WORKSHOP ON THE TREATMENT OF DECOMPRESSION SICKNESS

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This report summarizes a workshop held 17-18 February 1976 in London. The thirty physicians attending from seven nations sought a uniform approach to the treatment of decompression sickness in the North Sea environment.

Aspects considered include recompression profiles, gas mixtures, ancillary drugs, aftercare, qualification of assistants, and communication problems. Included in this report is an outline approved by the EUBS for guidance in the choice of treatment tables.

The continuing expansion of the offshore oil and gas industry involves large numbers of divers in the construction and maintenance of underwater equipment. When these divers suffer decompression sickness (DCS), as they do in spite of the latest decompression techniques, a variety of approaches may be made with regard to treatment. This diversity of treatment exists at all levels, from the supervisor on the scene, through the diving company management, to their medical consultants, whether industrial or naval. Because of the fast pace of development and the multinational complexion of the diving industry, this lack of a consolidated approach is nowhere more evident than in the North Sea.

A more uniform approach might improve the treatment outcome of many cases, particularly when the care of the diver passes through several levels of management or to several medical consultants. Toward this end, the European Undersea Biomedical Society (EUBS) invited a number of diving medicine consultants to participate in an informal workshop, held 17 and 18 February 1976 at the Royal Society of Medicine in London. The goal was to establish consensus, where possible, in the practical aspects of the treatment of decompression sickness offshore. The workshop, chaired by Surgeon Cdr. DH Elliott, RN, was one of a series of “Tables Rondes sur la Biomedicine Sous Mer” organized by the EUBS. Financial support was provided by the UK offshore Operators Association, an oil industry organization. Medical representatives of diving contractors, navies, and civilian medical establishments came from the UK, Norway, France, Italy, Switzerland, Canada and the US. A summary report is to be published in the US by the Undersea Medical Society. In the interest of informality and spontaneity, it was agreed that the participants would not be directly quoted.

The participants were invited to review their individual approaches to the management of DCS as a starting point toward delineating areas of agreement and disagreement. Then the specific components of therapy were discussed in detail.

Recompression profiles The expected differences of emphasis and application related to the backgrounds of the participants were evident. For example, DCS occurring at the surface is treated generally according to the USN or RN standard recompression tables, using oxygen at 60 ft pressure or air at 165 ft. The French, however, also use an intermediate profile with oxygen-rich mixtures at 100 ft. In oxy-helium diving to depths greater than 300 ft, commercial divers often follow short bottom-time schedules, where naval divers would use a prolonged saturation technique. As a result, there are no naval standard procedures to guide the treatment of DCS occurring before surfacing from these deep “bounce” dives. Many firms use a complex set of recompression tables to treat the diver without committing him to full saturation.

Experience has shown that in many cases this kind of manipulation results in recurrence of DCS. The participants agreed that in most cases of this sort, it would be better to recompress to the depth of symptomatic relief and return the diver to the surface on a saturation decompression schedule. In saturation diving, DCS is treated by minimal recompression, but the Royal Navy consultants recommend 30 to 60 ft of added depth without special breathing gases, while US Navy practice favors less depth, with oxygen-rich mixtures.

In the end, the choice of therapeutic compression profile according to the antecedent dive was the area in which concensus was achieved by the workshop. An outline of the agreed approach (see appendix) was endorsed “for guidance” by representatives of the EUBS and the Association of Diving Contractors. One point on which opinion was unanimous was that recompression should absolutely never be undertaken in the water.

While other specific components of treatment were discussed individually, there was markedly less uniformity of opinion. The interchange served to emphasize the rather glaring lack of convincing evidence, of the sort required in other areas of medicine, to support the use of many of the ancillary therapeutic agents. The participants agreed that there was a lack of controlled formal clinical trials. It was suggested that a central case reporting system would also be helpful in the evaluation of various modes of treatment.

Drugs The use of various ancillary drugs was advocated for nearly all cases of DCS by the French representatives. Others rarely used any, particularly in the offshore setting. Most of the practitioners present used one or more drugs such as dextran and glucocorticoids only in severe cases. Dextran was recommended by most, although it, like all the other agents discussed, is not backed up by controlled clinical trials involving DCS. Its properties and use in other diseases were reviewed. Although dextran-40 (40,000 molecular weight) is the most widely used, there was discussion of the relative merits of dextran-70. Some potential advantages were claimed for dextran-70, for example, longer persistence in the circulation and greater anti-platelet effect. One potential disadvantage of dextrans is the tendency to inhibit blood coagulation. This was said to occur, however, only when a dose of two or more litres was exceeded in 24 hours. One participant felt that this possibility contra-indicated its use in DCS of the inner ear. Specific indications and dosages could not be agreed upon.

Glucocorticoids were mentioned by some discussants for use in DCS of the central nervous system, particularly in the absence of satisfactory initial response to recompression. The rationale involves reduction of oedema in the affected areas of the spinal cord or brain, or the preservation of ischemic cells. This use of glucocorticoids is based primarily on inference from other clinical applications. The dosage suggested by its advocates was 10 to 12 mg of dexamethasone intravenously, followed by maintenance over as long as three days, using about eight mg every six hours. This is similar to the regimen used for cerebral oedema in brain tumor patients. On the other hand, one member of the group cited studies in animal surgical shock models, which showed that the beneficial effect of protecting hypoxic cells required doses of steroid many times greater. There was no concensus on the indications or dosage for steroids in DCS.

Heparin has been used occasionally in severe DCS, based on a few animal experiments-

in the absence of clear evidence of efficacy in human DCS, the potential risk of hemorrhagic complications at the site of the lesion (eg, central nervous system, inner ear) discourages its use.

Asprin was endorsed by the French representatives for all cases of DCS. Others pointed out that there was evidence only for a prophylactic effect in animals, and no demonstrated value in treatment beyond mild analgesia.

Diazepam was said to be used frequently by the French, but apparently only as a non-specific tranquilizer. One participant also noted its specific effect of suppressing the symptoms of vestibular damage. It could thus be used after treatment failure in inner ear DCS, but should not be allowed to obscure the response to recompression. A few other less important drugs were also discussed and not endorsed by the group.

The aftercare of DCS patients was also considered. In cases of inner ear damage, follow-up with audiometry and electronystagmography was emphasized, since even with complete loss of labyrinthine function, symptoms may resolve within a few days. In the case of residual spinal cord damage, repetitive hyperbaric oxygen therapy was recommended by some. It was agreed that daily treatment could be continued as long as it was accompanied by steady improvement.

The participating doctors were asked to describe the kind of assistant they would like to have in an offshore treatment chamber in the absence of a doctor. Despite lively discussion there was no concensus on either the type of training required or even the scope of medical procedures which should be required of the assistant. Suggestions ranged from divers with advanced first aid training, to fully- qualified Physician’s Assistants. All agreed that improved telecommunications were needed between an offshore facility and the doctor ashore, and that a personal rapport between doctor and assistant was more important than the level of qualification of the assistant.

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5.3 Any deterioration of the patient during the compression following a therapeutic compression should be treated by further compression to the depth of significant relief.

5.4 This outline is for guidance only since it cannot predict every situation and some differences of opinion may still exist on details of treatment between medical practitioners experienced in this field.

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APPENDIX

THE CHOICE OF A THERAPEUTIC COMPRESSION TABLE IN RELATION TO THE CAUSATIVE DIVE (AS RECOMMENDED BY REPRESENTATIVES OF THE EUROPEAN UNDERSEA BIOMEDICAL SOCIETY AND THE ASSOCIATION OF DIVING CONTRACTORS, LONDON, FEBRUARY 1976)

1. Air diving

Decompression illness arising at the surface following air or oxy-nitrogen dives (of a duration less than saturation) should be treated in accordance with one of the following procedures:

1.1 Immediate Treatment (If Not Life-Threatening)

i. Compress chamber with air, breathing oxygen from the surface to 60 ft (18m)

ii. At 10 mins review:

- if limb-bends cured - USN 5 or RN 61
- if serious symptoms cured - USN 6 or RN 62
- if improving - remain at 60 ft (18m) and at 45 mins review:
  - if cured - USN 6 or RN 62
  - if not cured - USN 6 with extra oxygen sessions
- if symptoms worsening - off oxygen and compress to 165 ft (50m) AIR
  - if on arrival at 165 ft (50m) limb-bend is cured, use USN 2A (RN 52) but for all serious manifestations use USN 4 (oxygen at shallow stops compulsory for patient and attendants) or RN 54.
  - French-trained divers would tend to use 30m oxygen-rich rather than 50m air tables.

1.2 Immediate Treatment if Life-Threatening or if Cerebral Air Embolism is Suspected

Proceed direct to 165 ft (50m) AIR. Do not spend time on oxygen at 60 ft (18m).

For air embolism the US Navy now use table 6A, but Royal Navy experience favours a version of USN 4 (RN 54) using a continuous rate of ascent (18 to 10m at lm/hr, and 10m to surface at 0.5m/hr) in place of stoppages from completion of 6 hrs at 18m.

1.3 Treatment After Some Five or More Hours' Delay Between Onset and Compression

Use USN 6 (RN 62) with extra oxygen sessions as needed. Frenchtrained divers also would use 18m oxygen tables but with a 30m oxygen-rich option if there is no relief after 15 mins.

2. Saturation Diving

2.1 Treatment During Saturation Decompression

For the onset of decompression sickness during a slow saturation decompression breathing oxy-helium or other mixtures, compress at 5 ft/min (or 2m/min) to depth of significant relief, but by not more than 2 bar (60 ft; 20m) for pain-only limb bends and by not more than 3 bar (100 ft; 30m) for serious decompression sickness, inner-ear manifestations in particular.

It is worth noting that the onset of inner-ear decompression sickness may be associated with a recent switch from helium to air during the decompression. If compression is required in these circumstances, the patient should be returned to an oxy-helium atmosphere. For this reason alone, when the change to air is made, it is advisable to keep one of the chamber compartments not being used by the divers at the time filled with oxy-helium. Thus it is immediately available for any necessary treatment during the period following the change to air.

Remain at that depth for a minimum of 2 hours and possibly 6 hours. Oxygen-rich mixtures (1.5 to 2.5 bar O_2) may be breathed for up to six 20-min periods with 5-min intervals on chamber atmosphere.

Resume saturation decompression from treatment depth, but with initial upward excursion.

2.2 Excursion Diving From Saturation

Following an excursion, immediate compression is necessary to the depth of relief. This depth may be less than the depth of excursion, but for serious symptoms it should be not less than 3 bar.

Remain at the treatment depth for a minimum of 2 hours, for as long as improvement occurs and possibly for as long as 24 hours.

Oxygen-enriched mixtures may be used (as in 2.1). Initiate saturation decompression from treatment depth, but with no initial upward excursion.

3. Oxy-Helium “Bounce” Diving

Deep oxy-helium dives from the surface, with a bottom time of relatively short duration, which lead to decompression sickness during the course of, or soon after, a decompression more rapid than used for saturation diving.

3.1 Onset of Decompression Sickness at the Surface

Breathe oxygen by mask from the surface and compress chamber with air to 60 ft (18m). If cured or improving after 10 minutes, continue oxygen treatment as detailed in paragraph 1.1.

If condition not improving at 10 minutes, discontinue oxygen and compress chamber to depth of relief, using pure helium. (This incoming gas must be well-mixed, perhaps by venturi, with the chamber atmosphere of air and the divers should breathe an oxy-helium mixture by mask during the

compression until mixing is complete.)

If the condition is serious at the surface, compress to 60 ft (18m) with air but do not stop at 18m. Continue on helium to depth of significant relief.

Ideally, the chamber should have a partial oxygen pressure of about 0.4 bar at all times, the diver breathing a higher-oxygen mixture by mask (as in 2.1), as needed. (The upper limit of oxygen in the chamber atmosphere should be 0.6 bar). Since the chamber contained 2.8 bar air and was further compressed using 100% helium, the chamber atmosphere will have a partial pressure of oxygen of about 0.6 bar, whatever the depth of relief.

Other methods of achieving an acceptable atmosphere are possible, but need to be carefully planned in advance.

Remain at least 2 hours (as in 2.2), after which decompression should be initiated on a saturation table, but with no initial upward excursion. For guidance the following rates may be used:

deeper than 100m	1.5m/hr
100 to10m	1.Om/hr
10m to surface	O.5m/hr

3.2 Onset of Decompression Sickness During the Original Decompression

- Immediate compression to the depth of relief and, if relief is not achieved, to at least the full depth of the dive.

- Remain at least 2 hours, optional oxygen-enriched breathing mixtures (as in 2.1 and 2.2)

- Begin saturation decompression from treatment depth, but with no initial upward excursion.

4. Uncontrolled Ascent (Blow-Up) to the Surface

The unscheduled surfacing of a diver is hazardous at all times but especially so if he has not completed all the necessary stoppages.

0NE MUST ALWAYS BE PREPARED TO COMPRESS THE DIVER, IMMEDIATELY UPON SURFACING, IN A CHAMBER TO THE FULL DEPTH OF HIS DIVE, AND, IF NECESSARY, TO DECOMPRESS ON A SATURATION SCHEDULE.

5. Notes for all Classes

5.1 Attention must be paid at all times to preventing pulmonary oxygen toxicity. A UPTD (unit pulmonary toxicity dose) of 615 (equivalent to a reversible 2% decrement of vital capacity) should not be exceeded, thus allowing latitude for any further treatment.

5.2 The rate of decompression should be determined by the condition of the patient, symptoms usually being a more sensitive guide than outward signs.

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