"LOST BELL" INCIDENT: SURVIVING HYPOTHERMIA

Based on information provided by Wharton Williams Taylor Diving Contractors

ABSTRACT

The umbilical of a bell (SDC) operating from a well equipped vessel began to leak gas while the bell was at 515 fsw, and ruptured during raising procedures. The bell wire remained intact. During the raising of the bell it lost pressure dramatically at 165 fsw, relief being obtained by urgent lowering to 400 fsw. The two divers trapped in the bell reported that they were cold and shivering but the true severity of their hypothermia was not appreciated until after the rescue. Ship/bell communication difficulties were experienced. Survival was the result of the high state of training of all concerned and the availability of two Survival Kits in the bell for each diver. An improved (Mark II) 2 W Survival Kit is reported. Rescue was affected by Comex divers operating from a bell lowered from another 'diving' ship, transfer in a strong current being made possible by a swim line between the two bells. Post-decompression helicopter flight to shore was followed by a simple knee bend in one diver.

THE INCIDENT

At approximately 10.05 hours on 21.1.81 the 2W Superintendent visited the dive shack to check the progress of a routine bell dive to inspect a mooring over 500 feet deep. Dive platform was the well equipped MV Stena Seaspread. He noted that the umbilical winch had 2 bars "up" pressure set to counteract the tendency of the umbilical to pay out as a result of the very strong surface current (2 knots on the port bow). While this was being discussed it was noticed that gas was escaping downstream from the panel and bubbles were seen to be escaping through the moonpool, though these were difficult to observe because of the wave action.

A message was sent to the two divers, both of whom were in the bell at this time, to inform them of this leak of surface supply gas. They replied that their onboard gas had just cut in. As the bell was connected to the job and the tool basket was adjacent to them, one diver was instructed to lock-out on onboard gas to stow the TV camera/cable and black light/cable clear of the bell, in the basket, while the other took the bell out of motion compensation into constant tension and pulled the clamp weight off the seabed in preparation for aborting the dive.

As the crane began to recover the basket clear of the bell a loud noise together with a sharp shudder was felt in the dive shack. The crane driver immediately stopped hauling up when he felt the shudder. At this precise moment the colour TV monitor went dead. It was connected to the camera in the basket. The diver was urged back into the bell and a seal was obtained. As the swim line was still attached he was allowed to lock-out again and remove it. He was able to report that the bell-umbilical-basket were all clear. A seal was again obtained, one of the divers being seen to indicate this to the bell monitor at the precise moment that this TV monitor and the communications went dead, the internal and external gauges dropped off to zero, and the umbilical started to move up as the tail pressure of 2 bars took effect.

The Superintendent ran to the moonpool and felt the main umbilical. It was very slack. The remainder of the umbilical was recovered in order to clear the moonpool for the communications transducer. After several attempts contact was established with the bell and the divers were informed of the plan to lift them, stage by stage, to 165 fsw so that the standby surface diver could make a visual check of the situation. The bell depth was checked by interrogation of the X beacon on the bell. When the bell reached 165 fsw communications were very good but the surface diver was unable to see the bell and was swept off his intended route from his basket to the bell wire. Having regard to this difficulty and the fact that the vessel was on dynamic positioning with thrusters running, this diver was recovered onto the ship and given therapeutic Table 5. Two more standby divers were made ready should they be required. By this time the bell had been at 41 metres for about 20 minutes. There had been some loss of pressure ascribed to cooling of the bell gas but now there occurred a sudden loss of bell pressure, which the divers thought was a loss of seal and so demanded an urgent lowering of the bell. This descent was stopped at 400 fsw, where the divers signified they were happy to remain. Communications were difficult and careful choice of all questions was required to enable short clear replies to be made.

In view of the changed situation, for initially the situation seemed merely to require the winching up of the bell, it was decided to request assistance from the MV Uncle John, which had a diving system and was relatively nearby. An emergency control centre was set up on shore also. The divers were now dressed in their survival suits with emergency onboard battery packs supplying power for the bell scrubber and lighting. Two hoses were made ready, one for gas (4%) and the other for hot water, it being intended to lower these attached to the bell wire for an emergency hook-up temporarily, the transducer was recovered and a sodasorb drum put around it to act as a shield from thruster and surface noise interference. A slight improvement in communications was obtained. The bell was slowly brought up 10 feet but the divers called and urged "all stop!". Shortly after this a black and white TV camera was lowered down the bell wire to ascertain bell attitude (vertical) and provide additional light to the divers. A strong current was observed, made visible by the rapid plankton flow across the screen.

It was arranged with the Uncle John that a swim line would be run down the bell wire and the other end passed to the Uncle John and thereby to the rescue bell to enable it to locate and the divers cross despite the current. The emergency bell evacuation cross haul wire is run to starboard and would not serve, so a

surface diver was used to under run the intended swim line to the ship's port side.

In order to view the swim line when it arrived at the bell the TV camera was recovered and run down the port guide wire. When the Uncle John's remote controlled vehicle arrived near the crippled bell this swim line greatly assisted the Comex divers cross over to it. The gas and hot water hoses were lowered down the main bell wire to the bell. The Comex diver, after a delay caused by the strength of the current, took a spare gas rig (AGA mask) and hot water with DUI fittings on it to the bell. A message board was used for communications before entering the bell. The Comex diver reported the two bell divers to be "in high spirits". He sprayed hot water around them to slowly warm them through. A second rescue diver came over and after observing one diver for 20 minutes judged him fit to be escorted over to the safety of the rescue bell. Due to the current and the fact that the Uncle John's bellman now had 3 rigs to tend, some delay occurred while the rig was untangled and taken back for the second diver.

The divers were transferred under pressure aboard the Uncle John and examined by a doctor. The bell itself was recovered and the probable course of events established. It is surmised that the strong current had drawn off an excessive amount of bell umbilical and that this had snagged in at least one place on a number of possible snag points. The tool basket had been lowered through a loop of snagged umbilical, effectively putting a complete turn round its wire. Chaffing of the outer fibre covering of the umbilical occurred due to the friction of this wire as the ship heaved. The initial loss of pressure was due to a hole wearing in the gas hose. The "bang" heard by both divers and the surface crew was probably the TV cable snagging and then parting when the tool basket was raised, and the actual severing of the umbilical was almost certainly caused when the basket was raised the second time: the SWL of the crane is rated at 15 tons. This snagging explains why neither the bell nor the surface experienced undue tension on the umbilical, as the only excessive load would have been between the tool basket and the point where the umbilical was trapped on the SALM. The bell's internal depth gauge valves are connected to the surface gauge via the umbilical and it was through this line that the bell depressurisation took place, the loss being limited because the severed umbilical trailed below the bell during the ascent and only became apparent when bell pressure exceeded ambient at the open end. It was not realised that the gauge valve was open. From loss of services to transfer under pressure was 11 hours.

MEDICAL COMMENT

The divers reported at debriefing that they had experienced fairly severe and uncontrollable convulsions in their arms and legs. These spasms occurred with no regularity and lasted between 1 to 3 seconds, the affected limb suddenly jerked violently, uncontrollably and without warning. This appears to have been a hypothermia effect. The growing ability of both divers to ignore the cold as time wore on, such that towards the time of their rescue they were rather unconcerned about it, is an indication that they had suffered severe heat loss and were much worse off than they realised at the time of their rescue. It is suspected that had rescue been delayed another hour they would have both become unconscious, which would have greatly increased the problems of rescue. In line with the North Sea practice, they were airlifted by helicopter after the completion of decompression, the usual prohibition of flying for 24 hours not being applied to helicopter flights. This may be a factor in the development of a simple knee bend in one of the divers. The diver who had to work the communications suffered more from heat loss than his companion, because he had to change from the foetal position they adopted to conserve heat and get his hands free from the survival pack. This matter has been noted and the Mark II Survival Kits have sleeves (insulated and retractable).

DISCUSSION

These divers survived because the positive safety factors which had been deliberately built into the diving procedures outweighed the negative environmental factors, the chief of which was heat loss. Those involved prepared for possible emergency situations through the provision of survival kits and practice drills, they were alert and rapid in their recognition of and response to trouble, of good morale, and willingness to call for additional assistance at the appropriate early stage. It cannot have been altogether easy to request the assistance of another diving organisation. The response of the Comex diving organisation similarly demonstrated that their personnel could undertake a difficult and unfamiliar rescue task under adverse conditions, one which required the co-operation of two diving platforms. The availability (and use) of two survival packs for each diver was critical to their survival, though this was not appreciated till later. Had the trapped divers not acted so correctly to reduce their heat loss in this helium atmosphere, or acted in a panic fashion, the outcome of this incident would have been a double fatality. The incident revealed the need for improved communication backup facility efficiency, surface/bell contact assisting both situation assessment and maintenance of morale by all parties, a new avenue for the operation of Murphy's Law (an open gauge) and the value of survival suits. The new 2W Diver Survival Pack, the Mark II, will meet the problem experienced here of increased loss when operating essential equipment (retractable insulated arms with mitts) and unit to reduce respiratory heat loss (thermal regenerator). The practice of allowing helicopter flights soon after leaving decompression may require closer evaluation. That this full description of what occurred was made freely available for publication is an excellent sign of awareness that diving safety requires publication and discussion of problems.

APPENDIX

2W Diver Survival Kit Mark II

Presentation: The kit is vacuum packed in two strong PVC canvas satchels which incorporate a window showing the representation of the contents and dressing procedure. The compressible items have been selected for their recovery properties after such packing. Tie cords are fitted to assist in installation. Closure is by sealed zips.

Contents

Thermal Undersuit plus towel: dryness increases comfort.

Survival Bag. The Holofil™ bag has a full harness fitted to hold the diver back onto the seat in a slouched forward position, away from the risk of fouling the bottom hatch. There is an inflatable seat cushion and waterproof back and bottom section. External (retractable) insulated arms allow the diver to work yet remain insulated. Bag and harness are sized for divers 5'4" to 6'6".

Breathing System integrates thermal regenerator and CO_2 scrubber. Dead space is only 0.05 litre. Testing at Robert Gordon Institute of Technology is reported to show 95% heat recovery in heliox at 300 m. The oral nasal has been selected for maximum comfort.

Consumables. A high energy pack ensures energy balance and 1.5 pints of water is supplied to offset dehydration. Also, four sanitary bags are included.

Training

It is vital that emergency equipment be used properly. A video cassette recording is available on request.

SPUMS SCIENTIFIC MEETING 1980

THURSDAY JUNE 26th

DECOMPRESSION SICKNESS SESSION ONE

Dr John Miller

My first case history is about a young lady of 22 who was on a package deal holiday from Switzerland to the Caribbean who was diving at about 100 feet. She saw a big fish which surprised her. She shot towards the surface. She was held by her companions a short while at about 70 feet and then she went to the surface. She arrived on the surface unconscious and needing artificial respiration, she was also paralysed. She was taken to the nearest recompression chamber and recompressed. She regained consciousness, but she was difficult to deal with. She was very slow in mentation and she was still paralysed. They did as much for her there as they could by treating her with one of the short oxygen tables. Then they telephoned us and we made arrangements for her to be shipped to our facility. She was recompressed at Duke and subsequently made a fairly good recovery. But she still had some residual paralyses of her hip, which has taken about 4 to 5 months to regress. It is fairly typical of what we are doing.

This girl had both a cerebral air embolism and probably decompression sickness. The majority of the cases that we get from the Caribbean and the Bahamas are a mixed type of lesion. Another one that we had was a young woman taking an instructor's course. She was supposed to be doing a simulated rescue where she was the victim unconscious on the bottom of a twenty foot tank. Another student was to go down and give her a breath from his regulator, then support her airway and take her to the surface. He hyperinflated her lungs with an almighty push on his purge button and then managed to support her airway by placing his whole hand around her larynx. He forcefully dragged her to the surface despite her protests. She was recompressed in the chamber there for her cerebral air embolism. She was a little slow to regain consciousness so they stayed longer than 30 minutes at 165 feet. In these circumstances they should have used US Navy Table 4, but they used an "exceptional exposure" decompression. This gave her decompression sickness which they then treated inadequately. She developed a recurrence. They did that five times, with each recurrence getting worse and worse. Eventually they shipped her to us. She required a very prolonged treatment indeed.

I want to talk about the elements in the treatment of decompression sickness. Recompression is the standard thing to do, and the other things that are important are oxygen and fluid therapy, adequate time an depth and then the use of specific pharmacological agents.

Figure I is a simple man's approach to treating a diving accident, particularly decompression sickness when you have recompression facilities available. It has proved to be very effective. I included the possibility of having unlimited recompression facilities available, but most chambers do not have unlimited capability. So there are cut off points along the way to go into. Either you have symptoms occurring on the surface after a dive or at depth during decompression. We generally regard symptoms that occur at depth as being potentially more serious than similar symptoms which started at the surface. This is because a patient who develops symptoms at depth is not nearly as far into his decompression as a patient who develops symptoms at the surface. That is why you go through a complicated system of calculating the time between dives and the various sort of categories that you can get into for a second dive during the day.

The symptoms can be pain only, limited only to the joints, or involving other organs as well. The other organs are generally the central nervous system and/or the lungs. Usually if one has severe decompression sickness involving the lungs, otherwise known as "the chokes", unless that is treated very rapidly the patient will die. I do not know of any patients who have spontaneously recovered from the chokes. This is not true in most other cases of central nervous system decompression sickness. It is true in a number of cases of cerebral air embolism. Regardless of what you do they do not survive.