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This paper was accepted as the required thesis for the award of the Diploma of Diving and Hyperbaric Medicine to Dr Mitchell.

Dr S.J Mitchell BHB MB ChB is a Full time

Medical Officer at the Stark Hyperbaric Unit, Royal New Zealand Navy Hospital, Devonport, Auckland, New Zealand. Phone (64) (09) 445 5922. Fax (64) (09) 445 5941.

PROVISIONAL REPORT ON AUSTRALIAN DIVING-RELATED DEATHS IN 1992

Douglas Walker

Introduction

Of the 18 deaths in 1992 four were breath-hold (snorkel) divers, nine used scuba, four had a hose supply (one was using a cylinder air supply while the others were compressor (hookah) supplied) and a single diver was using a rebreather set.

Medical conditions were recorded for three of the breath-hold, five of the scuba divers and two of those using hookah. However in several instances the findings were either incidental or possibly so. In only one was a possible missed medical diagnosis apparent and it cannot be known whether the patient gave a full history to her doctor (case SC 92/8). The asthma factor has uncertain significance in case H 92/2 as there were significant other factors (fatigue, cold, rough water, inexperience) present.

Trauma to the head was a factor in two cases, a breath-hold diver and a military diver, and general trauma dramatically ended the life of a hose supplied diver in a dam.

Breath-hold diving deaths

BH 92/1

Because the sea was too calm for them to go surfing or fishing the two friends decided they would go diving. Although the victim was to be snorkelling, something he did infrequently, he was not a spear fisherman. The victim's friend (buddy) was to be using scuba. He was trained but had made no dives in the previous 12 months. They entered the water from rocks and swam out a short distance before the buddy descended leaving the victim at the surface. He was very surprised when, about 5 minutes later, he saw his friend lying on the sea bed. as he did not consider him capable of swimming to that depth (5 m). The victim was without his mask, snorkel and fins and it was apparent that he was unconscious. The buddy described trying, unsuccessfully, to give him air from his regulator and then pulling him up to the surface after partly inflating his buoyancy vest.

The buddy managed to bring the victim back onto the rocks and was then assisted in giving CPR by other people. This was unsuccessful. There was a suggestion that they had been attempting to share the buddy's regulator underwater but the autopsy revealed no evidence of pulmonary barotrauma.

It is not known why the victim lost all his equipment but retained his weight belt. One witness stated his belief that the victim had been in poor health recently, a result of his life style, but there was no comment by the pathologist bearing on this possible factor. Why he drowned in calm water is an unanswerable question as the event was not witnessed.

AVERAGE ABILITY BREATH-HOLD DIVER. FOUND ON SEA BED BY SCUBA BUDDY. POSSIBLE DRUG RELATED ILL HEALTH. NO EVIDENCE THAT HE SHARED AIR WITH BUDDY. NO INQUEST.

BH 92/2

According to his wife this man liked to dive solo in rough water and to surface near rocks, but "always" had someone diving with him. This dive was an exception. His wife raised the alarm when he did not return at the expected time and she found his car still parked where he had left it when he went diving. The sea was described as being quite rough and choppy. A search was made using the surf club inflatable. After some time they located the victim's weight belt and catch bag, but an attempt to retrieve the belt failed due to the rough sea conditions. His body was found floating next morning.

At the autopsy a fracture of the right mid temple area of the skull was noted, so it was concluded he had hit his head on a rock and drowned while dazed or unconscious. There is no information in relation to his breath-hold diving skill.

EXPERIENCED BREATH-HOLD DIVER. SOLO. LIKED ROUGH WATER NEAR ROCKS. NO BUOYANCY VEST. WEIGHT BELT OFF WHEN FOUND. HEAD TRAUMA. NO INQUEST.

BH 92/3

No information is at present available other than the cause of death was coronary insufficiency, a 60% obstruction of the (dominant) left coronary artery. This was diagnosed as having caused vagal inhibition, followed by drowning.

SNORKELLING. CORONARY ARTERY ATHEROSCLEROSIS PROBABLE FACTOR IN DROWNING. NO INQUEST.

BH 92/4

The skipper of a charter boat was a trained scuba diver but much preferred to go breath-hold spearfishing. He had taken a group of divers out to the Barrier Reef. When the scuba divers returned he asked one of them whether he had seen any fish, and was told there was a nice sized one near to the boat. His wife, who assisted with the running of the boat, was aware of his keen desire to do some spear fishing and encouraged him to go for a dive with this man, also a breath-hold spear fisherman.

The skipper entered the water wearing a short wet suit, fins, mask, weight belt. He had a spear gun but not the catch bag he usually carried. No reason for this omission was suggested. The buddy saw him spear the fish he had been told about, then stuff it down the front of his wet suit. The buddy had to help zip him up again. He was later seen to spear another fish before the buddy lost sight of him. The buddy suffered cramp and allowed himself to drift back to the boat. He was apparently a little anxious at being unable to see the victim at the surface, so asked the man in a dinghy, who was watching over the snorkellers, to make an unobtrusive search of the surface around the boat. This was unsuccessful but no great alarm was felt as the victim's wife stated that it was his custom to get involved in his diving and stay away till he had had enough. However his continued absence ultimately became too long and it was realised this was no ordinary absence. A radio call was made and a formal search was initiated.

His weight belt and discharged spear gun were found next day, about 2 m from an area of damaged coral, but no trace of the missing man was ever found. Although he had a long history of right temporal lobe epilepsy this explained neither the ditching of his weight belt nor the failure of the body to float. No sharks were seen in the area at the time of the dive or in the following week so this disappearance must remain a mystery.

EXPERIENCED BREATH-HOLD SPEAR FISHERMAN. CALM SEA. SEPARATION AS BUDDY HAD CRAMP AND LEFT THE WATER. NO CATCH BAG SO FISH PLACED INSIDE WETSUIT. NO BUOYANCY VEST. BODY NEVER FOUND. HISTORY OF TEMPORAL LOBE EPILEPSY.

Scuba diver deaths

SC 92/1

The instructor was taking 4 pupils, including the victim, on their first open water dive. On the sea bed, at 6 m, each was required to demonstrate mask clearing after the instructor lifted the mask to partially flood it. When the victim had partly cleared his mask he suddenly began to make a panic ascent, a little delayed by having the instructor holding on to one of the shoulder straps of his buoyancy compensating device (BCD). As soon as he

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 92/1	23	No training Some experience	Trained Some experience	Buddy separation before incident	Recreation	5 (15)	Not stated	On	2.5 (5)
BH 92/2	59	No training Experienced	Not applicable	Solo	Spear fishing	Not stated	Surface	Off	Not stated
BH 92/3	61	Not known	Not known	Not known	Recreation	Not known	Not known	Not known	Not known
BH 92/4	45	Trained Experienced	Training not stated Experienced	Buddy separation before incident	Spear fishing	Not stated	Not stated	Off	4 (9)
SC 92/1	27	Some training No experience	Trained Experienced	Group separation during incident	Class	6 (20)	6 (20)	Buddy ditched	10 (22)
SC 92/2	27	Trained Experienced	Trained Experienced	Group separation before incident	Recreation	46 (153)	46 (153)	On	Not stated
SC 92/3	15	Trained Some experience	Trained Experienced	Buddy separation before incident	Cray fishing	9 (30)	9 (30)	On	10 (22)
SC 92/4	18	Some training No experience	Trained No experience	Buddy separation before incident	Army test	3.6 (12)	3.6 (12)	On	10 (22)
SC 92/5	54	Not known	Not known	Not known	Recreation	Not known	Not known	Not known	Not known
SC 92/6	29	Trained Experienced	Trained Experienced	Buddy separation before incident	Recreation	56 (183)	Not stated	On	5 (11)
SC 92/7	54	No training No experience	Trained Experienced	Group no separation	Resort	5 (17)	5 (17)	Not stated	Not stated
SC 92/8	41	Trained Some experience	Trained No experience	Group separation before incident	Recreation	3 (10)	Not stated	On	Not stated
SC 92/9	63	No training No experience	Not known	Not known	Recreation	Not known	Not known	Not known	Not known
H 92/1	28	Trained Experienced	No training No experience	Buddy separation before incident	Recreation	10 (33)	10 (33)	On	4 (9)

DIVING-RELATED DEATHS IN 1992

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Owner	
None	Not applicable	Not applicable	Not applicable	Own	Possible ill health. Buddy had scuba. Unproven buddy breath and CAGE.
None	Not applicable	Not applicable	Not applicable	Own	Rough, choppy water near rocks. Possibly hit head.
Not known	Not applicable	Not applicable	Not known	Not known	Coronary insufficiency.
None	Not applicable	Not applicable	Not applicable	Own	Ditched weight belt and spear gun. Temporal lobe epilepsy. Body never found.
No information	Yes	Yes	No fault	Dive shop	Panic ascent. Drowned at surface. Tuberosclerosis. Instructor's action criticised.
No information	Yes	Yes	No fault	Own	Wreck dive. Recent advanced course. Trio group. Separation at start of ascent. Nitrogen narcosis. Pneumothorax and CAGE.
No information	Yes	Yes	No fault	Own	Night dive. Lost inside groyne.
No information	Yes	Yes	No fault	Army	Night dive. Buddy line came off. Sudden ascent. Cold. Ditched backpack but not weights. CAGE.
Not known	Not known	Not known	Not known	Not known	Heart attack. No inquest. No further information available.
No information	Yes	Equipment lost	No test	Hired	Drift dive. Vertical currents. Recent advanced diver course. Body never found.
No information	Yes	Yes	Not known	Hired	Past history of liver disease. Said to be fit. Cerebral haemorrhage.
No information	Yes	Yes	No fault	Borrowed	Unrecognised heart symptoms before dive. Probable cardiac death.
Not known	Not known	Yes	No fault	Dive shop	Apparently fit. Dissecting aneurysm after dive.
Not known	Not applicable	Not applicable	Faulty	Own	Off work with back pain. Intake hose fault. Carbon monoxide poisoning.

PROVISIONAL REPORT ON AUSTRALIAN

Case	Age	Training and experience		Dive group	Dive purpose	Depth m (ft)		Weights	
		Victim	Buddy			Dive	Incident	On	kg (lb)
H 92/2	36	Trained Scuba experience	Trained Some experience	Buddy separation during incident	Cray fishing	10 (33)	10 (33)	Not stated	12 (26)
H 92/3	49	No training Some experience	No training Experienced	Buddy separation during incident	Cray fishing	10 (30)	10 (33)	On	Not stated
H 92/4	20	Trained Some experience	No training Experienced	Buddy separation during incident	Work	3 (10)	3 (10)	On	11.5 (25)
RB 92/1	33	Trained Experienced	Trained Experienced	Group no separation	Army exercise	Not stated	0.5 (2)	Not known	Not known

reached the surface he tore off his mask and spat out his regulator. When the instructor tried to restrain him he broke free and sank. The instructor reached him at one metre depth. He refused the offered regulator and struggled free again, managing to regain the surface. Here he failed to respond to the instructor’s calls to inflate his BCD. Instead he grabbed the instructor, then clung onto the marker buoy carrying the diving flag. This lacked sufficient buoyancy to support him and his head went underwater.

Although the instructor claimed to have managed to ditch the victim’s weight belt and BCD the victim lost consciousness. These events were observed by another instructor from the shore who recognised the need for intervention. He swam out and began giving in-water EAR while towing the victim back to the beach. He later made highly adverse comments on the manner in which the victim’s (inexperienced) instructor had shouted advice to his panicking pupil from a distance and failed to inflate the latter’s buoyancy vest or ditch his weight belt.

SCUBA COURSE. SECOND SEA DIVE. POOR SWIMMER. ANXIOUS UNDERWATER. SUDDEN PANIC ASCENT DURING MASK CLEARING EXERCISE. CRITICISM OF MANAGEMENT BY INSTRUCTOR. REGURGITATION OF FLUID MADE EAR DIFFICULT. INCIDENTAL FINDING OF TUBEROUS SCLEROSIS.

SC 92/2

As there were seven divers on a charter boat they decided to form two buddy pairs and a trio group. The victim was a member of the threesome. All were reputedly

experienced divers but their actual experience of deep dives is not known. They were to be diving on a wreck, maximum depth 46.7 m (155 ft). Conditions were good and the interest in underwater photography of several of the divers was naturally associated with a relaxed interpretation of dive discipline. At the end of their planned bottom time the trio group returned to the anchor line and started their ascent. At the decompression bar the leader of the trio checked and recognised the diver nearest him and saw there was a third diver further away. He incorrectly assumed this diver was the other member of the trio

The last pair to ascend looked down while still close to the bottom and saw a solo diver lying motionless on the sea bed. They descended to investigate and found he was unconscious, had blood in his mask, and was not breathing, so started to bring him up. They were observed by the ship’s skipper, who was making a bounce dive to release the anchor. This was part of the agreed dive plan. He assisted them and took the victim the last part of the ascent while the others made their decompression stop. There was no response to resuscitation efforts, which were made difficult by the blood and vomit coming from the victim’s mouth.

The autopsy showed that he had suffered a right sided pneumothorax and a cerebral air embolism, findings indicative of a severe barotrauma. The equipment was examined and appeared to be in good condition. His tank still had 80 bar of air. Although close to others he was not closely observed at the critical time so the reason why he suffered this fatal barotrauma cannot be known.

EXPERIENCED SCUBA DIVER. UNKNOWN DEEP DIVE EXPERIENCE. GROUP OF THREE

DIVING-RELATED DEATHS IN 1992

Buoyancy vest	Contents gauge	Remaining air	Equipment Tested	Owner	
No	Not applicable	Not applicable	Minor faults	Borrowed	Unfit. History of asthma. Rough seas. Inadequate hookah air supply. Subarachnoid haemorrhage. Drowned on surface.
No	Not applicable	Not applicable	No fault	Borrowed	Unexplained sudden ascent. Myocarditis or sarcoidosis. Symptoms suggest of CAGE.
No	Not applicable	Not applicable	Minor faults	Work	Attempting to find and close a hole in a dam wall. Sucked into the hole.
No information	Not applicable	Not applicable	No test	Army	Hit by propellor of following boat's outboard motor during exercise.

DIVERS. DEEP WRECK DIVE. GOOD VISIBILITY. NITROGEN NARCOSIS. UNRECOGNISED SEPARATION AT BEGINNING OF ASCENT. BUOYANCY VEST NOT INFLATED. ADEQUATE REMAINING AIR. PNEUMOTHORAX AND CAGE AT DEPTH.

short distance then the police completed retrieval of the body. The passages were deemed too dangerous for there to be any prolonged search for the missing mask, torch, and cray hook. The victim's depth gauge showed a maximum depth of 8.5 m and it is assumed this was during his last dive. It is unknown if either had made any previous night dives.

SC 92/3

Danger is always present while diving and safety requires a constant awareness of potential dangers. These two youths failed to take into account the dangers of making a night dive in the interior of a groyne constructed from rocks of various sizes. Over time the filling had washed away and left passages between the larger stones, fine places for crayfish. Although they had hunted here previously this was apparently their first night time search. The victim had been trained for 10 months, his friend for 3 years.

TRAINED. LIMITED EXPERIENCE. NO TRAINING IN CAVE OR WRECK DIVING. NIGHT DIVE. CRAY FISHING. SEPARATION TO ENTER PASSAGES IN GROUYNE. LOST WAY IN PASSAGES. RAN OUT OF AIR.

SC 92/4

As part of their training the army apprentices were given experience of several stressful situations, these included abseiling and scuba diving. Although they were given a little more instruction than for a Resort Dive Experience, they were to be more stressed. They received a lecture and a pool session and then were ordered on a night dive in still water above a weir on the river. Those who attempted to opt out were told they could do so but would have to perform the dive at a later occasion. Though the officer in charge had the assistance of an experienced diving instructor, the latter was not in a position to alter the plan of the dive despite suggesting a daytime alternative. This was not the first group to undertake this dive protocol and nothing untoward appears to have occurred during those dives.

Each had a torch when they entered the water near the end of the groyne. Naturally they soon became separated as they searched for crayfish. After a time the buddy's torch began to fail and he left the water, returned to the car and waited for his friend to return. He gradually grew increasingly anxious at the non-appearance of his friend and after about three hours spoke to a security guard patrolling the area. The police were notified and the police divers arrived. He offered to assist the search and re-entered the underwater passages after putting new batteries in his torch.

The buddy found his friend at the end of a blind passage, minus his mask and obviously dead. The victim's tank was empty. The buddy managed to pull the body a

There were not enough wetsuits so only the first few divers had dry ones to put on. It was a cold night but bonfires were lit to keep the waiting and post-dive

apprentices from getting too cold. The medical orderly was instructed to watch for signs of hypothermia in any of those present.

The plan was for trained divers to guide the novices, attached by a buddy line, round an underwater course marked by a sunken rope. The free outer end of this buddy line was attached to a float, carrying a light so that those ashore could monitor their progress. None of these guides had any diving experience other than their initial scuba course, except for some who had acted as guides on a previous dive similar to this. The dive appeared to be proceeding normally until they were more than half way round the course. Then the buddy became aware that the recruit was no longer attached to him. There had been no indication that separation was about to occur, no behaviour suggestive of stress, no jerking of the line to indicate the victim was trying to remove it from his wrist. Visibility was poor, this being night time, so the buddy surfaced after a quick look around underwater.

He found the victim at the surface, obviously panic stricken. After inflating his own buoyancy vest he tried to calm the victim but found himself at risk of being drowned as the victim climbed onto him. He was unable to inflate the victim's buoyancy vest and the victim was not capable of following instructions to ditch his weight belt, inflate his vest, or replace the regulator in his mouth. The buddy retrieved him at least once after he submerged but then lost contact and when he surfaced again the victim was no longer there. He swam to the bank to give the alarm, then swam back and dived, happening to come into contact with the victim, who he managed with difficulty to bring up and get to the bank. His weight belt was in place but his mask and back pack were missing. There was no surface safety boat as this was considered a possible risk to the divers.

Resuscitation efforts were vigorous but the victim died some hours later, in hospital. The autopsy showed aspiration of vomit, a pneumothorax, surgical emphysema, and air in the superior vena cava. It is probable that pulmonary barotrauma occurred during the victim's ascent, followed by inhalation of water, but that the damage was greatly increased by the resuscitation procedures. In addition to the factors of gross inexperience, natural anxiety, the cold water and night conditions, the victim was almost certainly overweighted. The equipment was seemingly provided on a de facto one-size-suits-all basis. The behaviour of the buddy was highly creditable and beyond what could reasonably have been expected.

RESORT DIVE TYPE SITUATION. FIRST OPEN WATER DIVE AFTER ONE POOL DIVE. NO-CHOICE DIVE. ANXIETY. COLD. NIGHT. INEXPERIENCED DIVER AS GUIDE. UN-NOTICED SLIPPED BUDDY LINE. SURFACE PANIC. VALIANT BUDDY ATTEMPT TO RESCUE. FAILED TO DROP WEIGHTS. IN ERROR DITCHED BACK PACK UNIT. EXCESS

WEIGHT. PNEUMOTHORAX AND CAGE. VIGOROUS RESUSCITATION EFFORTS MAY HAVE INCREASED AIR ENTRY INTO TISSUES.

SC 92/5

No details are available as no inquest was held. The autopsy found a small myocardial infarct involving the right ventricle and extending into the right auricle, and the left coronary artery was found to be almost completely obstructed near its origin.

ACUTE MYOCARDIAL INFARCTION.

SC 92/6

After completing an Advanced course with a total experience of eleven (11) dives, she joined a diving trip on the Barrier Reef. During this she made several successful dives, including one drift dive. On the fatal day, with 23 dives to her credit, she was the least experienced diver on the trip, though regarded as competent. It was to be a drift dive in a channel which was up to 56 m (185 ft) deep, with a 5 knot current and known to have vertical currents of water from run off from the adjacent reef. Although, for safety reasons, she had previously maintained hand contact with her buddy she decided this would not be necessary for this dive.

The plan was for a group dive to go no deeper than 20-30 m (65-100 ft) and to surface after 20 minutes or when the current petered out, whichever was sooner. Water entry was to be in rapid succession, and separation inevitably occurred. The divers formed two groups and as each assumed the victim was with the other group her absence was not noticed until they were picked up at the end of the dive. The down draft of water affected at least one of the divers and it is assumed that the victim was similarly taken deep and events became more than she could control. Her body was never found. Afterwards the diver in charge admitted that during this trip several of the group had deliberately dived deeper than the dive plan permitted. This was not a factor in this tragedy but indicated the problem of enforcing a dive plan. However a wise instructor will not take those not known to him to a location deeper than their permitted maximum depth.

RECENTLY TRAINED. SECOND DRIFT DIVE. ADVISED TO DIVE AT LESS THAN WATER DEPTH. DECIDED NO NEED FOR DIRECT CONTACT WITH BUDDY. GROUP DIVE. SEQUENTIAL WATER ENTRY. SEPARATION. DOWN DRAFT CURRENTS. BODY NEVER RECOVERED

SC 82/7

The victim signed on for a Resort Dive Experience on the Barrier Reef. He told the instructor in charge of

proceedings that he had already made three similar dives. All intending divers were given a basic talk on scuba diving before being kitted up, checked, and allowed to enter the water. The instructor took three for a scuba dive and descended to about 5 m (16 ft) without incident. Then he noticed that the victim "looked unusual", his mouth was open, the regulator hanging free and he was moving away from the group, one side of his body apparently not functioning. The instructor immediately brought him to the surface and began attempting to resuscitate him.

The victim was evacuated to a shore hospital but died there 2 days later. The autopsy confirmed that he had suffered a large right sided cerebral haemorrhage, though his death was due to a basal pneumonia. Only a limited health history was obtained, that he had been taking unnamed tablets for swollen legs and had previously suffered from some kind of liver disease.

RESORT DIVE. MASSIVE CEREBRAL HAEMORRHAGE. RAPID INSTRUCTOR RESPONSE.

SC 92/8

At the time there was no reason for anyone to anticipate that this would be other than a normal dive. The victim had passed a Dive Medical examination 13 months before, later taking a basic scuba course. This had been completed three months before this dive, and she had made several dives after her course. In the interval between her medical and commencing her course she had apparently suffered some symptoms of breathlessness and chest pain. These symptoms had been present at the time of her course and since. She had apparently reported these symptoms to her doctor but seemingly made them seem more minor than was very probably the case. None of her friends questioned her fitness.

Three divers snorkelled out from the shore together. Only now did the victim notice that she had forgotten her weight belt, so the other two divers waited until she had retrieved it from the shore. They then made an uneventful 30 minute dive and surfaced. After a discussion they opted to dive again to use up their remaining air. The water was shallow but the sea was choppy and visibility had fallen to only 4-5 m (13-16 ft). The victim became separated from her companions during this dive and was not in sight when they surfaced. After a short search she was found on the sea bed nearby. They started resuscitation as they brought her back to shore and it was continued during transport to hospital where she was formally pronounced dead.

Autopsy showed fairly severe atherosclerosis but there was no clear evidence of any recent myocardial infarction. The cause of death was given as cardiac disease, a diagnosis in accord with the incident history.

TRAINED. EXPERIENCE NOT STATED.

ONSET OF UNDIAGNOSED CARDIAC SYMPTOMS AFTER DIVE MEDICAL BUT BEFORE TRAINING COURSE. TRIO GROUP. SEPARATION. SOON FOUND. WEIGHTS ON. BUOYANCY VEST NOT INFLATED. VALIANT RESPONSE BY NEWLY TRAINED BUDDIES. X-RAY FAILED TO SHOW APICAL EMPHYSEMA CHANGE. PROBABLE RECENT MYOCARDIAL INFARCTION. NO INQUEST.

SC 92/9

During a tourist trip to Australia this man included a trip to the Barrier Reef to dive. His dive was without adverse incident but later, on the boat, he complained of a severe chest pain and he was taken to a shore hospital. He died there about 8 hours from the onset of his pain. A ruptured aortic aneurism was found at the autopsy. No history of previous ill health was obtained.

RESORT DIVE. POST DIVE DISSECTING ANEURISM. HEALTH HISTORY UNKNOWN.

Hose supplied diver deaths

H 92/1

The victim was owner of the boat and the compressor system (hookah). He was reported to have obtained diving instruction some time in the past. He had years of diving experience and for this reason had been asked by other residents in the caravan park to take them diving. One of those with him for this dive had been shown how to use hookah in the caravan park pool, the other being content to watch because he had made some scuba dives in the past (though never used a hookah) so considered he had no need of this "training".

Three of the four rubber engine mounts for the compressor were broken so it tended to move around when it was working. The air intake hose was fixed to the middle of the windscreen but it was not only worn and had small holes but was liable to come free from the compressor. The boat was anchored so rode with its bow to the wind, but there were exhaust fumes in the stern area. It is probable that the air supply smelled "dirty" but the victim was used to the conditions and the other two accepted this as they knew no different. There were two hoses and the three were to take turns in using them.

The one whose instruction had been a single period in the pool, became panicky on his first dive, but later swam about with a spear gun using the hookah supply. After one dive the victim surfaced and asked for his power head as he had seen a wobbegong shark and wanted to kill it. Many would deprecate such an action. A short time later he was seen from the surface lying on the sea floor, motionless. It required the combined efforts of the two

remaining divers to pull him to the surface using his air hose.

Tests showed that the mask was ill fitting, letting in water so requiring frequent clearing, and that the air the compressor provided was heavily contaminated with carbon monoxide. This was present even with the intake pipe attached but was naturally worse if it was detached. The regulator was defective, giving a fine spray of water with each inhalation. Resuscitation attempts were unsuccessful.

TRAINED DIVER. POORLY MAINTAINED HOOKAH. BUDDIES BOTH UNTRAINED. WATER LEAKS MASK AND REGULATOR. CARBON MONOXIDE POISONING.

H 92/2

This was a dive which never should have happened. The diver who owned the boat and the hookah had taken a scuba course 8 years before, overseas, and admitted that he had never understood diving tables. His experience using hookah is unknown. The equipment was 18 months old and had not been serviced for 12 months. He is called "the buddy". The victim had also trained overseas, in 1983, and had made over 200 dives subsequently. He had a history of asthma, once requiring hospitalisation, and had been suffering a sinusitis problem during the 2 weeks preceding this dive. It is not known whether he told the doctor who performed his diving medical about his asthma history. The third member of the group had made a single scuba dive with a friend some 9 years previously and this was his first use of hookah apparatus. He is called "the novice".

The buddy had heard in a pub that there was a good supply of abalone and crayfish in a rocky area some distance away. That it was a marine reserve did not trouble him. The trip out there was cold and rough and their success in the hunt is uncertain, as later search found nothing and the survivors naturally claimed they had caught nothing. Their compressor had a capacity to supply two at a maximum depth of 18 m (60 ft) if two hoses were used, but they had a single hose ending in a T-junction to which were connected hoses to the divers regulators. These hoses were secured by rope to the weight belts. The novice seems to have managed well on his first dive, correctly accepting the signal to ascend given by his buddy when the latter began to find his air supply inadequate. During this ascent the novice realised he was short of air also, and felt he was lucky to reach the surface. It is probable they had been deeper than 18 m (60 ft), but neither depth nor time was measured at any time.

They took turns in diving, one remaining in the boat while the other two dived. On his third dive the novice found his weight belt had come loose without his knowledge, this becoming apparent when the regulator

was pulled from his mouth unexpectedly. He was fortunately a very level headed person and remembered hearing, some 9 years before, about the need to exhale during ascent. He made a successful but worrying ascent thanks to this information and his breath-hold diving experience. The belt had come loose, but not fallen off, once previously. He decided this was his last dive !

The fatal dive proceeded without incident, the victim wearing the weight belt which the novice had just used plus a second belt, as his new wet suit was thicker than those worn by the others. After about 15 minutes they noticed the underwater current had now become far stronger, so decided to ascend. They found the surface conditions had also deteriorated. The buddy managed, with the help of the novice, to pull himself back to the boat along the air hose. He looked back once and saw that the victim was making no effort to return to the boat, merely holding onto the air hose and keeping the regulator in his mouth. He looked tired. As they were sharing a common hose he was being pulled back towards the boat along with the buddy. After the buddy had been pulled into the boat he looked again and saw that the victim was no longer at the surface. He at first thought the victim had chosen to submerge but soon after he saw his body floating face up and drifting away.

The buddy immediately jumped into the water, but then had to be assisted back into the boat as he had removed his regulator but was still wearing his weight belt. The novice now donned one of the boat's life jackets and effected the recovery. They found it very difficult to pull the victim into the boat. The novice knew little about resuscitation, the buddy even less, and their efforts were not successful. They were unable to summon assistance as they had no radio and it took several hours to return, in the rough conditions, to their starting point, load the boat and start their return drive. They later explained their passing many places from which they could have phoned the police as due to their panic, though this was not unreservedly accepted by the fisheries officers.

Examination of the equipment showed that it could not supply adequate air to two divers at 18 m (60 ft). and it was noted that there was twice the permitted carbon monoxide in the air which it supplied, though neither of the survivors reported suffering any ill effects. The boat was found to fail almost every requirement for safety; out of date flares, no lifebelt, no radio, no light for night time use, no diving flag, they had no charts of the area and it was unregistered.

The pathologist reported that he found some small bubbles in the epicardial vessels and over the surface of the brain. These were almost certainly of no significance. The heart was healthy and the lung findings were consistent with drowning. There was some hypertrophy of the smooth muscle in the bronchioles and some mucus plugs were seen

in peripheral bronchi, but he found no evidence of pulmonary barotrauma. A diffuse subarachnoid haemorrhage was noted, chiefly over the left cerebral hemisphere. Analysis showed evidence of the use of both Ventolin and cannabis but their significance was not discussed. At the inquest the pathologist first stated that the cause of death was primarily barotrauma, though his report noted that he found no evidence of this, secondary to asthma. He later stated the subarachnoid haemorrhage was due to bubbles in the blood but in later correspondence denied making this statement. Regrettably, medical evidence is not infrequently the weakest element in the investigation of the deaths of divers.

EXPERIENCED SCUBA. INEXPERIENCED HOOKAH. COLD. ROUGH WATER. FATIGUE. NO UNDERSTANDING OF DIVE TABLES. HOOKAH PROVIDED INADEQUATE AIR FOR TWO DIVERS AT WORK DEPTH. SURFACE DEATH. ASTHMA HISTORY AND SUBARACHNOID HAEMORRHAGE OF UNCERTAIN SIGNIFICANCE. POST INCIDENT IRRATIONAL BEHAVIOUR BY SURVIVORS.

H 92/3

Three friends were using a hookah to dive for cray fish. It had a single hose ending in a T-piece to which were attached two 6 m hoses, each with a regulator. They took turns to dive in pairs, keeping close together. Suddenly and without warning the victim was seen by his buddy to start to ascend, regulator out of his mouth. He had been behaving normally during the previous 30-45 minutes of the dive. The buddy ascended to join him at the surface to discover the reason for his ascent and found he seemed stressed. He checked to make sure his regulator was working and gave it back to him. The victim began to breathe from it in an apparently normal manner and the buddy thought that all was well. But as he was about to descend again he saw the victim was "kicking around" in a purposeless manner and the regulator had fallen from his mouth. It was not retained when the buddy replaced it. The buddy tried to keep him at the surface and pull them both back to the boat by the air hose but lost contact and the victim sank out of sight.

Attempts to pull him back to the surface failed when the hose snagged on the reef. When the buddy descended to free it he found the victim was no longer attached. After about 15 minutes his body was found floating by searchers in another boat. There was no response to resuscitation efforts. He was reported to have done a lot of scuba diving 15 years ago and recently to have renewed his interest. His recent diving history is not recorded and it is not known how much, if any, hookah diving he had done nor whether he had any formal training.

The autopsy appeared to show that he had been a very fit man and no evidence of air embolism or pulmonary

barotrauma was found, though the history is diagnostic of CAGE. Histology changes suggested he had myocarditis or sarcoidosis but the story does not support a suggestion he experienced cardiac symptoms. No equipment fault can be blamed as the buddy experienced no problems and later testing found it worked correctly. The 15 years break from diving was probably the decisive factor.

UNTRAINED. NO DIVING FOR 15 YEARS. AMOUNT/TYPE OF RECENT DIVING UNKNOWN. CRAY FISHING. UNEXPLAINED SUDDEN ASCENT. SYMPTOMS OF CAGE BUT NO SIGNS. MYOCARDITIS OF UNCERTAIN SIGNIFICANCE. NO INQUEST.

H 92/4

Once again the dangers of diving anywhere near any underwater outflow from a dam or similar head of water have been dramatically illustrated. A recently completed earth dam was seen to have water gushing out from a hole in its base near a pipe which passed through its base. This pipe had been included in the design at the request of the local authority and construction specifications had been calculated by professional engineers. During construction it had been noticed that this pipe had become deformed by the weight of the dam above it but no significance was apparently attached to this observation.

The first diver to attend found the water was cold and the visibility poor. He was careful to have a line attached to a fixed point underwater, the inner end of the pipe, before beginning sweeps to locate any hole through which water might be escaping. He found a current of water entering holes in the dam floor over the pipe and informed the dam's owner and the dam's construction company owner of his findings. At their request he took down an old mattress and had this sucked from his hands into the hole he had found. He approached it carefully, feet first, holding onto his rope and then reported to those ashore that the problem would not be solved by mattresses, that the dam should be allowed to empty and that it was dangerous to any diver. He then left, having used all the air in his tank, complaining of being cold.

Soon afterwards two other divers reached the scene. Through a failure of communications they were not informed that the first diver regarded the situation as dangerous to divers, but they were obviously aware of the need for caution when near where water was escaping through a restricted area. They also took a mattress down and had it enter the hole. A suggestion that hay bales be used met the problem of their refusal to sink. They wore ropes held by men on the inner wall of the dam and carried lines to enable communication. They descended a short distance apart and unexpectedly one received a line call to return. He was informed that his colleague's line had gone

slack, then too tight for them to move it. He descended carefully, feet first, and when he reached the hole, which had now formed in the base of the dam, he was nearly sucked into it. With the assistance of those holding his line he was dragged free. It was hoped that the missing man might survive. as they were using a hose supply system from a cylinder on the wall of the dam. Hopeful listening made them think he was still breathing, though unfortunately this was not true.

The police were called and more rope attached to the rope attached to the victim, this enabling the direction of pull to be in line with the hole and not down the dam wall and angled back into the hole. A police diver who checked the situation was nearly sucked into the hole although fully aware of the problem and proceeding with great caution.

Although the divers were aware of the danger posed by this escape of water they underestimated its true power. It was later suggested that had the victim carried a knife he could have cut himself free from his line and passed through the passage which had developed under the dam. However, events occurred too rapidly for anyone to react sufficiently rapidly, and passage through the dam would undoubtedly have been too traumatic for him to survive. His death was undoubtedly caused either by the water flow pressing him onto the wall so firmly that he was unable to make respiratory movements of his chest, or he died from the sudden trauma of the water flow.

Poor construction of the dam and inadequate awareness of the dangers were the critical factors. None of the divers who were involved in the attempt to close the leak were registered as commercial divers and only one had any training, a basic scuba course. Though they had a variety of experience in commercial diving jobs, none had undertaken any job like this before. It was noted that the two divers believed they would be likely to lose their jobs if they refused tasks they considered to be unduly risky.

SOME EXPERIENCE BUT UNTRAINED AND UNREGISTERED AS COMMERCIAL DIVERS. DIVE TO PLUG WATER ESCAPE FROM DAM. COLD. POOR VISIBILITY. DIVER AWARE OF DANGER FROM FLOW OF ESCAPING WATER. BUT UNDERESTIMATED THIS POWER. CYLINDER AIR SUPPLY. NEARLY MULTIPLE TRAGEDY. DAM CONSTRUCTION FAULTY.

Rebreather unit diver death

RB 92/1

The operation of Murphy's Law is irresistible and no amount of training, experience and planning can guarantee it will not suddenly influence events disastrously. In this incident a well practiced and strictly controlled

procedure was changed into one which resulted in one fatality and two lesser injuries among the group of divers.

This army exercise involved the "recapture" of an oil rig by assault divers. Four boats carrying the divers were to approach in a diagonal array, each succeeding boat astern and to starboard of the boat ahead. In the event one boat became unmanageable for a short period and changed course, over running not only its own divers but those in the boat ahead of it. One diver suffered fatal head injuries from its propeller, one was hit on the foot but was fortunately wearing a hard fin which protected his foot and another was fortunate to hit his head on the relatively soft bottom of the boat as it passed over him.

The critical elements in this tragedy were in themselves harmless. The unit had just been supplied with new, more powerful outboard engines to replace weaker, old and unreliable ones and was the first time they had been fitted. The second factor was that the assault divers had to remove but retain their fins in order to climb (and later leave) the oil rig. For this reason it was the custom to have a stiff loop of cord through each fin so it could be easily carried on an arm. The factor which critically directed the course of events was one never considered by either the designers of the engine nor those who approved its use. It had a T-shaped engine gear lever. As the last diver seated on the starboard side of this boat made his backward roll the loop of one of his fins caught this T lever and twisted the engine from the control of the driver for a critical moment. The change of course proved fatal to one of the divers who had just entered the water from the boat ahead.

TRAINED EXPERIENCED DIVERS. HEAD TRAUMA FROM OUTBOARD PROPELLER. NEW MORE POWERFUL ENGINES HAD T-PIECE HANDLE TO GEAR CHANGE. DIVER'S FIN CAUGHT THIS DURING BACK ROLL WATER ENTRY. CAUSED DRIVER TO LOSE CONTROL.

Discussion

A total of eighteen (18) divers were identified as dying in Australian waters during 1992. Details are still not available for two of these fatalities (one breath-hold, the other a scuba diver), which will be reported at a later date. The critical factors were different in each case but there was an unexpectedly frequent incidence of medical conditions, although these were not, in some cases, necessarily significant in either the initiation or progression of the incident.

In the three breath-hold fatalities where there are details available there was one common factor, the absence of any witness of the actual incident, though in case BH 92/1 there is an element of doubt concerning the buddy's

evidence. This victim's health is believed to have been compromised by drugs. Rough water close to rocks is the assumed cause of death in one person, though there was no evidence the conditions were any worse than he usually liked to encounter. Similarly there is no evidence as to whether, in case BH 92/4, the temporal lobe epilepsy played any part in his death and neither is the suggestion of a shark attack more than a possible explanation for the absence of the victim's body. Though coronary artery disease was found present in case BH 92/3 and was given as the critical factor, details concerning this death are not yet available.

In the eight scuba diver deaths discussed, cardiovascular factors were noted in two, cerebral haemorrhage in one, and tuberous sclerosis was a surprise finding in another. Two night-dive deaths occurred, both with avoidable factors. Not for the last time it was shown that the management of drift dives requires careful thought and that control of a group of divers may be difficult or impossible. Case SC 92/5 was apparently also a coronary artery disease death, however no details of this incident are available at present.

There were four fatalities among those who used hose supply for their diving, the critical factors being different in each. In the first the state of the equipment was such that even after the air intake hose was attached there was too high a carbon monoxide level in the air supplied and when this hose came loose the level was further increased. Only the gross ignorance of the divers can explain their lack of awareness of this fact. In this as in other instances there seems to be an assumption that using a compressor to supply air obviates the need for training (and the application of common sense) on the part of the users. While it is reasonable to assume a dive shop will provide clean air, a similar assumption is unwise concerning compressor supplied air.

The second hookah death was the result of an even worse example of irresponsible behaviour. Not only was the condition of the sea adverse, the chosen dive location a nature reserve and the boat inadequately equipped but one participant, not the victim, was almost totally ignorant of diving. While it is possible that there was some reduction in the victim's survival chances due to his asthma reducing his respiratory efficiency, the effects of cold and fatigue were a significant element in his drowning. It should be noted that when two divers are supplied by a common hose their air supply is very significantly compromised.

No reason can be advanced for the sudden ascent made by the diver in case H 92/3 but he was probably lacking in confidence, having only recently resumed diving after a 15 year break. Though he may not have panicked, his symptoms at the surface are those of classical cerebral arterial gas embolism even though there was no autopsy proof that this occurred.

The force exerted by even a modest height of water was once again tragically demonstrated in case H 92/4. It should be plain that caution is not enough, a diver should maintain a significant distance from any place where water is escaping forcefully and in no instance assume that a rope held by others offers a guarantee of safety.

The rebreather fatality resulted from trauma to the head as an out of control outboard passed over him. The cascade effect of even an apparently minor change in diving procedures or equipment is here strikingly demonstrated. Every change has more than the predicted consequences in any living environment.

Acknowledgment

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 service in some States in reference to cases where no Inquest was considered necessary.

Others who have supplied identification of cases or supplied information are also thanked. It is hoped that one day there will be a wider involvement in this project by members of the diving community.

Information and correspondence to
Dr Douglas Walker
PO Box 120
Narrabeen
New South Wales 2101

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Plans for a Fiordland trip before the conference have fallen through, so the meeting will be preceded by a diving charter in Marlborough Sounds. Space is strictly limited on this diving tour which will be an excellent opportunity for Australian and North Island members to see this lovely part of New Zealand. Bookings will be on a first come basis. Divers wishing to confirm their booking should write immediately to

The Hyperbaric Medicine Unit
Department of Anaesthesia
Christchurch Hospital
Private Bag 4710
Christchurch
New Zealand

enclosing a cheque or bank draft for NZ\$200 made payable to "SPUMS NZ 1996".

Other enquiries should also be addressed to the Hyperbaric Medicine Unit.