## 14. DIVING ACCIDENTS AND DEATH

### THE ROAD TO SAMARRA

by Dr Douglas Walker

> "Any worthwhile activity where injury or loss of life are accepted as outside possibilities should be so planned to ensure that these are kept to a minimum level. What are the accepted death and injury rates for any activity must vary considerably with the enthusiasm or profit in that particular field. Always there must be a striving to reduce it and always it must be very small or the participants will be discouraged and its progress lapse.
>
> Much can be learnt from the study of accidents that can increase the safety of diving as a whole. One single lesson that is apparent is that however tedious, time-consuming cumbersome may be the rules and regulations in the best diving manuals there is no doubt whatever that strict adherence to them will reduce the accident rate by at least 75%. The provision of adequate communication and contact with the diver at all times is essential."

The above quotation is the conclusion drawn by Stanley Miles in his 1964 paper '165 Diving Accidents'* and is reinforced by the findings of all other investigations into diving accidents. It is the justification, if such be necessary, for the investigations of diving accidents. As diving is advanced to greater and more sophisticated equipment and gas mixtures are employed so new problems and dangers become apparent. A continuous monitoring of incidents and morbidity is required as a balance to the erroneous belief that 'they' know all about bends an gas mixtures, etc. The present interest in hearing defects and aseptic necrosis of bone in divers and caisson workers demonstrates the re-discovery of problems documented in the 19th century and then forgotten because they became less gross. The rate of progress converts yesterday's experimental dive into today's work diver and tomorrow's diver for the moneyed amateur. The rate of advance in the engineering is in excess of the advance in understanding of the problems, as witness the occurrence rate for bends in experimental dives. Diving, like medicine in general, is an art as well as science and will so remain as long as man is a 'one off' product.

The purpose of any accident investigation should be to discover how to prevent any repetition. To this end it is first necessary to discover the sequence of events which occurred and thence to identify the points of critical decision at which the response to the problem then present influenced the outcome for better or worse. Should a common factor be found on several occasions where injury has occurred, it is likely that a significant fault in selection, training, dive procedure or equipment requires urgent attention. The

* *For all Tables, see Appendix A*

safety margin underwater is small; the environment being terribly unforgiving of any incapacity, carelessness or neglect. It is found that the most important factor is the diver himself: it is rare for equipment failure or sudden acute illness to be inevitably fatal if the trained diver has an alert and trained buddy and surface support. In an incident in America, the element of panic decided the different fates of three helmet divers trapped in mud under a wreck in the same incident.

The investigation of accidents is not simple, as most authors remark. There is a natural reluctance to report foolishness, which may not even be recognised as such, if nothing serious eventuates. Even greater is the desire to minimise or deny stupidity or gross carelessness should death result. 'Nihil nisi bonum' limits one's own responsibility: but without open recognition of faults they will continue to be repeated. It is well known that those who suffer the bends lie concerning the dive depth-time when first seen. For such reasons the notification schemes of diving clubs and organisations give an incomplete picture of the true frequency of incidents. Nevertheless, progress has been made by the University of Rhode Island in America and the British Sub-Aqua Club in the UK in the collection of details of fatal and non-fatal incidents. These reports show value for effort despite the admitted limitations.

The welcome paucity of diving deaths has the troublesome effect of giving no cause for the inclusion of a code for such deaths in the international classification of deaths. They can only be identified by direct knowledge or from newspaper reports, and not every death is newsworthy. In the Los Angeles and Florida areas there are local notification schemes instituted by interested coroners, but published reports still note that no details can be obtained regarding many known deaths. In this respect then all assistance offered by the Attorney-General's and Justice Departments of all the Australian states, to make copies of the investigations by coroners into such deaths available for study, is in advance of the position anywhere else in the world. This article is in part, a plea for reporting of incidents both fatal and non-fatal by all who hear of them (Project Stickybeak): only thus can the maximum benefit be obtained from this proffered assistance.

Initially medical interest was in the mode of death, articles describing Pulmonary Barotrauma, Air Embolism and Decompression Sickness. The intent was to warn against the too simple findings of 'drowning asphyxia' and also to indicate the special problems to be considered by pathologists at such autopsies. It is still apparent that the differentiation of air embolism from post-mortem decompression tissue gas is not always appreciated, with resultant misdirection of the coroner. The Medical Research Council in the UK is circularising pathologists there concerning the examination

of deaths associated with work in compressed air or diving. It is hoped that the same approach be introduced into Australia: a copy of the notice is given in Appendix B. The passage of time between the accident and death may allow resolution of air bubbles in Coronary or Cerebral blood vessels, but the clinical course may suggest such a cause. The findings of subarachnoid haemorrhage or evidence or a coronary occlusion may explain why some divers have died, though even such cases might survive in the presence of immediate rescue facilities.

The next phase in published reports was the noting of the incident to see what had gone wrong and why the result was death. Here different reports found a variety of significant factors, the most important single one being the isolation of the victim at the critical time. Some reports are summarised shortly, but many questions remain unanswerable as too rarely is any note made of the equipment. It is suggested that a note always be made concerning weight belt, life jacket, knife, depth gauge, watch, contents gauge, harness and cylinder, demand valve system, air reserve and air remaining. Check of the cylinder for water or contamination is necessary; though rarely implicated as cause of trouble, cases have been reported. A check of 25 tanks by the University of Washington, reported by FR Smith, showed two had nil contamination, 18 had 10-25 ppm CO and 5 had over 25 ppm CO (one being over 75 ppm CO). It is not stated how these tanks were chosen. A BS-AC survey of air purity suggested that minor impairment of alertness may occur more often than is suspected and carbon monoxide contamination should be suspected if post-dive headaches occur without obvious other cause.

Investigation of the deaths of breathhold divers revealed a preponderance of good swimmers, many of Spearfishing Championship Standard. In fact deaths occurred, and still occur, at such competitions. Apart from the occasional entanglement in kelp, speargun line or anchor line, such deaths were long a mystery. However, the work by Craig has led to the general acceptance of prior hyperventilation as the critical factor in such drownings. This valuable finding would be more helpful if divers acted on it: in the recent spearfishing championships in Chile divers were noted to hyperventilate while lying on the deck before diving, taking up to 50 very long deep breaths while completely relaxed.

The logical next phase of reports should be to consider the reasons why divers fail to follow ‘the accepted safe diving procedures’ and so fail to survive unscathed the inevitable mishaps that occur. It may be that they are unaware of the dangers, inexperience, diving beyond their capability to cope or just do not accept that their practices are potentially dangerous. The current interest in better instruction and the limiting of the hire of equipment to those with evidence of basic skills is a welcome advance.

The British Sub-Aqua Club reports are given at their Diving Officers' Conference each year. They reveal the need to have a buddy, to consider the power of moving water and the dangers of poor seamanship.

The power of currents is a frequently underestimated factor, Weirs, water intakes, currents and wave surge over rocks or as surf have all caused drowning. Especially at risk are those who leave their boat unattended and possibly poorly anchored and surface down current. Should they lack brightly coloured lifejackets they may never survive to learn better.

That seamanship is neglected is apparent from the numerous reports of failure to be able to restart the dive boat outboard engine when the divers surface and require picking up. There are also incidents of boats endangering divers in the water and of insufficient safety cover. This aspect of training is now receiving attention in the UK as a result of these findings.

So diving, or separation from one's buddy, are frequent findings in fatal incidents. Of the 39 deaths in the BS-AC reports, 17 were diving alone and 12 were separated from their buddies at the critical time. There were 3 failed reported attempts due to inability to drop the victim's weight belt. One pair of cave divers relied on sticking tape to join lengths of their lifeline, so died.

The value of an alert buddy has been demonstrated in the BS-AC reports and also in Australia. Poor training can result in death of a rescued diver through inability to give EAB in the water. The reported deaths of a snorkel diver and a scuba diver. He was waiting to re-enter the dive boat, by entanglement in kelp, causing drowning remind one that it can be fatal to forget safety at any stage of the dive.

In America the two areas most reported are Los Angeles and Florida. In Los Angeles the Department of Parks and Recreation not only regulates diving areas but also arranges training facilities. This represents an intelligent response to diving incidents. Dr Glen Egstrom, University of California, has informed me that of 17 deaths in 1970, 10 were solo and 2 were separated by waves at the surf line at the time of death. There were 5 unsuccessful attempts at rescue by buddies.

Taylor et al. have reported on the Florida area, where cave deaths have been a cause of major concern. Information could not be obtained regarding all cases, in only 18 of the 24 cave deaths being made available. Of these, 10 had no safety line and 6 went beyond their lines. Sixteen had buddies, but 2 were alone. Such are the conditions in caves that multiple deaths are to be expected, and occur, as both divers are probably taking the same risks. It seems that ignoring of rules rather than lack of training were responsible. Concerning

open water cases, in the 11 in which facts were available, 7 were separated from their buddies at the critical time, 4 were inexperienced and one died after a shark attack. The need for co-operation by the authorities involved is well illustrated by the paucity of hard facts in this survey, though the information often neglecting to answer questionnaires. The report by Desautels gives an age-season-site breakdown of fatalities, but nothing concerning diving experience or the dives themselves, once again being an incomplete picture of the events that occurred.

Hassel has noted that 'lung' failure was not conclusively demonstrated and should not cause death if safe diving procedures are followed. He stressed the need for thorough, competent instruction in diving, this to include buddy-diving techniques. At not time does the buddy seem to have been near at the onset of the fatal series of events in his series. Most victims were apparently novices and some couldn't quick release their equipment. One experienced diver died from the probable combination of Nitrogen Narcosis at 180ft + poor sleep the night before + cold water. Another expert, Conrad Limbough, dived into a cave alone + no lifeline + current + poor visibility: somewhat naturally, he died. The conclusion drawn by Miles was that non-fatal cases depend for the most part on good planning, efficient safety organisation and alert comrades. Okalyi also commented on the fact that in the Torres Strait the divers rarely drowned (except during attempted recompression in the water) as they watched each other carefully. However a lack of understanding of decompression, with reliance on the experience of the lugger captain, and lack of recompression facilities combine to give a high morbidity rate.

The first report to note the dangers occurring during the period of instruction in scuba was that of the University of Rhode Island. This noted that 11 persons died on their very first attempt at scuba diving, raising a serious question about the current standards of diving instruction and sporting retail store policies.

Neither the manufacturer nor the retailer stands to gain from a system with these casualties. In at least four of these cases the water was less than 10 feet deep: sometimes the victim barely got underwater. There were 17 cases of death during training activities. Only two deaths occurred in pool training, and one of these was due to a heart attack. One death occurred on the first ocean dive made by the victim and his brother after 'C' card certification by a nationally advertised organisation's pool-only scuba course. The authors of the report say they would award damages if on a jury judging such as case. The novice scuba diver, and his parents, cannot be expected to judge the relative risk differential between pool and ocean diving. When anyone is 'qualified' by a school they have every reason to expect that they have been trained to deal with the normal environmental problems associated with ocean or lake dives. These include poor visibility, waves, surges, currents, surf, cold,

greater depth, kelp, and weed, inshore rocks and (Appendix B) suggests that the present teaching of progressive ocean skills is deficient: even schools including some ocean dives may be advancing some trainees too rapidly into deep rough water.

In at least 19 separate cases, one buddy attempted to save the other. It would appear that the buddy system is employed but that there is a lack of knowledge as to what to do in case of trouble. The authors wonder how many scuba courses include sessions on the management of emergencies in the water, and how many trainees have ever attempted to remove the weight belt and tanks of an unconscious man, let alone a fighting one. They suspect that over the years the 'buddy system' has been given a great deal of lip service but relatively little careful study.

In engineering terms, a pair of scuba divers should be considered a single integrated system. Such a system must stay together, a difficult job when twenty people in full, black wetsuits are involved in a multiple dive. Buddy identification is thus essential. The diving equipment must be readily removable by both the wearer and his buddy: similarly, the life vest should be inflatable by either. The buddy-breathing problem also requires further study as in practically every fatal case where buddy breathing was attempted, the survivor notes that he was running out of air. This is not unexpected, as both divers have usually about equally used their supply when the emergency occurs.

The possibility that Air Embolism had occurred was suggested by witness accounts in 28 cases, autopsy confirming in eight. Ditching failure, weight belt or lung, occurred in 17 cases but success was noted in 24 others. Of 4 cases with Coronary Thrombosis, 3 were aware of their heart condition.

Webster also noted the inexperience of victims and that in virtually all cases the victim had disregarded one or more of the recognised rules or procedures of safe diving. Twenty eight overestimated their abilities, 15 were solo, 24 were separated from their buddies at the critical time and some were diving in groups of three.

The US Navy reports stress the poor results they obtain when treating non-military 'bends', apparently due to the victims having markedly departed from recommended decompression schedules and then delayed seeking treatment. Some illustrative cases are described in which DC problems were influenced by poor sleep, discomfort, minor injury or minor activity during decompression staging. Two post-dive 'drunk and disorderly' cases are noted as possibly ascribable to DC sickness. The dangers of emergency raising of divers using Helium mixtures at depth are noted, avoidance of the need for this dangerous situation being advised in view of the extreme risk of death from

such procedures other than if the dive of a short duration and less than 150 feet depth. Oxygen partial pressure of max. 1.6 ATA is advised having regard to carbon dioxide dangers. Treatment facilities must be immediately available for all deep dives, and gentle handling is important, as witness one diver whose spine was damaged by rough, careless helpers. The US Navy, like other navies, has few diving deaths (average two per year) but these reports reveal the fact that 'bends' remain a serious problem as diving progress outstrips knowledge.

We in Australia cannot be complacent about diving accidents, cases being known that match almost every case reported overseas. For this reason a brief summary may be an aid to reducing accidents:

| | |
|---|---|
| BS-AC | Victim alone at time of most fatal accidents. Seamanship is important for safety. |
| Denney and Read | Of 21 deaths, 18 in water less than 25 feet deep. Air embolism suspected in 11 of these cases. |
| Desautels | Cave divers must take extra care; equip and train specially. |
| Uni. Rhode Island | High danger in learning period with scuba. |
| US Navy | Poor results civilian DC sickness treatment, so obey 'table'.<br>Dangers of 'blow up' when using $HeO_2$ except short duration dive and less than 150 feet. Need $HeO_2$ limit 300 feet and oxygen partial pressure 1.6 ATA. Use submersible Redepression Chamber Technique. Every dive plan must consider the possibility of sudden loss of air. |

Postscript

The Arabs tell of a merchant in the market plan of a far fair city, resting after the labours of his journey. He chanced to look up to find himself face to face with Death. Both showed surprise

at the unexpected meeting. Immediately abandoning his friends and possessions without a further word, the merchant fled to seek the safety of his house, for he had seen Death's ways with other men. Many dangers beset him, but he never rested till he reached his journey's end. There he was met by smiling Death, who said "Had you not hastened so, you would have missed our appointment here in 'Samarra'".

## APPENDIX A

### DIVING ACCIDENTS AND DEATH

**Dr Douglas Walker**
Heron Island
June 1972

Bayliss (Non Military Diving Deaths Australian waters 1957-67)

| Year | 1957 | '58 | '59 | '60 | '61 | '62 | '63 | '64 | '65 | '66 | '67 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Deaths | 4 | 48 | 2 | 4 | 10 | 13 | 10 | 3 | 7 | 4 | 9 |

| Causes of Death | | |
|---|---|---|
| | Drowning, no specific antecedent features | 30 |
| | Drowning, equipment or entanglement blamed | 12 |
| | Drowning, pre-existent disease noted | 6 |
| | Drowning, in skin diver known to hyper ventilate | 3 |
| | Pulmonary Barotrauma | 11 |
| | Decompression Sickness | 9 |
| | | 71 |

BS-AC Incident Reports

| Diving Officers Conference | 1966 | 1968 | 1969 | 1970 |
|---|---|---|---|---|
| Deaths | 13 | 8 | 10 | 8 |
| Bends | 2 | 5 | 4 | - |
| Suspect Air Embolism | 1 | 2 | 1 | 6 |
| Solo Divers | 5 | 7 | 5 | 4 |
| Separated from buddy | 5 | 6 | 4 | 4 |
| Dive boat engine failure | - | 9 | 3 | 4 |
| Inexperience | - | 5 | 1 | 2 |
| Power of water (river, weir) | 3 | 8 | 2 | 1 |
| Current (sea) | 1 | 6 | 1 | 5 |
| Lifejacket pack/failure | 2 | 2 | 2 | 4 |
| Weight belt trouble | 3 | 2 | - | 1 |
| Diver surfaces, unobserved | 1 | 5 | 4 | 1 |
| Unattended boat | 2 | - | - | 2 |
| Exhaustion | - | 1 | 1 | - |
| Trouble from other boats | - | 4 | 5 | 2 |
| Shared ascent | 1 | - | 1 | 1 |
| Probable FA or Breathholding | 1 | 4 | 2 | 6 |
| Rescue attempt by buddy or another diver | 5 | 6 | 8 | 6 |
| Contaminated air | - | - | 3 | 1 |
| Water in cylinder | - | - | 1 | 1 |

Desautels: Florida Diving Deaths

| Year | 1960 | '61 | '62 | '63 | '64 | '65 | '66 | '67 | '68 | '69 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Open Water | 6 | 4 | 4 | 2 | 3 | 7 | 7 | 7 | 5 | 13 | 58 |
| Scuba Caves | 4 | 8 | 8 | 3 | 4 | 6 | 4 | 12 | 8 | 9 | 66 |
| Free Diving | - | 2 | 5 | 2 | 3 | 3 | 4 | 3 | 2 | 3 | 27 |

Multiple Accidents: 1 x 4 deaths; 1 x 3 deaths



Miles: 165 Diving Accidents 1959-1964 (excludes hard hat)

| CAUSE | FATAL | NON-FATAL | |
|---|---|---|---|
| Asphyxia | 18 | 6 | Loss of air supply |
| Anoxia | 8 | 14 | Rebreathing sets |
| Illness in water | 5 | 10 | CT, virus, epilepsy |
| Oxygen poisoning | 5 | 5 | XS depth, sensitivity tests |
| Syncope, collapse | - | 40 | $O_2$ rebreath; hyperventilation |
| Pulmonary Barotrauma | 4 | 4 | FA training (excludes escape training) |
| D/C sickness | - | 27 | Failed use DS tables. XS exertion |
| Shark attack | 3 | - | |
| Ear injuries | - | 7 | |
| Others | 2 | 7 | U/W explosion,squeeze |
| **TOTAL** | **45** | **120** | |

| Predisposing Factor | FATAL | NON-FATAL | Examples of Factors |
|---|---|---|---|
| Inadequate safety precautions | 25 | - | No buddy, lifelines, supervision |
| Inadequate training | 21 | 95 | Failure to follow correct procedures |
| Hazardous diving | 14 | 18 | Repeat dives *[illegible]*; entanglement |
| Failure of apparatus | 8 | 22 | Lack of air, wrong gas mixture |
| Illness in water | 5 | 11 | Even minor respiratory infection |
| Personal factors | 2 | 31 | Anxiety; stress; *[illegible]* |

Okalyi: Native Divers in Torres Straits

| | FATAL | NON-FATAL |
|---|---|---|

| | | |
|---|---|---|
| Drowned | 3 | *[illegible]* |
| Pulmonary Barotrauma | 14 | *[illegible]* |
| DC Sickness | 5 | *[illegible]* |
| Illness | 2 | *[illegible]* |
| Cause uncertain | 2 | *[illegible]* |



University of Rhode Island: 1970 USA Diving Deaths

| | Skin Divers | Scuba |
|---|---|---|
| 1965 (Webster) | 27 | 67 |
| 1970 (URI) | 21 | 101 |

Diving Experience of Victims (Scuba)

| | |
|---|---|
| First dive ever with scuba | 11 |
| First open water dive | 7 |
| Early open water dive | 12 |
| Some experience with scuba | 24 |
| Considerable experience with scuba | 11 |
| Very experienced with scuba | 11 |
| **Total** | **76** |

17 of these deaths while under instruction

US Navy Research Reports

EDU RR 1-66

Average number of reported USN diving accidents 78 per year
Average fatalities 2 per year
Types of accidents: DC Sickness 50%
Lung over pressure 10% (50% with air embolism)

Comment 40% of diving accident in 'No Decompression' limits
8% cases actual decompression taken is less than required amount

USN EDU RR 10-68, 11-70, 12-70

| YEAR | 1967 | 1968 | 1969 |
|---|---|---|---|

| Civil - Military | C | M | C | M | C | M |
|---|---|---|---|---|---|---|
| DC Sickness | 21 | 46 | 25 | 55 | 28 | 37 |
| Lung over pressure | 3 | 9 | 6 | 9 | 3 | 4 |
| Other | - | 23 | 7 | 36 | 5 | 22 |
| TOTAL | 24 | 78 | 88 | 99 | 36 | 63 |

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Results of Recompression Treatment

| **Results Treatment DC Sickness** | **1961-66** | | **1967** | | **1968** | | **1969** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **M** | **%** | **C** | **%** | **M** | **%** | **C** | **%** | **M** | **%** | **C** | **%** | **M** | **%** |
| Complete relief | 189 | 79 | 11 | 52 | 36 | 80 | 9 | 36 | 44 | 80 | 9 | 32.1 | 22 | 59.5 |
| Substantial relief | 20 | 8 | | | 1 | 2 | 8 | 32 | 7 | 12.7 | 10 | 35.7 | 7 | 18.9 |
| Substantial residual | 6 | 3 | | | 1 | 2 | 6 | 24 | 1 | 1.8 | 6 | 21.4 | ? | 3.5 |
| under pressure | 12 | 5 | | | 1 | 2 | | | | | 1 | 3.6 | ? | 2.7 |
| Recurrence at surface | 11 | 5 | 10 | 48 | 4 | 9 | 2 | 8 | 3 | 5.5 | 1 | 3.6 | ? | 2.7 |
| Deaths | - | | - | | 3 | 6 | - | | - | | - | | - | |
| No treatment | - | | - | | - | - | - | | - | | 1 | 3.6 | | 2.7 |
| TOTALS | 238 | | 21 | | 46 | | 25 | | 55 | | 28 | | 37 | |

Time of Onset of DC Sickness Symptoms (Military)

| Cumulative% | 1963 | 1961-66 | 1967 | 1968 | 1969 |
|---|---|---|---|---|---|
| During Dive | 9.1 | 12 | 11 | 45 | 51.6 |
| After surface 1 hr | 54.7 | 56 | 59 | 72 | 728 |
| After surface 2 hrs | 66.8 | 65 | 69 | 74 | 76.8 |
| After surface 6 hrs | 88.2 | 90 | 90 | 88 | 8?.9 |

Fatalities: Report of Solo Diving

| Source | Area | Year(s) | Total Deaths | Solo Diver | Separated from Buddy | Failed attempt Buddy Rescue |
|---|---|---|---|---|---|---|
| BS-AC | UK | 1966-70 | 39 | 17 | 12 | 8 |
| Egstrom | California | 1970 | 19 | 10 | 2 | 55 |
| Hassel | S Calif. | 1953-60 | 41 | 26 | 3 | - |
| Taylor et al. | Florida (open water) | 1960-62 | 11 | - | 7 | - |
| URI | USA | 1970 | 107 | 18 | - | 19 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Webster | USA | 1965 | 86 | 15 | 24 | - |

Reported Depth of Fatal Incidents

| | | | |
|---|---|---|---|
| **Denney and Reed** | 1959-65 | Michigan | of 21 deaths, 18 at 25 depth |
| **University of Rhode Island** | 1970 | USA | 25% at 15 feet<br>50% at 30 feet<br>only 16% over 100 feet |

**SOME INVESTIGATIONS INTO SKIN AND SCUBA DIVING DEATHS**

| AUTHOR OF REPORT | SOURCES OF INFORMATION | PERIOD COVERED | DEATHS |
|---|---|---|---|
| Bayliss | Forensic Pathologists, Departments of Health in Capital cities, Aust., Statisticians | 1957-67 | *[illegible]* |
| BS-AC | Reports from BS-AC Branches and individual diver | 1965 onwards | 9 |
| Denney & Read | Death Certificates, with co-operation Michigan State Vital Statistics Bureau; Coroners | 1959-1965 | *[illegible]* |
| Desautels | State Board of Health, Florida | 1960-1969 | *[illegible]* |
| Hassel | Los Angeles Fire Dept (?) | 1959-1965 | *[illegible]* |
| Miles | Chance reports to RN Medical College (excluded ‘hard hat’ divers from report) | 1959-1964 (5 years) | *[illegible]* |
| Noguchi | Department of Chief Medical Examiner, Coroner County of Los Angeles | 1961 onwards | *[illegible]* |
| Okalyi | Thursday Island Hospital records | | |
| Press, Walker | Illinois Dept of Health: enquiries to 4 other states also | 1965-1966 (12 months) | *[illegible]* |
| Smith FR | Seattle - King County Safety Council | 1959-1965 | *[illegible]* |
| Taylor, Williams & Chappell | Florida State Board of Health who gave diving deaths on ‘code’ in death certifications | 1960-1962 | *[illegible]* |
| USN | EDU Research Reports based on NAVMED 816 accident reports | 1961-19?? | *[illegible]* |
| URI | Newspaper reports; | 1970 | *[illegible]* |

| | | | |
|---|---|---|---|
| | Coroners | | |
| Webster | Facilities Accident Prevention Bureau of State Services, US Dept of Healths, Newspapers | 1965 | *[illegible]* |

Project Stickybeak Newspaper reports, private reports, reporting schemes of AUF and SDAA and full co-operation Attorney Generals' and Justice Departments of States

**APPENDIX B**

## DEATHS ASSOCIATED WITH WORK IN COMPRESSED AIR OR DIVING POST MORTEM EXAMINATIONS

In view of the many gaps in our knowledge of the causes and mechanism of death from decompression sickness the Medical Research Council Decompression Sickness Panel is most anxious to collect information from the post mortem examination of divers dying following exposure to compressed air and during or after diving. In order to obtain adequate information it is essential that special care should be taken when carrying out such examinations and it is hoped that Pathologists will kindly co-operate with the Panel so far as they are able.

1. External Examination

   Particular note should be taken of the presence of sub-cutaneous emphysema and also the appearance and distribution of abnormal blotching or marbling of the skin. (A colour photograph of any such markings would be extremely useful).

2. Radiological Examination

   Whenever possible radiography of the chest and major arteries should be carried out before any internal examination. The chest radiograph may show lung pathology, such as a cyst, and the presence of gas in the heart and blood vessels. Joint radiographs can indicate the choice of bones to be examined (see 3c).

3. Internal Examination

   a. Central Nervous System - the calvarium should be opened before any other incision is made in order to prevent the accidental introduction of air into the body. The presence or absence of bubbles in the vessels on the surface of the brain should be noted. The brain should be removed in its entirety and, where possible, fixed in formalin without dissection. If possible the whole spinal cord should be removed and similarly fixed.

   b. Chest and Abdomen - it is advised that the trachea should be tied and occluded through a neck incision before the chest is opened.

i. HEART - it is particularly important to note the presence and distribution of gas in the heart and thoracic blood vessels. The heart should be examined under water in the conventional manner for the presence of gas in the chambers and coronary arteries and it must also be carefully examined for evidence of valvular or non-valvular communication between the left and right compartments.

ii. LUNGS - particular interest centres around the presence or absence of localised or generalised air trapping in the lungs. The heart and lungs should be removed with care and any local distension or collapse or any evidence of

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sub-pleural spread of air, noted. The heart-lung preparation should, if possible, be preserved in its entirety for subsequent dissection. In any event the whole of both lungs should be retained for later examination.

iii. BLOOD VESSELS - arteries and veins should be examined for the presence of gas in such sites as the alimentary canal, the brain and the kidneys. The consistency of the blood should be noted, for haemoconcentration, and a sample kept for carbon monoxide estimation.

c. Skeletal System - There is a particular interest in caisson disease of bone; and, where possible, at least the head of a femur and the head of a humerus should be removed and fixed for subsequent examination. Where there is radiological evidence of bone disease, as many specimens as possible should be obtained from both affected and unaffected regions.

d. Other Systems - where possible, other organs should be preserved in entirety, or portions retained for examination. This particularly applies to the kidneys and the endocrine system. Specimens of voluntary muscle, and of skin at the site of any lesion, should be obtained.

It would be greatly appreciated if the Medical Research Council Decompression Sickness Panel could be informed, at the telephone number given below, of a forthcoming post mortem on a subject who died during or following diving, or after working in compressed air. A member of the Panel would be willing to attend a post mortem examination should the Pathologist think this desirable.

Medical Research Council Decompression Sickness Panel
University of Newcastle upon Tyne
21 Claremont Place
Newcastle upon Tyne, NE2 4AA
Telephone: 0632 - 24987