINE EXHAUST INTO BOAT. AIR INTAKE HOSE NOT FIXED. DISLODGED BY DOG AND FELL INTO THE CARBON MONOXIDE POOL IN BOAT. NO BREEZE. CO POISONING.

H 93/3

Work for divers on a pearl farm is unromantic, cleaning the lines and shells of marine growths. The task is performed by pairs of divers working from small boats. The compressors were left unattended because the noise level was too high for anyone in the boat to tolerate. The debris causes the water to become turbid and attracts many fish, including tiger sharks. However these had never troubled the divers. The two divers were working on adjacent lines, supplied by the same compressor, when the buddy noticed he was short of air and had to use his bail-out bottle to surface. He checked that the compressor was working correctly then donned a fresh bail-out bottle and weight belt, intending to dive to continue his work. He found he was unable to descend any deeper than 3 m before he again experienced an inadequate air supply. Puzzled he called to the occupants of a nearby boat. They saw bubbles breaking the surface and when they pulled up the victim's hose they found he was missing, as was the end coupling of the hose with the regulator. Although aware that this almost certainly indicated a shark attack the buddy dived, using air supplied from the second boat, to see whether he could recover the body. He found evidence that an attack had occurred, damaged lines, but there was no sign of the victim. Some damaged parts of the equipment were recovered, the weight belt being still closed when found. A 2.5 m shark was caught 6 days later and found to contain a skull and a few vertebrae. Tests established they were the victim's. The buddy experienced air lack because of the free flow which occurred after the regulator was bitten off the air hose.

EXPERIENCED HOOKAH DIVER. PEARL FARM. CLEANING SHELLS AND LINES. SHARK ATTACK. NO PREVIOUS SHARK ATTACKS HERE. TURBID WATER.

H 93/4

A married couple had a salt water aquarium and held a licence to catch small reef fish for it. They left the boat unoccupied while they dived, the compressor unattended. Though both had obtained scuba training their experience with hookah is not recorded. They used a fine net to catch the fish, each one being disentangled and placed in a catch bucket in the boat as soon as possible. As they were returning to the boat with a fish the wife's fin came off. While she tried to replace it her husband returned to the boat. After placing the fish in the catch bucket he submerged again but was unable to see his wife. He returned to the boat and saw from underneath it that her air hose was leading out from the stern of the boat in the direction of the 1 knot current. About this time people in a nearby boat saw his wife surface and heard her call for help. By the time they reached her position she had sunk from view. Her husband, who was still underwater at this time, saw her slowly sinking. She was about 15 m (50 ft) distant, her back towards him, her demand valve hanging free. She was on the sea bed, weight belt on and mask off, before he reached her. He brought her up and CPR was commenced but she failed to respond. She had been underweighted for this shallow dive, drifting up while replacing her fin. It is unexplained why she was unable to remain at the surface. A formal finding of drowning was reached but it is possible she could have suffered a cerebral air embolism during her ascent through concentrating on her task and holding her breath. But there is no evidence that this occurred. The hookah was noted to supply inadequate air if two divers were working hard: this was not the case here. The air compressor was one designed to spray paint.

TRAINED. UNKNOWN EXPERIENCE HOOKAH. SEPARATION AFTER LOST A FIN. BUOYANCY CAUSED ASCENT WHILE REPLACING FIN. CALLED FOR HELP THEN SANK. MASK OFF. WEIGHT BELT ON. NO BUOYANCY VEST. POSSIBLE CAGE. SOME ADVERSE COMMENTS CONCERNING HOOKAH.

Discussion

The four deaths while using snorkels illustrate the impossibility of any effective supervision of a group of swimmers at the surface, particularly if some are making occasional dives. The fact that bodies appear to have drifted away unobserved underlines this fact. There is also proof that death can occur unobserved in a group where nobody is taking specific notice of anyone else. It was an example of the injustice of life that revealing a history of epilepsy placed the person in a less protected situation, as the instructor would have been observing her had she been in his Resort Dive group.

The scuba diver group of deaths contains examples of an unusually wide range of factors. There were two shark attacks (SC 93/2, SC 93/7), a highly unusual situation, and a suicide (SC 93/1) in addition to the more commonly identified factors. In three there was a proven or possible cardiac factor (SC 93/5, SC 93/8, SC 93/11) and in two an indisputable finding of CAGE (SC 93/3, SC 93/6) on X-ray before autopsy. There were three cases where the victim was either inexperienced or had not dived for a number of years (SC 93/5, SC 93/8, SC 93/12) and one where an instructor took three part-trained pupils on a drift dive without accepting that he had a duty of care (SC 93/9). To balance this, the instructor in case SC 93/11 did everything possible when incapacity struck his charge. Incomplete opening of the tank valve was a significant part in two deaths (SC 93/3, SC 93/8) and in eight there was separation (SC 93/3, SC 93/4, SC 93/5, SC 93/7, SC 93/8, SC 93/9, SC 93/12, SC 93/13), while in one the victim was alone and making an apparently safe dive (SC 93/10). The problems inherent in deep diving were illustrated in case SC 93/6 where the factors of nitrogen narcosis, probable carbon dioxide retention (due to the extra breathing effort required

because of the performance characteristics of the regulator and his low usage of air, either of which would encourage carbon dioxide retention) and possible oxygen toxicity may have been involved. It is possible that nitrogen narcosis, cold, dark and stress influenced the response of at least one of his buddies.

Three bodies were not recovered, one shark attack victim (SC 93/7) and two who simply disappeared (SC 93/10, SC 93/13)

The story of the occurrence of CAGE in case SC93/3 was a recapitulation of text book descriptions, a rapid ascent while breath holding. However case SC93/6 was unconscious and not breathing before being given a rapid, unattended buoyant ascent from 13 m. That this was enough to cause some pulmonary barotrauma is uncertain. Reports describing the recovering of an unconscious diver from depth are rare. Rarer still has been any discussion of the risk of causing pulmonary barotrauma while bringing an unconscious diver to the surface using different procedures. Possibly the present trend to deeper diving makes it important to address this matter.

There will inevitably be discussion on the importance of an active asthma history in case SC93/4. While this man certainly had well controlled symptoms, in that his work colleagues were not aware of his condition, he was on regular medication to maintain his activity level. However in the circumstances of this death it should be noted that he was very inexperienced, at the surface in rough water and had become separated from his buddy. While it is not known whether he attempted to dive to follow his buddy, he was certainly aware that he was in a low-air situation. He failed to inflate his buoyancy vest or ditch his weight belt, either action might have saved him. Whether there was an element of uncharacteristic panic cannot be known. The part played by some respiratory impairment due to his asthma cannot be estimated but it was certainly not the only significant factor in his death.

Hose supplied divers are always dependent for survival on receiving an adequate and wholesome supply of air. In the double tragedy (H 93/1, H 93/2) a combination of circumstances led to fatal carbon monoxide poisoning. It is especially tragic because it would not have occurred had simple changes been made to the equipment. The shark attack (H 93/3) occurred in low visibility where plentiful edible debris induced a feeding frenzy among bait fish. The shark is assumed to have failed to identify the diver as such. The last case (H 93/4) is difficult to explain but any differential diagnosis would include cerebral arterial gas embolism consequent on a floating ascent while concentrating entirely on the problem of replacing a fin.

It is hoped that examination of these case reports will lead to an increased awareness of the factors which cannot be disregarded by those wishing to dive safely.

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Project Stickybeak

Anyone with any information is asked to contact the author at the address given below. Confidentiality is guaranteed for all correspondence. The identification of diving-related deaths is the vital first step, and one in which readers can greatly assist and so play a part, in attempts to improve diving safety.

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