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PROVISIONAL REPORT ON AUSTRALIAN DIVING-RELATED DEATHS IN 1991

Douglas Walker

Summary

In 1991 two breath-hold diving related fatalities were identified from the Great Barrier Reef area. It is possible that other deaths occurred in other areas but were recorded as drowning without full identification of the details.

Fifteen scuba diving related fatalities were identified, although details are still unavailable about one case.

Not all of the fatalities were regarded as requiring a formal inquest though all were thoroughly investigated by the police on behalf of the appropriate Coroner.

Breath-hold divers

BH 91/1

A group visiting the Barrier Reef included a business man, his son (age 14), and a new employee. After a morning of fishing, then lunch, they were offered masks and snorkels and the opportunity to swim and observe the coral. The employee, the victim, declined an offer of fins on the grounds that he was a good swimmer. The boy swam near the victim for a time and heard him say he was feeling tired. They became separated and on his return the boy thought the victim was playing a game with him as he was floating motionless, face down. He realised something was seriously wrong after there were no response when he pushed him.

The unconscious man was brought back to the boat and CPR started. He was taken by helicopter to hospital but died there later from the effects of anoxic cerebral damage. No reason can be given for his silent surface drowning in calm water close to others as no other pathology was identified.

SEPARATION/SOLO. NEAR OTHERS. RAPID SILENT SURFACE DROWNING. CALM WATER. GOOD SWIMMER. HEALTH HISTORY UNKNOWN. ASPIRATED GASTRIC CONTENTS DURING RESUSCITATION. DEATH DELAYED BY CPR.

BH 91/2

Three friends went to the beach, one remained ashore while the other two entered the water. The buddy was wearing half a wet suit, the victim a full one. Although they probably intended to spear fish this was not directly stated.

The buddy separated from his friend and returned to shore when he was feeling cold. The victim chose to remain diving over a ledge. Both the swimmer and the friend on the beach could see the victim at this time but from the beach about 20 minutes later neither could see him and they began to feel alarmed. A shore search was not successful. The body was washed ashore next morning. Possibly the victim had been held beneath a ledge by water power and freed only after the tide changed. He had not ditched his weight belt. As there is no information about his breath-hold ability it cannot be known whether this is an example of post-hyperventilation blackout.

Autopsy confirmed the cause of death was drowning but there was significant (90%) atheromatous narrowing of the left coronary artery and this may have been significant, although no evidence of myocardial infarct was noted. There was no history of ill health.

BREATH-HOLD SPEAR FISHING. SEPARATION WHEN BUDDY BECAME COLD. SKILL UN-

KNOWN. WEIGHT BELT NOT DITCHED. LEFT CORONARY ARTERY DISEASE. NO INQUEST

Scuba divers

SC 91/1

While one of their sons was having a scuba lesson from the instructor who had trained them, this couple made a separate dive. The victim had completed her training eight months previously but her husband had been trained for several years. Neither of them had dived there before.

They swam out from the beach underwater till at 12 m depth. After 35 minutes the victim showed her husband that her gauge read 50 bar (one fifth full tank). She remained where she was while he surfaced to check their position. He was not entirely sure where they were but decided to swim north in hope of finding their entry beach. After swimming about 39 m they surfaced, she near the rocky shore in moderately rough water, he 10 m further out and in calmer water. He signalled for her to join him and then lost sight of her and assumed she had dived to return to him. He dived, intending to meet her underwater but instead saw her lying on the sea bed with the regulator out of her mouth. There was no response when he replaced it in her mouth. He had not immediately realised the gravity of her condition but now he inflated both their buoyancy vests and brought her to the surface. She vomited when he performed EAR, which gave him hope, and he towed her to the rocks.

Water power foiled his attempts to pull her ashore and he lost his mask, had the regulator torn from his mouth, and lost his grip on his wife. He managed to climb the rocks and reach the beach where he told the instructor what had occurred. The instructor made an immediate search and saw her under a ledge but had to await an abatement in the water surge before he could retrieve her. There was sufficient air remaining to inflate the vest. It is possible she hit her head when tossed about in turbulent water and lost her grip on the regulator, but no significant head injury was found.

TRAINED. SURFACING SEPARATION. HELD UNDER LEDGE BY WATER POWER. POSSIBLY HIT HEAD ON ROCKS. WEIGHT BELT NOT DITCHED.

SC 91/2

This man had been certificated but was thought to be unco-ordinated and rather slow in grasping what was required. For this reason that he was buddied with his former instructor on this boat dive. The conditions were ideal, with good visibility and no current. The depth was 24 m. After reaching the sea floor his buddy (the instructor) helped him adjust his buoyancy as buoyancy management was one of his poor skills, then looked away for a

moment to watch another diver feed a sea urchin to some fish. When he looked back he saw that the victim was lying in a balanced, relaxed posture quite unlike his usual appearance. This worried the buddy who swam over to find that he was unconscious with the regulator out his mouth.

The buddy immediately replaced the regulator and inflated the victim's buoyancy vest. He ditched the weight belt after reaching the surface and towed the victim to the boat. Resuscitation attempts were hindered by mucus coming up. The victim failed to respond. The equipment was correct and the only autopsy findings were those of drowning. The pathologist offered no reason for his loss of consciousness. His wife later revealed that he "was not asthmatic but used "Ventolin" for a similar condition" (sic) and was surprised he had been assessed as Medically Fit to Dive. No cardiac pathology was noted but he may have suffered a cardiac arrhythmia. He would not have reported symptoms of ill health to others.

TRAINED. LACKED CONFIDENCE. DETERMINED PERSONALITY. HID ASTHMA HISTORY. SLOW LEARNER. SUDDEN SILENT DEATH CLOSE TO BUDDY. IMMEDIATE CORRECT RESCUE. RESUSCITATION EFFORTS UNSUCCESSFUL. POSSIBLE CARDIAC DEATH

SC 91/3

This 67 year old man, whose usual exercise pattern is unknown, died from natural causes during a dive in a basic scuba course. There was no history of any ill health and he had passed a Fit to Dive medical check.

It was a boat dive to accustom the pupils to the underwater situation, planned to conclude with a practice "emergency controlled ascent" from 10 m. The victim accompanied by the instructor, was the first to ascend. They ascended the anchor line and at the surface the instructor left the victim close to the boat. The victim told the coxswain that he was feeling tired and that his gear was heavy. His tank was taken into the boat, then he swam from the bow to the stern platform. Two divers saw him lean forward on the platform, then topple into the water. He was two feet under water when reached and his arms were limp. He was recovered into the boat but failed to respond to resuscitation efforts. Autopsy revealed a thrombus completely occluding the right coronary artery. There was no evidence of any air embolism. This was an "unavoidable" death.

PUPIL IN CLASS. SUDDEN DEATH WHEN ABOUT TO BOARD BOAT. FATIGUE AS ONLY SYMPTOM. PRACTICE EMERGENCY ASCENT NOT THE CAUSE OF DEATH. DIED FROM CORONARY ARTERY THROMBUS.

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and experience		Dive group	Dive purpose	Depth m (ft)		Weights	
		Victim	Buddy			Dive	Incident	On	kg (lb)
BH 91/1	33	No training or experience	Not stated Not stated	Group Separation before incident	Recreation	Not stated	Surface	None	Not applicable
BH 91/2	40	No training Experienced	Training not stated Experience not stated	Buddy Separation before incident	Spear fishing	Not stated	Not stated	Not stated	Not stated
SC 91/1	42	Trained 8 months	Trained Experienced	Buddy Separation before incident	Recreation	11 (36)	Surface	On	11.4 (25)
SC 91/2	49	Trained some experience	Trained experienced	Buddy not separated	Recreation	25 (86)	25 (86)	On	Not stated
SC 91/3	67	Pupil Inexperienced	Trained Experienced	Group Separation before incident	Class	18 (60)	Surface	Off	Not stated
SC 91/4	52	Trained 2 years	Trained Experience not stated	Buddy Separation before incident	Recreation	16 (53)	Ascent	Off	Not stated
SC 91/5	19	Trained Experienced	Trained Experienced	Buddy No separation	Recreation	8 (27)	8 (27)	On	Not stated
SC 91/6	64	No training No experience	Trained Experienced	Group Separation before incident	Recreation	3 (10)	Surface	On	Not stated
SC 91/7	58	No training No experience	Trained Experienced	Group Separation before incident	Recreation	4 (13)	4 (13)	On	6.4 (14)
SC 91/8	33	Trained Experienced	Trained Experienced	Buddy Not separated	Recreation	50 (165)	50 (165)	On	Not stated
+ SC 91/9	30	Trained Experienced	Trained Experienced	Buddy Not separated	Recreation	50m	50m	On	Not stated
SC 91/10	44	Trained Some experience	Trained Experienced	Group Separation before incident	Recreation	4 (13)	4 (13)	On	Not stated
SC 91/11	34	Trained Inexperienced	Trained Experienced	Buddy Separation during incident	Recreation	24 (80)	24 (80)	On	12 (28)
SC 91/12	51	Just trained Inexperienced	Trained Inexperienced	Buddy Separation before incident	Recreation	4 (13)	Surface	On	16 (35)

DIVING-RELATED DEATHS IN 1991

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Owner	Comments
None	Not applicable	Not applicable	Not applicable	Hired	Separation. No fins. Silent surface death. Found floating face down. Delayed death.
None	Not applicable	Not applicable	Not applicable	Own	Separation after buddy became cold. Some coronary disease. Possible water power factor.
Not inflated	Yes	Low	No fault	Own	Water power at rocks. Trauma to head ?
Not inflated	Yes	Yes	No fault	Dive shop	Sudden death. Cardiac death. Wife thought he was unfit.
Inflated	Yes	Low	No fault	Dive shop	Sudden death while boarding dive boat. Cardiac death.
Inflated	Yes	Low	No fault	Own	Separation. Solo ascent. Collapse at surface. Air shown on X-Ray. CAGE
Not inflated	Yes	Yes	No fault	Own	Shark attack. Body never recovered
Not inflated	Yes	Yes	No fault	Dive shop	Resort dive. Loose dental plate "Follow the leader". Rock weight in vest.
Not inflated	Yes	Yes	No fault	Dive shop	Resort dive. "Follow the leader" Separation. Solo ascent. Drowned
Not inflated	Yes	None	No fault	Own	{ Trained wreck divers. Each with life line { which he did not use.
Inflated	Yes	None	No fault	Own	{ Went into crew compartment of wreck. { "Silt out". { Unable to find exit.
Not inflated Hose not connected	Yes	None	Significant fault	Own	Night dive in line ahead. Separation. Out of air. Tangled in bucket chain. Lost fin and torch. Ear drum lacerated. Air shown on X-Ray. CAGE.
Not inflated	Yes	None	No fault	Own	Third dive after course. Out of air. Failure of octopus breathing when buddy ran out of air. Middle ear bleed. CAGE.
Partly inflated	Yes	Yes	No fault	Dive shop	Sudden death. Snorkelling on surface. First dive after course. First night dive. Cardiac death ?

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and experience		Dive group	Dive purpose	Depth m (ft)		Weights	
		Victim	Buddy			Dive	Incident	On	kg (lb)
SC 91/13	64	Trained Experienced	Not applicable	Solo	Recreation	Shallow	Shallow	Off Tangled	Not stated
SC 91/14	41	Trained Experienced	Trained Experienced	Group Separation before incident	Recreation	Great depths	Great depths	On	Not stated

SC 91/4

The charter boat carried five divers and the dive boat operator, an instructor, who also intended to dive leaving the boat unattended. Conditions were excellent with no current and good visibility. The divers were assigned as a buddy pair and a trio, with the instructor watching in mid water above them. He was very visible in his bright suit. Water depth was 14-16 m.

The victim had been trained for two years and had made 14 logged dives, one deeper than the present one. Two of these dives were recent, following a 9 months break from diving. His buddy was trained but her experience is not recorded. After about 30 minutes he signalled that he was low on air and intended to ascend. She was aware that his use of air was greater than hers (she still had between 50 and 100 bar) so she decided to continue diving but watched as he made an unhurried and apparently normal ascent. Later she could not recall whether she saw bubbles coming from his regulator. The instructor noticed that she was alone and joined her to find the cause, and when he was unable to see any diver at the surface they ascended together.

The instructor saw the victim trying to climb from the water onto an islet whose steep rocks appeared a poor alternative to returning to the boat. He was alarmed by the risk of an accident although the diver did not appear to be in any danger at that time. He decided to take the boat across to the diver, a short delay occurring as he assisted the buddy aboard after himself. When 50 m from the rocks he stopped the boat and shouted to the victim to swim out to him. The victim seemed to fall into the water and lie face up and motionless, so the instructor jumped in and swam to him. The victim's buoyancy vest was inflated and weight belt missing when he was reached.

The victim was got aboard with difficulty and the boat taken to a safe distance from the rocks. With the help of one of the other divers the victim was placed on the engine cover, the only available flat surface, and CPR commenced, but this produced no response.

The autopsy was performed by a pathologist fully aware of the procedure for diving-related deaths. An X-Ray examination showed the presence of air in the aorta and both ventricles, the middle cerebral and the basilar arteries. The coronary arteries also contained air. There was a patent foramen ovale, which allowed a 5 x 2 mm probe to be passed, but it had an intact valve flap with 6 mm of overlap and there was no evidence of it having caused previous morbidity.

It is noteworthy that the victim made an apparently calm and correct solo ascent and was actively attempting to climb up the rocks before his collapse and death.

TRAINED. RECENT LIMITED EXPERIENCE AFTER NINE MONTHS WITHOUT DIVING. BUDDY'S SKILLS NOT STATED. SEPARATION AFTER LOW AIR. APPARENTLY NORMAL ASCENT. DITCHED WEIGHT BELT AND INFLATED BUOYANCY VEST. SURFACE SWIM. ATTEMPTED TO CLIMB ROCKS BEFORE COLLAPSE. BOAT UNATTENDED. X-RAY EVIDENCE OF MASSIVE AIR EMBOLISM. PATENT FORAMEN OVALE.

SC 91/5

The sudden attack by this shark was completely unexpected. Two divers were close to the sea floor, at about 8 m, the buddy leading but looking back from time to time to check they did not become too separated. They were swimming near to a drop-off (to unstated depth) and getting near to their dive boat when the buddy stopped to examine a brightly coloured rock growth. He heard "a roaring sound like a motor boat" and a large shark rushed past, stirring up sand. Blood was coming from his companion, who was in its mouth. The sound was due to air escaping from the severed air hose as the tank emptied itself. There had been no sightings of sharks in this area by any of the many divers there that day. The buddy hurried back to the boat and reported the attack. There was no doubt in his mind that it was a large white pointer of possibly 3-4 m length, but in the circumstances estimates

DIVING-RELATED FATALITIES 1991 (CONTINUED)

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Owner	Comments
Not inflated Hose not connected	Yes fault	Yes	Significant faults	Own	Crutch strap over weight belt. Inflator hose not connected. Leaky regulator case. Duodenal ulcer history. Acute gastric bleed.
Not inflated	Yes	None	Not applicable	Own	Left others filming. Solo. Deep dive. Nitrogen narcosis. Body never found.

cannot be expected to be exact. The time was about 1500 to 1530.

An immediate search was made of the area but the only portion of the body recovered was part of one lung. His tank, fins, portion of his weight belt (buckle area), the severed air hose without the regulator, and torn wet suit hood were also found. The autopsy was limited to confirming that the lung was human tissue and the Inquest to confirmation that the missing diver had indeed been taken by a shark.

SHARK ATTACK. BODY NOT RECOVERED. SOME SEPARATION FROM BUDDY AS RETURNING FROM DIVE. DEPTH 8 m. NEAR EDGE REEF DROP-OFF. POOR VISIBILITY. DAMAGED EQUIPMENT PROOF OF ATTACK.

SC 91/6

Day trips to the Barrier Reef often offer a scuba dive under the supervision of a diving instructor to passengers. They have to declare their medical history and are given a short introductory talk on diving and the equipment while the boat is sailing to its destination. To reduce the risk of such novices making a sudden uncontrolled ascent, with the danger of air embolism, they were not told how to use the buoyancy vest or to ditch the weight belt. They were to rely on the instructor for this service.

Seven people took up the dive option on this trip. One was a trained diver who commented that the talk, though necessarily brief, was informative. The victim forgot to mention in his health profile that he had a past cardiac problem.

The novices and all their equipment were taken ashore before the other passengers. They were given an introduction in shallow water and then divided into two groups, the victim and three others being in the first group. He was initially underweighted but this was corrected by placing a coral rock in his buoyancy vest.

They swam out from the beach, the instructor leading, reaching a depth of 3-4 m when 50 m from the beach. Here the instructor, looking back, noticed one novice was missing. He signalled to the others to remain where they were and then surfaced. He saw the victim and noted that he was having great difficulty remaining at the surface, so inflated his buoyancy vest. The victim's primary problem was his difficulty in retaining the demand valve because his lower dental plate was loose, but he agreed to try to dive again. However he only reached half a metre before giving up and surfacing again. He said he wished to return to the beach. He was puffing a little and appeared tired so the instructor reinflated his vest, then turned the air off, and told him to swim on his back for the return. He seemed to be a little disorientated and distressed so the instructor decided to remain at the surface to watch his progress.

After the victim had swum 5-10 m he started to cough and splutter profusely, then his head fell back and he appeared to be lifeless. The instructor called to him and got no response so quickly swam to him. The instructor called for help and the dinghy soon reached him from the beach. The victim's equipment was ditched and EAR was commenced immediately in the dinghy, CPR was started after reaching the boat. He failed to respond. The lack of support for the face after removal of the lower denture made it difficult to obtain a good mask seal. There was also some problems caused by gastric reflux or vomiting.

The outcome could have been worse because the other three divers were left unsupervised and ascended by themselves. Luckily a windsurfer soon arrived and supported two with his board. The third, the trained diver, took care of himself and retrieved the equipment.

There were significant faults with the equipment but these were not critical to the fatal outcome. The regulator supplied an inadequate air at 6 m depth and allowed the entry of some water, in particular if under a heavy demand (as when a diver was stressed and air hungry). The secondary (octopus) regulator was similarly

hard to breath. There was also a small tear in the buoyancy vest.

The autopsy indicated that the cause of death was ischaemic heart disease.

RESORT DIVE. NOT TOLD HOW TO INFLATE BUOYANCY VEST OR DITCH WEIGHTS. INSTRUCTOR AHEAD OF GROUP OF FOUR DIVERS. SEPARATION NOT NOTICED. PROBLEM RETAINING REGULATOR. LOOSE LOWER DENTURE. REGULATOR GAVE INADEQUATE AIR AND ALLOWED WATER ENTRY. BUOYANCY VEST IMPERFECT. SURFACE CARDIAC DEATH. DIFFICULTY WITH FACE SEAL WITHOUT DENTURES. VOMITING A PROBLEM DURING RESUSCITATION.

SC 91/7

The basic facts are as for case SC 91/6 except that there was a greater stress on the previous health questionnaire. Again the instructor was leading, frequently turning to check that he was being followed. Again one novice ascended without warning and was found at the surface as they were beginning to return to shallower water as one of the group was having ear equalisation problems.

When the instructor surfaced a witness, a windsurfer, told him of seeing a diver surface and call out, though not appearing to be in distress as he was not waving his arms. The diver had submerged but surfaced again calling for assistance. However he sank before the windsurfer, hampered by a surface current, could reach him. A search, using the dinghy, was made for bubbles. The victim was soon seen lying unconscious on the sea bed with the regulator out of his mouth. The instructor retrieved him and ditched his equipment at the surface. Resuscitation produced some apparent response but death was certified soon after he reached hospital. The cause of death was drowning.

Again the unsupervised novices were of necessity placed in potential danger. They ignored orders to remain underwater but ascended successfully. The instructor inflated their vests as soon the victim was on his way back to the boat, then directed them to swim back to the beach while he returned to the boat to help with the resuscitation efforts.

RESORT DIVE. NO INSTRUCTION IN INFLATING BUOYANCY VEST OR DITCHING WEIGHT BELT. INSTRUCTOR AHEAD OF NOVICES. NO BUDDY CONTACT BETWEEN THE DIVERS. SEPARATION UNOBSERVED. DID NOT INFLATE VEST OR DITCH HIS WEIGHT BELT. SOME SURFACE CURRENT. SURFACE PROBLEM. DROWNED

SC 91/8 and SC 91/9

This double tragedy illustrates the truism that training and knowledge require experience before they are likely to be applied correctly. Both these divers held divemaster certification, had taken a wreck diving course, were regarded as careful divers, and had made several previous dives on this wreck.

In this instance they ventured into an enclosed area of the wreck and omitted to tie off the lines they carried before entering.

The dive trip was carefully conducted and when they failed to surface at the expected time it was thought that two divers of their experience could not have died but must have surfaced without being observed and drifted out to sea. Unfortunately this was not the case. None of the other divers who had been on the wreck had seen them at any time. A check of the wreck by the police and other divers found no trace of them, no significance being paid to silty water seen coming from the opening in the floor of the deck cabin, which led to the crew quarters, a space made dangerous by loosely hanging cables.

Some friends of the missing divers refused to believe that both would die without ditching their weights and inflating their buoyancy vests so assumed the bodies must be trapped within the wreck. They prepared carefully as the depth was 51 m and the compartment was dangerously cluttered and they expected to encounter nil visibility. The team of six divers had strong lights and the diver who was to make the search was on a line and supplied by hose from a tank placed close to the hatchway. They retrieved one body but left the other for the police as they were risking decompression sickness if they remained longer.

The victims presumably entered the compartment while there was satisfactory visibility, but became totally disorientated when stirred silt produced nil visibility. Lacking accurate knowledge of the compartment they were unable to relocate the hatchway. Nitrogen narcosis would have reduced their ability to reason out the position of the only exit.

DOUBLE FATALITY. TRAINED. EXPERIENCED. QUALIFIED WRECK DIVERS. FAILED TO USE LINES WHEN THEY ENTERED WRECK. STIRRED SILT. NIL VISIBILITY. DEEP DIVE. LIGHTS USELESS IN SILT OUT. NITROGEN NARCOSIS A FACTOR.

SC 91/10

Five divers were making a night dive after swimming 20 m from shore. They had dived together before, including night dives here. The victim had taken his basic course seven months before, dived regularly since, and

was regarded as a competent diver by the others. They all carried torches but his was the brightest. They descended to 3.5 m and swam for about 45-50 m along a rock face, then two divers decided to return while the other three continued a further 10 m before starting their return. The victim at this time had 50 bar, his buddies 70 and 90 bar respectively, and he was in the rear as they swam in line ahead, the leader looking back every 30 seconds or so. After swimming about 10 m the absence of the victim was noticed.

They retraced their way but did not see him or his torch so they surfaced. After a surface search they saw his torch and found it and one fin but not their friend. Further surface searching was fruitless so they returned to shore and notified the police. A formal search was made and the victim located, mask off and regulator lying loose, minus one fin and wearing only one glove. There was a chain, connected to a bucket, round his upper body and arms. Attempts to ditch his weight belt found the chain was tangled with the quick release and prevented it opening. As the inflator hose was not connected the searchers were unable to inflate his buoyancy vest. However they had no difficulty in bringing the victim to the surface. It was thought he had intended to collect mussels in the bucket. When tested, his tank was empty and contained some water.

The local pathologist recognised that the autopsy should be conducted by someone well informed in diving-related problems, and arranged this. A pre-autopsy X-Ray showed there was air in both anterior cerebral and middle cerebral arteries, the common carotid arteries, left vertebral artery, and the neck vessels bilaterally. The chest films showed air at the left hilum and small bubbles in the rest of the lung fields (thought to be intravascular rather than interstitial). Air was also seen in the liver. There was also (surprisingly) air in the internal jugular veins. He had suffered a massive air embolisation. An ill defined history of his suffering a recent fit was never resolved as he had not attended any doctor to report such an occurrence.

TRAINED. SOME EXPERIENCE. NIGHT DIVE. HAD BRIGHT TORCH. LAST IN LINE OF TRIO. SEPARATION. THEN LOST FIN AND TORCH. OUT-OF-AIR (PROBABLY). INFLATOR HOSE NOT CONNECTED. WEIGHT BELT QUICK RELEASE FOULED BY CHAIN WHICH ENTANGLED ARMS. POSSIBLE HISTORY RECENT FIT. PRE AUTOPSY X-RAY. CEREBRAL ARTERIAL GAS EMBOLISM.

SC 94/11

This club dive had no appointed dive master controlling the fifteen divers present but there was a de facto acceptance that the experienced diver who owned the boat in which the victim travelled was in charge. The apparent purpose of the dive was to strip the small reef of every fish

and crayfish of value. This was only the third dive, and the deepest, the victim had made since completing his club training three months previously.

Dive conditions on the wreck, depth 24 m, were described as ideal. Someone saw and speared a Port Jackson shark. The victim took part in its subjugation and then put it in the catch bag he had attached to his belt. Soon after this a witness saw he was looking agitated and appeared to be asking for air, so gave him his regulator and used his own octopus rig, though they soon changed. They established direct contact before starting their ascent. Their rate was reduced by the weight of the shark.

When they reached about 16.5 m the donor's tank became empty and they broke contact. The witness made a rapid ascent but the victim never surfaced. It is possible that he attempted, in panic, to find another air donor rather than attempting to ascend. After he reached the surface the witness attempted, without success, to attract the attention of some divers in one of the boats, but had to swim to their boat before they noticed him. They described seeing a diver surface but a head count revealed the victim was indeed missing.

The "dive master" descended and soon located the victim, who was obviously dead and wearing all his equipment. A brief attempt at resuscitation was soon abandoned. The autopsy revealed middle ear haemorrhages and no clear lung pathology but the histology showed widespread interstitial congestion and occasional marked intraalveolar haemorrhage with focal oedema, and some areas where ruptured alveolar walls "seemed consistent with barotrauma". No X-Ray check was performed in this case.

TRAINED. INEXPERIENCED. 3rd POST TRAINING DIVE. NO BUDDY DIVE DISCIPLINE. EXERTION GRAPPLING WITH SPEARED SHARK CAUSED RAPID USE OF AIR. FAILED TO MONITOR OWN AIR. SUCCESSFUL OCTOPUS BREATHING ASCENT UNTIL BUDDY RAN OUT-OF-AIR. THEN SEPARATION. DID NOT DITCH WEIGHT BELT OR SHARK. PULMONARY BAROTRAUMA. RUPTURED EAR DRUMS. PROBABLE CEREBRAL ARTERIAL GAS EMBOLISM.

SC 91/12

This was not only his first scuba dive since his just completed course but was his first night dive, so he was naturally a bit tense and worried although he was determined to undertake the dive. His buddy was similarly inexperienced, having been on the same course with him. This had involved six dives, two in a pool and the remainder during a single day. As he was aged 51 an ECG had been suggested as part of his Diving Medical and was to be performed two days after this dive.

The dive was organised by the course instructor and was on a wreck lying 200 m from the point of entry, a yacht club pier. The sea was calm and they were to snorkel out in their buddy pairs after they had made their mutual equipment checks. All had their air turned on and some air in their tanks, each carried a torch. The buddy was a little ahead of the victim and when he looked back on one occasion the latter seemed to be fiddling with his mask and snorkel. He heard a sound like someone clearing a snorkel and the next time he looked there was no sign of the victim and none of the others knew where he was. The instructor made an immediate unsuccessful underwater search then brought them all back to shore and organised a systematic search of the area, which was successful. The body was found drifting a little above the sea bed, all equipment present and the regulator hanging loose.

Autopsy revealed severe but patchy coronary atherosclerosis, the left anterior descending artery being 90% narrowed some 4 cm from its origin and other vessels less narrowed. There was no evidence of any past or recent thrombosis. Pre-autopsy X-Ray films showed no evidence of air embolism. Death was silent, at the surface, and he had made no attempt to call out, ditch his weights or fully inflate his buoyancy vest. It is possible he inhaled cold water and suffered a sudden fatal cardiac arrhythmia. There was no history of angina.

JUST TRAINED. FIRST NIGHT DIVE. "5th" OPEN WATER DIVE. CALM COLD WATER. SURFACE SEPARATION. SILENT DEATH. FAILED TO DITCH WEIGHT BELT OR FURTHER INFLATE BUOYANCY VEST. DELAY IN FINDING DESPITE HAVING A TORCH. MEDICAL CHECK FAILED TO REVEAL SIGNIFICANT CORONARY ARTERY DISEASE. CARDIAC DEATH. NO KNOWN PREVIOUS ILL HEALTH.

SC 91/13

Although he had been trained for 10 years and was an experienced diver he had not dived for 12 months or so. He was on holiday with his wife and after lunch by a lake he spent some time tidying his boat to pass the time till he thought it was safe to dive. His wife went for a walk then settled down to sunbathe. The only thing out of character was that although he had noticed he had forgotten to bring his radio and watch he uncharacteristically did not return for them.

His wife saw him surface about 20 m out, then submerge again in an apparently normal manner. Eventually she realised he should have completed his dive long ago and decided to walk along the beach to meet him, assuming that he had come ashore some distance away. When dusk began to fall and he had not returned she decided to seek help and was fortunate to meet some campers who drove her to the nearest house with a phone.

Only a helicopter search was made till next day as nobody was able to start the victim's boat. The body was found by police divers. He had ditched his weight belt but it was caught on the crutch strap of his BCD as he had not donned the weight belt after all other equipment.

The autopsy showed he had been a healthy man with a healthy heart but he had suffered extensive bleeding from multiple gastric erosions. He had a duodenal ulcer in 1986 and six months before his death had a dilation of a stenosis of the gastro-duodenal junction. He was taking anti-ulcer medications.

Examination of the equipment showed the tank was nearly half full but he would have been unable to inflate his buoyancy vest as the inflation hose did not fit the connection on his vest. In his time of need he was unable to discard his weight belt or inflate his buoyancy vest, so he drowned.

SOLO. TRAINED. EXPERIENCED. NO DIVES IN THE PREVIOUS YEAR. SHALLOW WATER. DITCHED WEIGHT BELT TRAPPED BY CRUTCH STRAP OF BUOYANCY VEST. INFLATOR HOSE DID NOT FIT, SO NOT CONNECTED. DEMAND VALVE ALLOWED WATER ENTRY. MEDICAL HISTORY OF DUODENAL ULCER. ACUTE GASTRIC BLEEDING FROM EROSIONS WITH NO APPARENT WARNING.

SC 91/14

A film on crocodiles and sharks required some additional shots of sharks feeding. The film maker was an underwater photographer and he took with him on this trip two experienced divers as his team and another diver, the victim (V), of reputed experience more as a friend rather than a member of the film crew. The water was calm and visibility excellent for filming.

The boat was anchored over a reef in 10 m close to a drop off where the depth exceeded 400 m. They let down a shark cage and bait and hoped for sharks to appear. The dive plan required that they remain beneath the boat and not exceed 10 m depth.

While one diver was in the shark cage with the camera the other two took turns "on guard" with a hand spear, with V nearby. One of them noticed V leave the cage area and swim towards the drop off and swam after him, but returned to the cage when he saw two of the crew descending for a private dive as it seemed that V was going to join them. He was seen to cross the reef edge and start descending in what appeared to be a completely normal manner, looking at the fish and corals, and he was seen to look at his gauges. The two crew members were surprised to see one of the film group diving solo here but they assumed it was with the knowledge and approval of the

group's leader. Nevertheless they were concerned and said so on their return but was only after the film group completed their task and surfaced that it was realised one person was missing, probably dead.

A search was organised, indeed two divers descended to 53 and 62 m respectively while a surface search was made. These divers later required recompression therapy. No trace of the missing man or of any of his equipment was ever found.

While it can never be known why he disregarded the dive plan and made a solo excursion over the reef edge it can be supposed he did not regard himself as part of the film team and could therefore leave them. It is possible the clear water made him unaware of his true depth and that he misunderstood the digital display of the borrowed depth gauge he was using, believing it to record feet rather than metres. Being an experienced, confident diver, a flying instructor, and SAS trained, he would have thought a solo dive in such ideal water conditions to be completely safe. Nitrogen narcosis was probably the factor which negated this assumption.

TRAINED. EXPERIENCED. EXCELLENT DIVING CONDITIONS. DISOBEYED DIVE PLAN. SEPARATION/SOLO. OBSERVED GOING TOO DEEP FOR WITNESSES TO FOLLOW. DELAY BEFORE ABSENCE NOTED. NITROGEN NARCOSIS. SEARCHERS SUFFERED DCS. BODY NEVER RECOVERED. POSSIBLY MISREAD DEPTH GAUGE UNITS.

Discussion

Both the breath-hold divers died after separation from others, one at the surface, inexplicably drowning in calm water, while the other may have suffered a post hyperventilation blackout or been held under a ledge by water power. The failure of the pathologist to comment on the significance of the severe coronary artery disease in case BH 91/2 is surprising.

The scuba fatalities illustrate the wide variety of routes to disaster. Diving instructors will undoubtedly empathise with the instructor in cases SC 91/6 and SC 91/7 concerning the impossibility of providing a "safety guarantee" even with a group of four (or one, as in case SC 91/2). There appears to be a need to review the rules governing the running of Resort Dives before further tragedies occur.

This series includes examples of most of the significant causes of scuba diving related fatalities, including a shark attack. There were four deaths where it is probable that a cardiac factor was the critical element which decided the outcome. These cases (SC 91/2, 91/3, 91/6 and 91/12) were all in the age bracket 49-64 years. There is no

certainty that even direct questioning of these divers before they entered the water would have revealed any cardiac risk factors, and certainly the possibility of gastric haemorrhage in case SC 91/13 would not have occurred to most people.

While some of the pathologists have followed correct "diving deaths" autopsy protocols, others have signally failed to provide as full and helpful assessment of their findings to the Coroners. This is in marked contrast to pathologists' evidence in criminal cases.

In three cases (SC 91/4, 91/10 and 91/11) there was evidence that air embolism had occurred. In one the ascent had appeared to be normal in rate and manner but in the other two an element of panic was almost certainly present. This was due in one instance to night time separation complicated by entanglement in a chain, in the other to failure of an octopus breathing ascent when the donor's tank ran out of air. Low air states probably initiated both these fatal incidents.

Several equipment factors were involved, including the failure to connect the inflation hose to the buoyancy vest and wearing the weight belt under other equipment. Not informing the Resort Divers about managing buoyancy vests and weight belts had adverse consequences. The rationale for turning off the air before initiating the surface swim return to the beach in SC 91/6 is difficult to understand. Whether the absence of an indication of the measurement units in the depth gauge lead to the death of case SC 91/14 cannot be known, but this is a potential danger to anyone using unfamiliar equipment.

In case SC 91/6 there was not only poor regulator function but also a spray of water with inhalation. This man had a loose lower dental plate and in consequence was unable to retain the regulator adequately.

Inexperience was probably a very significant factor in five of these deaths (the two Resort Divers and cases SC 91/3, 91/11 and 91/13) though was it far from being the only adverse factor in any case. The tragic double fatality is a reminder that knowledge which is not applied has no value.

Many of the victims failed to use their equipment properly. Weight belts were retained when buoyancy was required and only two (SC 91/3 and 91/4) inflated their vests.

Water power, the flow of water off rocks, was undoubtedly the reason for the death in case SC 91/1, while that silent enemy, silt out, again showed its lethal capability by claiming two lives.

Regurgitation of gastric contents has again been noted as a problem during resuscitation and the problems

which can arise from having loose dentures played a significant role in both the causation and management in case SC 91/6.

It is striking that, apart from the shark attack, there was a number of avoidable factors present in each of the fatal scuba diving incidents. This indicates that it should be possible to reduce even further the number of divers who die each year. So dive carefully at all times.

Acknowledgments

This report could not have been prepared without the generous help and forbearance of those charged with the management of the documentation concerning such fatalities. This is true of every State and includes the Police services in some States in reference to cases where no inquest was considered necessary. Others who have identified cases or supplied information are also thanked. It is hoped that one day there will be wider involvement in this project by members of the diving community.

PROJECT STICKYBEAK

This project is an ongoing investigation seeking to document all types and severities of diving-related accidents. Information, all of which is treated as being **CONFIDENTIAL** with regard to identifying details, is utilised in reports and case reports of fatal and non-fatal cases. Such reports can be freely used by any interested person or organisation to increase diving safety through better awareness of critical factors.

Information may be sent (in confidence) to:

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NITROUS OXIDE INDUCED DECOMPRESSION SICKNESS FOLLOWING SHOULDER CAPSULE BAROTRAUMA

Carl Edmonds

Abstract

A shoulder dislocation in a diver was complicated by her continuing the dive and developing barotrauma of ascent in the shoulder. Reduction under general anaesthesia, using nitrous oxide, was followed by clinical decompression sickness.

Case report

An experienced female diver, taking an advanced diving course in Northern Australia in June 1993, had the following dive profiles:

Day 1	3 m for 56 minutes.
Day 2	18 m for 33 minutes.
Day 3	(i) 21 m for 33 minutes, followed by a long surface interval, which left her with 4 minutes residual nitrogen time, and then (ii) 21 m for 29 minutes .

She had logged approximately 60 dives, and was diving with two physicians when she dislocated her right shoulder. This followed a backward roll entry with heavy equipment held in her right hand. At the time she was aware of a sharp pain, but it caused little difficulty during the remainder of the 29 minute dive, with the arm splinted by the wet suit and held immobile.

She was unable to use the arm or hand throughout the dive, but the shoulder pain increased significantly during the actual ascent. She was unable to hold onto a line with that hand, and the pain caused her great discomfort and difficulty. The increasing pain forced her to slow her ascent and the shoulder was extremely painful by the time she reached the surface.

Immediate attempted reduction by the companion diver physicians failed and she was transported to hospital.

Pethidine was given for pain and metoclopramide for nausea. An X-ray confirmed the dislocation and an attempted reduction again failed.

The shoulder dislocation was successfully reduced under anaesthesia, using nitrous oxide, some two and a half hours after the dive.

The following day she was aware of lethargy, sleepiness, distortion of vision, paraesthesia and numbness of the extremities. There was a sense of disorientation and dizziness (she felt that the car in front of them was moving backwards onto their car). At that stage she was also feeling nauseated.

On examination she failed the sharpened Romberg test.

Hyperbaric oxygen therapy commenced on the second day after her anaesthetic and resulted in a prompt resolution of most of the symptoms, with a dramatic improvement in the general status. She felt well, with no more numbness or paraesthesia and regained the ability to perform the sharpened Romberg test.

She said that with recompression "I began to feel much better and afterwards appreciated how wonky I must