In some cases the general standard of equipment and maintenance offshore leaves much to be desired. Diving supervisors and divers are permitted to carry out their own pet modifications and this can lead to a loss of quality control.

Every diving installation should have its own planned maintenance system. All maintenance carried out in accordance with the planned system should be signed for by the competent person carrying out the maintenance.

Any modifications to diving equipment should be carried out by a competent person and so tested to prove that it has not been detrimental to the safety of the original design. All modifications should be shown on the "as fitted drawing" up to date copies of which are available for each installation.

DIVING SAFETY MEMORANDUM NO 8/1987 EMERGENCY ISOLATION OF GAS CIRCUITS IN THE EVENT OF A RUPTURED BELL UMBILICAL

A study of accidents involving rupture of a diving bell main wire and/or surface to bell umbilicals has emphasised the following points:

(a) Occupants in the bell can be thrown about and injured or momentarily shocked.
(b) There is almost always an ingress of water if the external door is not closed.
(c) Surprisingly often, people fail to shut off valves on some circuits.

Points (a) and (b) can be remedied by the introduction of safety belts and by keeping the outer bottom door systematically closed during ascents or descents.

Point (c) can be explained by the fact that divers in such a situation can be emotionally upset, that not all valves are prominently displayed or can be clearly seen as being in an open or closed position, and often some are hidden behind equipment (umbilicals, survival bags, etc.)

In order to improve the diver safety when surface umbilicals are ruptured the following actions should be taken:-

Wherever reasonably practicable all gas and hot water circuits to diving bells should be fitted with a type of non-return valve (non-return valve, flow fuse, deadman handle, etc.) in addition to hull integrity valves.

Hull valves should be of a type that clearly indicates if they are in the open or shut position. ("Quarter turn" or "ball" type valves should have positive means of clipping them into an open or shut position to avoid accidental operation of the valve).

All valves should be clearly labelled by name as well as by number. A waterproof check list of all the valves that must be shut to ensure the pressure integrity inside the bell is to be carried in the bell with a duplicate check list kept on the surface.

DIVING SAFETY MEMORANDUM NO 9/1982 GUIDANCE ON MAXIMUM PLANNED DURATION OF BELL RUNS AND SATURATION EXPOSURES

Following discussion with the Association of Offshore Diving Contractors the following guidance is provided:-

Under normal circumstances bell should be planned not to exceed 8 hours duration. (The term "bell run" should not be confused with "bottom time". A bell run is the total time from the bell being separated from the deck compression chamber at the beginning of a dive to the time that the bell is reconnected to the deck compression chamber. "Bottom time" is used in conjunction with decompression schedules and is total time from "left surface to left bottom").

The planned duration of a normal saturation exposure for any individual should not exceed 28 days and it is recommended that a minimum of 28 days between saturation dives be applied.

HELICOPTERS AND DECOMPRESSION SICKNESS

Ken Wishaw

There is no doubt as to the usefulness of the helicopter in marine search and rescue. Many people owe their lives to its unique abilities in this role. However, its role as a medical transport vehicle is not, as yet, universally accepted. In particular, among diving medical authorities, two distinct opinions exist as to its value in transporting divers with decompression sickness.

In spite of its potential value in this area, there is a dearth of information in popular publications on its value in this situation. Reddick (1) reported six cases of *Aviation* decompression sickness. No complications occurred during flight if the helicopter stayed within 200 feet above ground level of the take-off point. Just how relevant this is to diver decompression sickness is difficult to estimate. Most other authors mention only in passing, that it is a possible transport mode.

ADVANTAGES

1. Most importantly the helicopter offers the ability to transport sophisticated medical assistance to the diver. Even without transport of the diver by air, it is of benefit to make a correct and detailed assessment as soon as possible after the incident. Early implementation of medical treatment (rehydration, high percentage oxygen, maintenance of ventilation if unconscious, etc.) vastly improves the final outcome.

2. Transport to a recompression facility is far more rapid by air than by road. This becomes even more apparent as dive site to chamber distance increases. Most helicopters have a cruising speed of about 110-140 miles per hour.

DISADVANTAGES

There are four arguments against helicopter transport.

Altitude

Obviously, this must be at a minimum, yet people often equate air transport with high altitudes. Most helicopter flights are done below 1,000 feet and extended flights are commonly flown below 100 feet without undue risk and are approved by the Department of Transport.

Looking specifically at the Sydney region, the highest altitude required for the patient will often be the front door of the chamber! In contrast, road transport from areas outside Sydney Region will necessitate considerable time at the 900-1100 feet altitude.

Vibration

Just when bubbles come out of solution when shaking a champagne bottle, so bubbles may come out of solution when a diver is shaken. Difficult as this is to prove, it is quite a logical argument. Just what frequencies are most harmful is not known.

A comparative study (unpublished) on mechanical vibration and noise was performed on helicopters, fixed-wing aircraft and road vehicles by RG Bosshard and J Yeo of the Spinal Unit at Royal North Shore Hospital, in conjunction with the Sydney Wales Helicopter Rescue Service and Dr C Ambrose of the Health Commission of NSW. Various helicopters, fixed-wing aircraft and commonly used road ambulances were employed. Mechanical vibration was measured using small accelerometers strapped to both patients and vehicle chassis, measuring in three axes.

Their conclusion was that the magnitude of the frequency was small (<0.14 g). Helicopters were free of two particular problems namely, increased vibration due to take off and landing by fixed-wing aircraft and adverse road and traffic conditions encountered by road ambulances. Weather conditions did not significantly alter the findings.

They concluded that vibration was not a factor against the use of the helicopter for patient transportation, in spite of hearsay evidence to the contrary. These findings are also supported by the conclusions of the authors (2.3).

Cabin Space

The ideal helicopter should have a large cabin space and weigh next to nothing to minimise the downdraught required to stay airborne. Unfortunately, medium to large helicopters require a downdraught which is often incompatible with marine or coastal rescue and landing.

The commonly used light medical transport helicopter in Australia is the Bell 206B Jet Ranger, which will accommodate three crew in addition to one or two internal stretcher patients. Although not as roomy as a standard road ambulance, most functions - IV infusion, O_2 therapy, etc., can be undertaken. With correct preparation by staff experienced in helicopter medivac, patient welfare can be maintained during flight. If major procedures become necessary, landing sites are always close by and if necessary, diversion to the closest hospital is more rapid by air than by road, from any given location. By use of this rapid transport system, the time the patient is out of the controlled environment of a hospital is drastically reduced.

Weather

Bad weather restricts helicopter flying only ten days per year in Sydney. It is a more stable flying platform than fixed-wing aircraft during windy conditions. As previously stated, adverse weather conditions do not effect vibrations. Within the next two years, all-weather helicopters will become far more common in this country.

INVESTIGATIONS

With all these factors in mind, the author investigated the subject with Surgeon Lieutenant Peter Sullivan from the School of Underwater Medicine, HMAS PENGUIN.

In the last ten years there have been seven well documented cases of divers with decompression sickness being transported by helicopter in NSW. No serious complication or deterioration occurred during these transports and three improved symptomatically. At present we are seeking details of other cases to attempt a statistical analysis.

We attempted to form an in-vitro model of vibration factors, using air compressed gelatin plates, transported by different modes and compared for bubble production. However, due to considerable variability in bubble formation from plate to plate in the control group, the experiment was abandoned.

CONCLUSION

The use of helicopters in rescue retrieval and transport of patients with decompression sickness offers many advantages, The apparent disadvantages when studied from a factual, rather than emotive and hearsay point of view, are minimal. It therefore warrants further usage in this role where time can often be significant in patient welfare.

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UNNECESSARY DEATHS

"The Old Master"

Three Naval Officers, who were not formally trained Navy divers, recently drowned while diving in an underwater cave. Though diving in underwater caves is not Navy diving mission-related, some of the conditions the victims encountered and some of the errors they committed are familiar. Therefore, an analysis of their mistakes and a knowledge of how they might be avoided can increase Navy diving safety. This story is recounted here as a case study in diving safety only, and does not constitute an official statement and/or analysis of findings.

The fatalities occurred while the divers were exploring a well-known, frequently dived underwater cavern in north central Florida. Two of them were experienced open-water sport divers. The third diver had recently completed sport diver training. Each wore a single 80-cubic-foot aluminium tank, had a single hose regulator with a pressure gauge, life vest, knife, wet suit, mask and fins and carried two underwater lights. Conditions in the cave appeared favourable: a maximum depth of 70 feet, visibility over 100 feet, a water temperature of 72°F, little or no current, but a floor covered with fine silt. Before the fatal dive, the three had swum from one entrance through the cave approximately 400 feet to a second entrance.

On the second dive, planned as an underwater photography venture, the divers entered a third entrance - still using the same air supply from the first dive, now partially depleted. Several hours later their bodies were recovered, their air supply completely exhausted, at a distance of between 50 and 150 feet from the cave's entrance and at a depth of 60 feet.

Apparently, they had ventured into the cave and passed the silt-free entrance into a heavily silted area. During the photography session, their finning motions had stirred up the bottom, completely shutting out their visibility. Although the divers were found apparently headed out of the cave, they obviously had had insufficient air to find the entrance in the disorientation caused by the silting.

Regardless of one's previous experience, when diving in a new and strange underwater environment, it is imperative to learn the specific dangers that might be encountered. Had these unfortunate divers received training in cave diving, their lives might not have been lost. Diving in this same underwater cave, experienced cave divers have made over 300 dives - charting over 21,000 feet of underwater passage, some of which is 3,000 feet from the nearest known entrance - without a single accident. However, in this same cave over 30 untrained cave divers have perished. The primary difference between the two groups: the trained divers understood the dangers involved and developed and practiced safety procedures to avoid accidents.

Had our ill-fated divers more knowledge of cave diving, they would have realised that, in all cave diving fatalities, at least one of the following cardinal rules is violated: First, *always* maintain a continuous guideline back to the surface. Second, reserve sufficient air for your exit in case of emergency. Third, *do not* dive deeper than 130 feet.

How do these conditions relate to Navy diving, and how can a Navy diver deal with them? Navy divers frequently find themselves working in similar conditions. While inspecting ship's hulls, divers frequently experience disorienting poor visibility, and their access to the surface is often blocked or restricted. When using surface supplied diving gear, a diver has a continuous guideline to the surface. Should the compressor air supply fail, does the diver always have sufficient air to make a safe ascent to the surface?

Perhaps you have encountered similar situations. Have you made a dive using SCUBA in an area where you could not directly ascend to the surface and did not have a guideline? When diving under a ledge, have you always made sure that you had reserve air for a safe exit? If not, you were probably fortunate not to have ended up like our three cave divers - a terrible and senseless waste of our valuable manpower resources,

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RECOMMENDATIONS FOR FLYING AFTER DIVING THE DIVING MEDICAL ADVISORY COMMITTEE

28/30 Little Russell Street
London WC1A 2HN

March 1982

In response to a request from helicopter operators and subsequently the AODC, DMAC was asked to consider what restrictive conditions should be applied to flying after diving. A Workshop with international representation from the aviation and diving medical communities was convened at the Institution of Mechanical Engineers on 18th and 19th January, 1982, to establish the basic scientific principles and to use them to build up a rational and acceptable set of guidelines.