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SURVEY UNDERWAY ON BONE NECROSIS

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*Faceplate Vol. 5, No. 3*

While diving is considered a reasonably safe endeavour, knowledgeable participants maintain an awareness of various potential hazards. The unexpected occurrence of decompression sickness on a "safe" decompression table is an ever present possibility; the enhanced possibility of decompression sickness from deeper and/or longer dives is well documented. Air embolism from improper exhalation while surfacing is always possible. Barotrauma with resultant ear and/or sinus involvement is also a constant possibility in any dive. While these possibilities are always present, they are all therapeutically manageable if adequate planning and precautions are taken.

There are diving problems that are not always recognized. Hearing loss and deafness have been recognized as possibilities that are under investigation for understanding, management, and prevention. The long-term consequences of central nervous system involvement in diving accidents are also of increasing concern. Currently being evaluated are the possible effects of diving on a diver's hones.

Bone abnormalities with the characteristics of aseptic bone necrosis or dysbaric osteonecrosis have been found in divers throughout the world. A survey for the presence of bone abnormalities, as determined by X-ray techniques, has been in progress in the US Navy for a number of years. In accordance with recent requests from the Diving Research Branch, Naval Submarine Medical Research Laboratory (NAVSUBMEDRSCHLAB), a number of active duty divers have been and are being surveyed radiologically for the presence of bone abnormalities. Various facts are gradually becoming evident from this survey.

Bone abnormalities consistent with the characterization of dysbaric osteonecrosis or aseptic bone necrosis have been found in some active duty divers. The exact percentage of cases is not yet known, but the occurrence of disabling bone abnormalities appears to be quite low (less than 0.45 percent). One or more incidents of decompression sickness do not seem to predispose the diver to the occurrence of bone abnormalities; nor does a diver's age appear to be related to the occurrence of this condition (within the normal age range of divers). No apparent correlation between the occurrence of bone abnormalities and the diver's NEC designation has been established for NEC's 5311, 5342, 5343 and 8493. These conclusions are based on preliminary data and will require additional input for verification. The causative factors that lead to the occurrence of bone abnormalities are not known at this time.

The effective pursuit to understand this subject is a task utilizing many Navy resources. Direction and guidance in the medical management of existing problems is a function of the Bureau of Medicine and Surgery. An active survey to establish a true incidence of this condition and to understand causative factors has been assigned to the NAVSUBMEDRSCHLAB at the Submarine Base, Groton, Connecticut. Objective diving data is supplied by the Naval Safety Center via the OPNAV Form 9940 input. Consultation services are provided by many facilities, including the National Naval Medical Center and the Armed Forces Institute of Pathology. In addition, an international group of experts is actively involved in finding the best possible approach to understanding and managing this problem.

The participation of many individual divers, the co-operation of various commands and activities, and the continuing involvement of many facets of the US Navy's biomedical research program are directed toward the safety of the individual diver in his duties. Doubtless there will be discussion and concern among Navy divers coincident with this official activity; rumors may circulate in various quarters about a variety of possibilities. To ensure an adequate presentation of reliable information, periodic status reports will appear in Faceplate. The purpose of these efforts is to assure participants that diving remains a safe endeavour, if standard precautions are observed.

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LCDR Adams has kindly offered to supply further information on the progress of this investigation at a later date.

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AN EXPOSURE TO RISK REGISTER FOR COMPRESSED AIR WORKERS

PD Griffiths

*Trans. Soc. Occup. Med. 1971; 21: 123-125*

The assessment of risk to which men in industry are exposed can be a thankless task because of the large number of variables and lack of essential data.

The hazards to which men are exposed when employed in compressed air in tunnels and caissons, and as divers, and known originally under such names as Divers' Palsy and Caisson Disease have been realised for very many years and considerable research concerning the aetiology and prevention of decompression sickness, as it is now called, has been carried out in the past, in particular by Paul Bert in Paris around 1870, and at the beginning of this century by Professor Haldane.

In 1945 the Ministry of Labour and the Institution of Civil Engineers decided to revise the Compressed Air Regulations, and it was then realised that very little was known about the risk involved and the reaction of men when actually employed in high working pressures, sometimes exceeding 40 psig on a civil engineering contract.

The first serious investigation of such a contract was carried out on the Tyne Pedestrian Tunnel 1948-1950 by Professor Walder and Professor Paton on behalf of the

Medical Research Council, and their important report was published in 1954 by the Stationery Office.

Since 1957 more data have been collected from all contracts in this country where men have worked in compressed air. These include the Clyde, Dartford, Blackwell and Tyne Tunnels, Tilbury, Dungeness 'A', Dungeness 'B', Wylfa, Fawley and Hartlepool Power Stations and a large number of smaller contracts involving sewage disposal, water supply, bridge foundations and harbour works. Since an international working party was arranged in London by the MRC Decompression Sickness Panel in 1965 considerable useful information has been collected from abroad, in particular from the United States of America.

The MRC decided to establish a Central Registry of compressed air workers where the mass of data already collected could be stored and assessed and from which research could be continued. This registry, the only one of its kind was established here in Newcastle in 1964.

Although originally the investigations concerned the aetiology of decompression sickness, they were extended from 1958 to cover the long-term ill effects of decompression, aseptic necrosis of bone, and during the last few years they have again been extended to cover the hazards to which commercial divers are exposed. In assessing exposure to risk there are two essentials:-

- (a) The intensity of the hazard (which naturally varies from contract to contract and even hourly on any one contract).
- (b) The period of exposure to that hazard.

We are lucky in having a large quantity of reasonably accurate data, but in retrospect one wishes that even more data had been collected in the earlier days - items which, at the time, were considered to be of little importance. This is one of the lessons I imagine we all learn.

#### What do we hold at the Registry?

The main file contains the names, date of birth and occupations of almost 10,000 men who have worked in compressed air, and the contracts on which they have been employed. Some have worked on one contract only, some on as many as ten. There are also separate files for each contract, recording details of men's experience. Identification is occasionally a problem, particularly with regard to Irishmen, a number of whom forget the year in which they were born and change their names at the drop of a hat, for various reasons, and so many of them are called Pat. There are over twenty Pat Gallaghers on the list.

Of a large proportion of these men we have personal details such as height and weight, their medical history, and details of their exposure to increased atmospheric pressure. The latter includes the number and length of shifts worked, the working pressures, the decompression procedures, the details of decompression sickness, if any, and details of the therapeutic procedures. Their occupations, such as engineer, miner, fitter and carpenter are known precisely.

The collection of data from contracts is not always easy - unlike a firm in industry which exists over a period of many years, the compressed air jobs may be completed in a few months or, at the most, three to four years and then the men disperse, only

a small proportion of them being found on subsequent contracts, may be completed in a few months or, at the most, three to four years and then the men disperse, only a small proportion of them being found on subsequent contracts.

The details of the individual experience to compressed air are recorded on men-lock registers. This is mandatory and the register is the property of the contractor, but is made available for us to copy. The remaining data which we require are not required by regulation, but are kept for us voluntarily by the medical officer and the medical attendants on pro-formata provided by the registry. Regular visits are made to the sites and there is no doubt that our advice concerning the decompression procedures and treatment of the men is fully appreciated.

Radiological examinations of joints produce special problems in that they have to be made on a voluntary basis, although 'regulation' in most other countries.

Whether the examinations are made at any x-ray unit attached to a site medical centre, at a mobile unit visiting the site or at an adjacent hospital, considerable organisation and the co-operation of the contractor's agent are required. Here it should be mentioned that, on the whole, co-operation of the contractors and their agents and staff in all our investigations has been good, and we are grateful to them.

1660 men have been radiologically examined, some of them a number of times, so we have 2400 sets of films of the shoulder, hip and knee joints, ie. approximately 15,000 radiographs. Of the 1660 men examined 330 have positive radiological signs of aseptic necrosis of bone. This figure of 20% must be viewed with care, as the men examined do not represent an absolutely true random selection; it is nevertheless alarming.

In the earlier stages of the investigation it became obvious that the statutory decompression procedures were inadequate in that:

1. A considerable number of cases of decompression sickness followed exposures to pressures below 18 psig and the decompression tables covered only working pressures above 18 psig.
2. Far too many men developed simple bends, and even more important, the much more serious Type II form of decompression sickness particularly when working for shift periods of over four hours and when working at the higher pressures. (800 cases of decompression sickness were treated in each of two major contracts).
3. Too many men developed aseptic necrosis of bone.

With regard to bone damage it was shown that the longer a man's experience at pressures over 18 psig and the higher the average working pressure the more likely he was to develop aseptic necrosis. On the other hand one exposure of eight hours to 35 psig and five shifts at only 17.5 psig can cause definite bone changes. Over 30% of men well experienced in high pressure work were found to have positive bone changes, and about a quarter of the lesions were juxta-articular and so potentially disabling. We know of over fifty men with a damaged articular surface and so suffering some degree of disablement. Some men have more than one joint affected, and four men who worked only on one contract had a damaged joint surface within 18 to 24 months of their first experience in compressed air.

During 1968-69 "atlases" were produced - each one contains 80 radiographs demonstrating the various stages and types of aseptic necrosis of bone. They were well received and were soon distributed on request to a number of countries. Requests are still being received for this atlas, but the preparation is very laborious and we have not had time to produce any more as yet.

In 1966 Dr Hempleman produced his revised (longer) decompression tables which, with the approval of HM Factory Inspectorate, have been used on all compressed air contracts where the working pressure has been above 14 psig since that date. We are now comparing the efficacy of the new procedure with that of the old with regard to both decompression sickness and bone necrosis. So far we are optimistic, but further data, preferably from one or two large contracts, are required before a final assessment can be made. Many contracts are being postponed for financial reasons.

Plans are now well advanced for computerising the data we already possess and those we hope to collect in the near future.

We have fairly recently investigated divers, of whom many are now based on the East Coast. Of these, 200 have undergone radiological investigation of their major joints, and in co-operation with CIRIA and commercial diving firms, details of divers' medical examinations, individual diving experiences and attacks of decompression sickness are being collected and filed. So far the results have been satisfactory in that bone damage is not commonly seen. These divers are frequently exposed to much greater pressures than are men working in tunnels but for much shorter periods. This could be taken as an indication that the length of exposure is of paramount importance in the development of bone necrosis. So it may be that if our new decompression procedures for tunnel workers are not as successful as is hoped, then a reduction of the shift periods as the working pressure increases will have to be advised; this is already being done in the United States and some other countries. Our main objective is to reduce the risk to the men to an acceptable level and at the same time to prevent a contract involving the use of compressed air from being an uneconomic proposition. So for the time being we are experimenting with decompression procedures but maintaining the standard eight-hour shifts.

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### Snippits

A "severed hand" was found by two men near the mouth of Narrabeen Lagoon in the early hours of Sunday morning while they were out fishing. With horror they saw what looked like a gloved hand in the wet sand. They took it to Manly Police Station. It was later taken by police to Manly Hospital where it was clinically examined. Study showed it may belong to a conjoin marine growth.

(*Manly Daily*, 23 February 1972)

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