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David H. Elliott, OBE, DPhil, FRCP is the Shell Professorial Research Fellow at the Robens Institute of Health & Safety, University of Surrey. His address is "Rockdale", 40 Petworth Road, Haslemere, Surrey GU27 2HX , UK.

OUTCOME AFTER TREATMENT FOR DECOMPRESSION ILLNESS IN AUSTRALASIA

Des Gorman and Maurice Harden

Abstract

In the decade, 1983-1992, there were at least 20 published reports of series of Australasian recreational divers who were treated for decompression illness. These series have been reviewed. With one exception they were retrospective and none were controlled. Only two series reported the type and severity of sequelae. Nevertheless, it would appear that conventional treatment regimens are often unsuccessful in controlling such decompression illness and that many divers are left with depressed mood and disordered higher functions.

Introduction

Australasian Hyperbaric Units still use algorithms based on United States Navy (USN) Treatment Table 6 (USN-6) to treat divers suffering from decompression illness (DCI). Although the USN has demonstrated a final success rate of more than 90% for divers treated with a USN 1, 1A, 2, 2A and 3,[1] and also with USN 5 and 6,[2,3] a review of reported outcomes from Australasian Hyperbaric Units suggests that overall success in treating DCI with a USN 6-algorithm may be less than 70%.[4]

Some fundamental differences between these groups (military versus recreational divers, time from onset of symptoms to treatment, type of post-treatment assessment) may invalidate this comparison. Therefore a review of the series of DCI treated in Australasia, and published in the decade from 1983 to 1992, is presented.

Clinical Series of DCI in Australasia, 1983-1992

AUCKLAND, NEW ZEALAND, 1967-1989.

A retrospective review of 23 years clinical experience at the New Zealand Naval Hospital identified records of 125 treated cases of DCI.[5] In most of these, a USN-6 algorithm was used. At discharge, only 57 (46%) had recovered fully; this frequency was not significantly changed in those reviewed subsequently. The timing of these reviews was not detailed, nor was the distribution or severity of sequelae described. However, outcome did not appear to be related to the delay prior to treatment. Some of these patients have been subsequently described in detail. One of these developed severe depression and intellectual impairment despite numerous hyperbaric oxygen treatments.[6] Twenty-five of the divers were treated in 1987; they were carefully monitored over the following year.[7] Two were lost to follow-up. Forty four percent had persistent problems approximately one month after discharge, increasing to 68% at the (about) one year review. In decreasing frequency, the reported problems were depression, problems with higher functions, motor and sensory disorders. It must be noted that these data were acquired retrospectively and (perhaps consequently) conflict with an earlier report of the same population.[8] A subgroup of these divers was also reported elsewhere,[9] but outcome was not described.

CHRISTCHURCH, NEW ZEALAND, 1979-1988

A retrospective review of 10 years clinical experience at Princess Margaret Hospital.[10] showed that 59 divers had been treated for DCI. However the outcome of these divers was not described.

SYDNEY, NEW SOUTH WALES, AUSTRALIA, 1983-1986

Patients admitted to the Royal Australian Navy School of Underwater Medicine (RANSUM) with DCI, from 1983 to 1986, inclusive were treated with a USN-6 algorithm and intravenous hydration.[11] These patients have also been reported on since then and by different authors,[12,13] but subsequent reports add little new data or analysis. Of the 87 entered into the study, 3 left RANSUM after treatment with persistent problems. Forty six presented for a review both at one week and one month after treatment. The frequency of abnormality changed significantly in that time, increasing from the time of discharge to the one week review (46 reviewed; 10 had overt neurological deficits, 22 had an abnormal EEG, 20 had poor psychometric performance), and then decreasing at one month (46; 2, ? and 8 respectively). This study suggested that :

a the time of measuring outcome after DCI is treated is critical and discharge morbidity will over-estimate treatment efficacy;

b the natural history of DCI sequelae is for early resolution;

c CT scanning of divers after treatment for DCI has an unacceptable frequency of false-negative results;[13] and

d. neuropsychiatric sequelae are as likely in those divers who initially have musculoskeletal symptoms only, Type 1 DCS,[14] as in those who have neurological symptoms and signs.

However, this study had limitations. Firstly, the psychometric screen that was used is probably inadequate.[15] Secondly, there was only a poor correlation between those divers with EEG abnormalities and those with psychometric deficits, and thirdly, the loss of patients to follow-up may have caused considerable bias.

ROCKINGHAM, WESTERN AUSTRALIA, 1984-1992

The Royal Australian Navy treated 40 divers with DCI in the period from 1984 to 1987 inclusive at HMAS STIRLING.[16] These divers were treated with USN-5 and USN-6. Six of the 40 did not recover fully. The type of sequelae was not described and no follow-up was reported. There was also no obvious relationship between final outcome and delay prior to treatment. A subsequent letter to an Editor,[17] referred to 111 cases of DCI treated at HMAS STIRLING since 1984. No outcome was described, but it was claimed that women in the series had a greater frequency of neurological involvement than men.

SYDNEY, NEW SOUTH WALES, AUSTRALIA, 1985-1989

An analysis was made of 100 cases of DCI occurring between 1985 and 1989 and presenting to the Prince Henry Hospital.[18] However, neither outcome nor type of follow-up was clearly identified.

ADELAIDE, SOUTH AUSTRALIA, 1987

Sixty four divers were treated for DCI at the Royal Adelaide Hospital during 1987.[19] A USN-6 algorithm was used. At discharge, only 31 of the patients had recovered completely. The distribution and severity of sequelae was not described. The time from onset of symptoms to treatment did not appear to be related to outcome.

MELBOURNE, VICTORIA, AUSTRALIA, 1987-1990

One hundred consecutive cases of DCI treated at the Alfred Hospital were reviewed.[20] A USN-6 algorithm was used. At discharge, 34% of the divers had obvious sequelae. These sequelae were not described and nor was follow-up reported.

ADELAIDE, SOUTH AUSTRALIA, 1990

Twenty divers with DCI were treated with a USN-6 algorithm at the Royal Adelaide Hospital in 1990, and were reviewed both at one month (15% had sequelae) and one year (10% had sequelae).[21] The type of sequelae was not described.

FREMANTLE, WESTERN AUSTRALIA, 1990

Forty-one divers with DCI were treated at Fremantle Hospital in 1990.[22] The treatment used, any follow-up and outcome was not described.

HOBART, TASMANIA, AUSTRALIA, 1990

Three cases of DCI were reported, without follow-up outcomes.[23]

TOWNSVILLE, QUEENSLAND, AUSTRALIA, 1990

Fifty divers with DCI were treated in 1990 at Townsville General Hospital, using a USN-6 algorithm.[24] Forty percent of the divers did not recover fully. No follow-up or analysis of the sequelae was reported.

EMERGENCY SERVICES AND MONITORING STUDIES

Both the Australian Divers Emergency Service[25] and the Diving Incident Monitoring Study based at Royal Adelaide Hospital[26] have reported series of divers with DCI (210 and 14 cases respectively) but did not describe outcome.

Discussion

All of the clinical series reviewed above are, to some extent, flawed; none of the series were controlled and only the original series from Sydney was prospective.[11] Most of the series did not report outcome after discharge, nor the type of follow-up, if any, nor the type or severity of sequelae. The series do however have the following in common: USN-6 algorithm treatments and treatment failure rates much in excess of those reported for such regimens by the USN.[2] There are several possible reasons for this difference:

a. the USN data is largely derived from the early treatment of male military divers;

b. the Australasian data is from the, usually late, treatment of male and female recreational divers; and

c. the early USN data did not include a thorough mental state examination.[1]

The relative risk of being female and developing DCI is controversial.[17,27] There are no data showing that being female is an independent risk for poor outcome after treatment.[5,19]

The significance of early versus late treatment of DCI is assumed, but not supported by data. For example, in three of the Australasian series,[5,16,19] delay to treatment was not significantly correlated with outcome. The difference between the USN and Australasian data may be best explained by the relative severity of the provocative decompressions. It is unlikely that the USN divers will have exceeded (or approached) decompression schedule limits. However, in the Australasian series employing a factorial analysis,[5,19,] a poor outcome (sequelae) was significantly more likely if the diver had exceeded conventional decompression limits.

It is clear from the series reviewed above, that treatment failures for DCI in Australasia, using a USN-6 algorithm, are common. Treatment failures vary from 5 to 60% at discharge,[5,11,16,19,20,24] from 15 to 51% at one month[8,11,21] and from 10 to 68% percent at one year.[7,21]

The natural history of "treated" DCI is not established by these series. Two reports suggest that the frequency of sequelae does not change significantly in the year after treatment,[5,21] another reports a significant increase in residual problems in the days after discharge with an almost complete resolution by one month[11] and a fourth report suggests that the frequency of sequelae may actually increase during the first year.[7]

Unfortunately, only two of the reports included a description of follow-up technique and type and severity of sequelae. The divers treated by the Royal Australian Navy most commonly had EEG and psychometric abnormalities.[11]

Similarly, those monitored after treatment by the Royal New Zealand Navy complained of, in order of decreasing frequency; depression, disorders of higher mental function, headaches, sensory and motor deficits, and impaired balance and "aches and pains".[7] Uncommon sequelae included visual disturbances, dysphasia, dyslexia and bladder and bowel problems. Other reports of some of these patients indicate that they were both incapacitated and invalided by these problems.[6,8]

In summary then, many Australasian recreational divers treated for DCI with a USN-6 algorithm do not recover fully. The, largely retrospective, uncontrolled and non-critical surveys reviewed here do not enable the natural history of these divers to be described, but it would appear that the brain is predominantly involved in sequelae.

Not surprisingly, the prospective controlled studies of oxygen versus oxygen-helium[4] and lignocaine versus placebo[28] involve a review of patients at discharge, and one week, one month and one year later. This review includes a careful neuropsychiatric assessment.

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Dr Des Gorman, BSc, MB, ChB, FAFOM, Dip DHM, PhD is the Director of Medical Services of the Royal New Zealand Navy. He is a visiting Consultant in Hyperbaric Medicine at the Royal Adelaide Hospital and the University of Adelaide.

Dr Maurice Harden, B. Med is a Medical Officer in the Royal Australian Navy seconded to the Royal New Zealand Navy.

A PROGRESS REPORT ON DIVING MEDICINE STUDIES IN THE ROYAL NEW ZEALAND NAVY

Des Gorman, Alison Drewry and Maurice Harden

Abstract

Studies of oxygen-helium and lignocaine in the treatment of decompression illness and the role of girdling in protecting against pulmonary barotrauma are underway at the Royal New Zealand Navy's Auckland Naval Base.

Introduction

A series of diving medicine studies are underway at the Auckland Naval Base. These include:

a prospective controlled randomised studies of oxygen versus oxygen-helium and lignocaine versus placebo in the treatment of decompression illness (DCI) arising from recreational air diving; and,

b a study of the role of chest and abdominal splinting in the prevention of pulmonary barotrauma.

These studies are reviewed below.

Oxygen-Helium Study

The rationale for a comparison of oxygen and oxygen-helium as the ideal therapeutic gas mixture to be breathed during the recompression of divers with DCI has been described previously.[1] This study is now underway. The progress results are detailed in Table 1. The outcome data after discharge are still being accumulated for these patients and are not reported here. Treatment, including compression to beyond 2.8 bar, and retreatments were determined by the study protocol.[1] No patients were compressed beyond 4 bar. Clearly, no significant advantage has been demonstrated yet and the study continues.

Lignocaine Study

The potential efficacy of lignocaine in the treatment of DCI has been demonstrated by both in-vivo studies and a clinical report.[2] A pilot study of lignocaine in