DECOMPRESSION ILLNESS IN SPORTS DIVERS THE UK EXPERIENCE

James Francis

Abstract

The development of the diving accident database at the Institute of Naval Medicine in 1990 has facilitated the study of decompression illness (DCI) in the UK. Although the collection of data remains incomplete, largely because participation in the scheme is voluntary, the situation is improving. The data from 595 cases of DCI arising from diving which were collected from 1991-1995 are reviewed and summarised. Four hundred and eighty two (81%) of the cases were recreational divers and 499 (84%) were male. In 434 cases (73%) the diver was aged under 40 years. In the cases where depth was recorded the average depth of the preceding dive was just over 30 m. The nervous system was involved in 457 cases (77%). Only 77 (13%) presented with what has classically been labelled Type I, or pain-only, decompression sickness (DCS). Only 325 divers (55%) were reported to have made a complete recovery following one recompression treatment. The remainder had residua of some kind. With a second treatment the cure rate improved to 68% (404 divers) and with a third to 74% (440 divers). One hundred and seven divers (18%) still had symptoms and signs after their hyperbaric treatments. In 8% (48 divers) there was no indication of the extent of recovery in the case report.

Key Words

Accidents, decompression illness, diver emergency services, recreational diving, sequelae, treatment.

Introduction

In 1990, Dave Smith, Rob Hills and I set up a diving accident database at the Institute of Naval Medicine (INM). The primary objective was to attempt to better define the syndrome of decompression illness. This turned out to be a considerably more involved task than was originally thought. The problems included software development, our initial choice of Advanced Revelation proved to be an error and the entire thing was rewritten in Fox-Pro in 1994 by Mike Ralph. We needed the cooperation of as many chambers in the UK as possible and, quite coincidentally, this requirement coincided with the founding of an organisation, which is now titled the British Hyperbaric Association, which has been a tremendous help. We had to persuade a lot of doctors to fill in our forms, legibly. This was not easy for some as it meant an end to the three line case report, dive profile, diagnosis and treatment table, which abound in the archives at INM and, I suspect, elsewhere. Instead, they were forced into recording a detailed description of the condition, its evolution, management and outcome. Last but not least, we needed a team of people to nurture the database by performing the essential tasks of data audit and entry. With each report containing over 100 fields, and with over 1,000 records now in the database, I am particularly grateful to Dave Smith, Mike Ralph, Peter Benton and Paul Kelleher who manfully took on this task.

Over the years, data collection has become more complete as more chambers have agreed to use our forms but it is still not universal. Each year the British Sub-Aqua Club (BSAC) collate data on UK diving accidents and it is evident that the INM database only contains about two thirds of cases identified by the BSAC. Those which are treated in an Accident and Emergency department or by family practitioners, and those who receive no treatment or who die, tend to be omitted. Nonetheless, the database now gets reports on over 90% of cases which attend a hyperbaric treatment facility. Unfortunately, a proportion of reports are still submitted with incomplete data fields, some do not get posted, some are still illegible and all of these need to be chased up. Thus, although the data set is incomplete, all this effort has permitted us to take a better look at DCI in the UK than has been possible previously and I will now summarise the most recent five years of data which are available to me. I searched the database in February 1996, at which time the 1995 data set was incomplete.

Results

Table 1 shows that the case load varies considerably from year to year. This is a familiar pattern. In 1989 there was over 200 cases yet in 1990 there was less than half that number. There is no satisfactory explanation for this variation. It would be of interest to compare the incidence of DCI with the number of dives conducted. Unfortunately there is no such record in the UK and thus it is not possible to determine whether there is a fairly constant incidence of DCI per 1,000 dives and the variation in incidence reflects variations in the number of dives undertaken or whether it is the incidence per 1,000 dives which varies. This is a problem which is universal in recreational diving. The planned launch, in 1998, of DAN's Project Dive Safety, in which the denominator will be known for a large sample of divers may make such an analysis possible.

TABLE 1

Year	Cases of DCI
1991	127
1992	98
1993	92
1994	170
1995	108
Total	**595**

Where these cases receive treatment is of some interest (Table 2). Much of the recreational diving in the UK is undertaken in the South West and off the West coast of Scotland. Inland, a lot of diving takes place at Stoney Cove in Leicestershire. It is therefore not surprising that a high proportion of cases are seen at the Diving Diseases Research Centre (DDRC) in Plymouth. Military chambers in the West of Scotland help out Aberdeen with the Scottish patient load, whose representation is artificially low in these data because it is only since 1994 that they agreed to send case reports to the INM. Whipps Cross Hospital, being in London, serves a large population of recreational divers but tends to get cases which develop some time after the provocative dive and also receives the growing number of cases which arrive by air at Heathrow or Gatwick from diving holidays around the world. INM used to receive just about all the cases which occurred on the South Coast. However, since the Chamber at Poole opened in 1994 a growing proportion are treated there.

Most of the cases are male (500 or 84%). Recreational divers provided 482 cases (81%). Military divers contributed only 36 (6%) cases to the database, the remaining 60 (10%) being occupational. The apparent safety of military diving has little to do with the advanced technology of their equipment but results from close adherence to procedures, with the supervisor exercising strict control of the divers in the water, and a conservative use of tables. It will be interesting to see if things change with the introduction of a set in 1997 with a deep (80 m) bounce-dive capability which will necessitate the military diver having greater control over his dive profile.

Despite the rapid growth of the dive computer industry during this period, when the information was recorded, 44% of decompressions were calculated using tables, commonly BSAC 88. The age distribution of cases is shown in Table 3. Table 4 shows that the dive preceding the onset of DCI tends to be quite deep, on average almost 30 m. Not surprisingly, many of these (43%) involved a staged decompression. This figure is likely to grow in the future as the popularity of deep, mixed-gas diving increases.

As we have published previously, the majority of cases presented with multiple manifestations, the most prevalent of which were neurological.[1,2] Dividing the manifestations into broad categories of: neurological (excluding pain), pain (predominantly limb pain), constitutional (including headache, malaise, fatigue, nausea and vomiting), skin, pulmonary and lymphatic, only 35% of cases presented with manifestations in a single category. The frequency of reporting each category is shown in Table 5 and a breakdown of the frequency of neurological involvement is shown in Table 6.

TABLE 2

CASES BY TREATMENT CENTRE

Diving Diseases Research Centre (DDRC) Plymouth, South West England	131
Defence Research Agency and INM Portsmouth area, South coast England	95
Other military chambers	58
Whipps Cross Hospital, London	62
Poole, Dorset, South West England	47
Dunstaffnage	27
Aberdeen, North East Scotland	26
Stoney Cove, Leicestershire, Midlands, England	24
Lancashire Constabulary, North West England	14
Fort William, North West Scotland	14
Great Yarmouth, East Anglia	13
Northumbria, North East England	12
Craigavon	9
Cork Naval Base, Eire	2
Other	61
Total	**595**

TABLE 3

AGE DISTRIBUTION OF CASES

Age	Divers	%
Under 20	24	4.0
20-29	194	32.6
30-39	214	36.0
40-49	107	18.0
50-59	24	4.0
60-69	2	0.4
Unknown	30	5.0
Total	**595**	**100.0**

TABLE 4

DEPTH OF DIVE PRECEDING ONSET OF DCI

Depth (m)	Number	%
0-9	31	5.2
10-19	117	19.6
20-29	174	29.2
30-39	153	25.7
40-49	65	10.9
50+	40	6.8
Unrecorded	15	2.6
Total	**595**	**100.0**

Remarkably, what I was once taught as being the most common presentation of DCI, the old 'Type 1" or pain-only DCS was seen in only 77 divers (13%). I can offer no firm explanation for this apparent disparity. It could be that the disease has changed. Advances in equipment, notably the thermal protection afforded by modern diving suits and larger capacity bottles mean that deeper and longer dives can be undertaken and this may influence the presentation of the DCI which results. It could also be that doctors are getting better at eliciting neurological symptoms and signs. Personally, I have found that being required to complete an accident form has improved the completeness of my history taking and the thoroughness with which I record my clinical observations.

A finding from these cases questions another piece of classical teaching, namely that DCI recovers with adequate treatment. In fact, only 325 cases (55%) in this series made a complete recovery after the first treatment. This increased to 404 (68%) after the second treatment and to 440 (74%) after the third. Further treatments reap a diminishing return in terms of complete recovery with 107 divers (18%) having residual manifestations at the completion of their hyperbaric treatments. Surprisingly, in only 77% of cases with limb pain was this completely resolved after the first treatment.

A final feature of the management of DCI in the UK which has changed over the past few years is the first aid management of the condition. In particular, the use of oxygen is becoming more common. Although the first-aid section of the diving accident reporting form is one which is generally completed less fastidiously than others, the available figures support my own observations. In 1991 only 6% of cases were recorded as receiving oxygen, 4% oral fluids and 3% both. In 1995 this had improved to 28%, 18% and 16% respectively. There are two principal reasons for this: the Coastguard now routinely carry oxygen and use it when recovering injured divers. More importantly, more dive boats and clubs are equipped with oxygen and trained in its administration. The BSAC now provides an oxygen administration course for sports divers which includes a three hour session on: the medical aspects of diving; symptoms and signs of diving-related injuries; resuscitation and the theory of oxygen and fluid administration. This is followed by a 2 hour practical session using a "Resusci®Anne" and then theory and practical examinations. It is too early to tell how this will affect the outcome of DCI, but it is unlikely to be detrimental.

TABLE 5

CATEGORIES OF MANIFESTATIONS IN 595 DIVERS

Category	Cases	%
Neurological	458	77
Pain	369	62
"Pain only"	77	13
Constitutional	196	33
Cutaneous	71	12
Pulmonary	36	6
Lymphatic	6	1

Note that many patients had more than one type of manifestation. See text for description of categories.

TABLE 6

NEUROLOGICAL MANIFESTATIONS IN 458 DIVERS

Manifestation	Cases	%
Sensory abnormalities	350	76.6
Motor weakness	160	35.1
Coordination abnormalities	97	21.2
Special senses	74	16.2
Higher function abnormality	49	10.6
Altered level of consciousness	42	9.1
Loss of sphincter tone	16	3.5

Note that many patients had multiple neurological manifestations.

References

1 Kelleher PC, Francis TJR, Smith DJ and Hills CP. INM Diving Accident Database: Analysis of Cases in 1991 and 1992. *Undersea and Hyperbaric Med* 1993; 20 (Suppl): 18

2 Kelleher PC, RJ and Francis TJR. A manifestation-based mathematical model to predict outcome of neurological decompression illness based on 214 cases. *Aviat Space Environ Med* 1996; 67: 654-658

Dr T J R Francis, one of the Guest Speakers at the 1997 Annual Scientific Meeting, was Head of Undersea Medicine at the Institute of Naval Medicine, Alverstoke, Gosport, Hampshire PO12 2DL, England, when undertaking the research for this paper. His address is now Naval Submarine Medical Research Laboratory, Naval Submarine Base, New London, Groton, Connecticut 06349-5900, USA. Telephone +1-860-694-4005. Fax +1-860-449-2523. E-mail francis@nsmrl.navy.mil .