ORIGINAL PAPERS

50 DIVERS WITH DYSBARIC ILLNESS SEEN AT TOWNSVILLE GENERAL HOSPITAL DURING 1990

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Abstract

This paper reviews the presentation, treatment and outcome of 50 consecutive divers presenting to the Townsville General Hospital with a dysbaric illness during 1990. Inexperience, repetitive diving and multiple ascents were identified as predisposing factors to dysbaric illness.

Introduction

Recreational scuba diving has become one of Australia's growth industries. There are no reliable estimates of active divers within Australia, however PADI Australia certified their 200,000th diver during November 1990.[1] However this growth in popularity has been accompanied by an increase in the number of divers treated by hyperbaric facilities. PROJECT S.A.F.E.R. divers[2] reported a total of 228 Australian divers treated for decompression sickness in 1989 compared to 126 with 1986.

This paper reviews the presentation, treatment and outcome of fifty consecutive divers with decompression illness presenting to the Townsville General Hospital Hyperbaric Medicine Unit during the period from 1st January 1990 to the 25th November 1990. This unit accepts patients from Queensland, Papua New Guinea and the South Pacific Island nations.

Treatment

Recompression, when indicated, was performed in either a twin lock Comex deck recompression chamber housed at the Townsville General Hospital (on permanent loan from The Australian Institute of Marine Science) or in a two man Dräger Duocom portable chamber whilst en route to the main facility in Townsville. The Duocom chamber is supplied and operated by The North Queensland Emergency Response Group (NQERG) which formed following the demise of The National Safety Council of Australia (Victorian Division) in March 1989. NQERG also provide a Beechcraft Super King Air (fixed wing) aircraft or a Bell 412 helicopter, both are capable of transporting the portable chamber. The static facility is equipped with a female NAT0 N1079 flange which permits transfer under pressure (TUP) from the portable recompression chamber. During this period there were 40 divers treated for decompression sickness (DCS) and 10 divers were referred with a provisional diagnosis of cerebral arterial gas embolism (CAGE). A diagnosis of CAGE was confirmed in six of these cases. A detailed breakdown of these 50 cases is presented.

Cases

Twenty five males and 15 females presented with the diagnosis of DCS and 6 males and 4 females with suspected CAGE. The ultimate diagnoses in the latter were CAGE in 6 and near drowning in 4. One of the 4 had an epileptic fit while the others panicked. Table 1 gives the age group of the patients.

TABLE 1

AGE DISTRIBUTION

Age	DCS		CAGE	
	Cases	%	Cases	%
15-20	2	5	2	20
21-25	15	37.5	5	50
26-30	12	30	2	20
31-35	4	10		
36-40	1	2.5		
41-45	3	7.5		
46-50	1	2.5	1	10
> 50	2		5	
Total	**40**		**10**	

Just over a quarter of those with DCS were under instruction, as were 60% of those with the initial diagnosis of CAGE. (Table 2).

TABLE 2

QUALIFICATION LEVEL

	DCS		CAGE	
	Cases	%	Cases	%
Student undergoing training	10	25	5	50
Open water certification	7	17.5	2	20
Advanced course student	1	2.5	1	10
Advanced certification	4	10	-	-
Divemaster certification	3	7.5	-	-
Instructor certification	8	20	1	10
Military	1	2.5	-	-
Unknown	6	15	1	10
Total	**40**		**10**	

The divers were assessed for experience. Over 40% of the DCS cases had done less than 20 dives. For the CAGE presentation the figure was 80%. (Table 3).

TABLE 3

DIVERS EXPERIENCE

	DCS		CAGE	
	Cases	%	Cases	%
Student undergoing training	10	25	5	50
Novice diver (<20 dives)	7	17.5	3	30
Occasional diver (eg once a year holiday)	5	12.5	-	-
Regular diver (>10 dive days/year)	3	7.5	-	-
Experienced diver (years of experience)	12	30	2	20
Unkown	3	7.5	-	-
Total 40		**10**		

Table 4 identifies North Queensland, in particular Cairns, Port Douglas and Townsville, as the major sources of referrals.

TABLE 4

GEOGRAPHICAL LOCATION OF INCIDENTS LEADING TO REFERRAL

	DCS		CAGE	
	Cases	%	Cases	%
Townsville	13	32.5	2	20
Cairns	13	32.5	4	40
Airlie Beach	4	10	2	20
Papua New Guinea	4	10	1	10
Brisbane/Gold Coast	3	7.5	-	-
Mossman/Port Douglas	2	5	-	-
Rockhampton	1	2.5	-	-
Fiji	-	-	1	10
Total	**40**		**10**	

In this series over 70% of divers with decompression sickness and 90% of divers presenting as CAGE were aged 30 years or less. This correlates with figures estimating that the majority of people being trained as sports divers in Australia are men aged between 19 and 35 years.[3]

It is of great concern that 27.5% of the divers treated for DCS and 50% of CAGE victims were participating in basic certification courses under the direct supervision of a qualified diving instructor. Most divers reported average depths of no greater than 15 m on any one dive. However, the students often completed nine to ten dives within a three day period. Inexperience is a major predisposing factor with 42.5% of the cases of DCS occurring in divers who had undertaken less than 20 dives. Similarly 80% of the divers referred with CAGE were novices.

Eight full time diving instructors were treated for decompression sickness (Table 2) and in all eight cases the practice of performing multiple ascents whilst engaged in conducting an open water course was identified as a contributing factor to their illness. These figures suggest that the practice of instructors escorting each student during emergency swimming and alternate air source ascents exposes the instructor to an increased risk of dysbaric illness.

Retrievals

The Dräger Duocom was used for 13 retrievals (8 DCS, 5 CAGE) while a further 4 patients were air transported with a sea level cabin pressure (3 DCS, 1 CAGE). Long distance retrievals require detailed planning. Air and oxygen requirements must be calculated accurately, and the relative lack of environmental control within the portable chamber creates difficulties in maintaining the fluid status of both patient and attendant, particularly in tropical climates.

It is this unit's policy not to use the Duocom chamber to transport a critically ill, ventilated patient suffering from CAGE. The confined space within the Duocom, combined with the lack of monitoring and mechanical ventilation capabilities, means the prolonged treatment of such a patient is less than ideal, notwithstanding the need for urgent recompression. Such patients are transported to Townsville in an aircraft capable of achieving and maintaining sea level cabin pressure.

Repetitive diving

Repetitive diving is the major contributing factor to the development of DCS in this group of divers. Table 5 gives the pattern of diving of those diagnosed as having DCS. All divers did at least 2 dives a day and up to 5 a day were recorded. In general the divers were unaware of the risk of multiple exposures to an increased ambient pressure. The Queensland Workplace and Safety Regulations[4] state a diver must not participate in any more than four dives in any 24 hour period, midnight to midnight on the same day. However it is a regular practice for divers to perform four dives within a six hour period, particularly on the final day of an extended trip. This trend for minimal surface intervals should be actively discouraged.

Decompression tables

Table 6 lists the decompression tables used by the individual divers. No inferences can be drawn from these figures as the total number of divers using any table is not

TABLE 5

DIVING PATTERNS
DECOMPRESSION SICKNESS CASES

	Cases	%
Single days diving	12	30
Two day dive trip	13	32.5
Three day dive trip	8	20
Four day dive trip	1	2.5
Seven day dive trip	3	7.5
Extended diving	3	7.5
Total	**40**	

The number of dives per day ranged from 2 to 5.

TABLE 6

TABLES USED
DECOMPRESSION SICKNESS CASES

	Cases	%
PADI recreational dive planner	22	55
Dive computer	5	12.5
PADI wheel	1	2.5
SSI tables	1	2.5
NAUI tables	2	5
USN tables	2	5
None	1	2.5
Unknown	6	15
Total	**40**	

known. PADI certifies the majority of Australian divers and so their tables can be expected to be used by the majority of divers.

The Queensland Workplace Health and Safety Regulations also state all dives performed within Queensland are to be planned as no-stop dives and conducted in accordance with dive tables as specified in the Australian Standard AS 2299.[6] This standard lists the following examples of tables currently acceptable; tables in use by the Royal Australian Navy (RAN), the Royal Navy (RN), the United States Navy (USN) and the Canadian Defence and Civil Institute of Environmental Medicine (DCIEM). Every diver treated for DCS attested his or her dives were within a particular table's limits. But only in 13 cases (32.5%) were the profiles within the limits of the DCIEM tables. Dive profiles were not recorded in the hospital notes, or not logged by the diver, in 6 (15%) of cases.

Other factors

In 20 (50%) of the divers, no contributing factors were identified. Nine divers, 8 of them full time diving instructors, who presented with DCS had done multiple ascents. This was the largest group when a contributing factor was identified. In 6 divers, seasickness or nausea was thought to have contributed, while 3 were obese and 4 had been drinking alcohol. Some of these divers had more than one contributing factor, so there were only 11 divers affected by these three conditions.

Predisposing factors that have been cited in the development of CAGE resulting from pulmonary barotrauma include inadequate exhalation, uncontrolled buoyant ascents and underlying lung pathology (cysts and bullae).[7] None of our patients with a definitive diagnosis of CAGE had any such identifiable risk factor. All had normal chest X-rays. None were asthmatic. All who arrived at the surface unaided had performed controlled ascents. This suggests the occurrence of localised air trapping, as opposed to a generalised overpressure injury, is an important cause of CAGE.

Presenting symptoms

Joint pain and sensory disturbance were the most often described symptoms in divers presenting with DCS. All patients had more than one presenting symptom (Table 7). Generalised fatigue, poor concentration and abnormalities of higher mental functions were frequently seen.

Ten divers were referred with the provisional diagnosis of CAGE. (Table 8). Five (50%) presented with loss of consciousness however 3 were not due to CAGE. One student who was found convulsing and unconscious in the water was later able to inform his rescuers that he was an epileptic, but not before an expensive retrieval and therapeu-

TABLE 7

PRESENTING SYMPTOMS
DECOMPRESSION SICKNESS

	Number	%
Joint pain	30	75
Paraesthesia/anaesthesia	22	55
Fatigue/lethargy	15	37.5
Headache	8	20
Unsteady gait	8	20
Dizzyness.lightheadeness	7	17.5
Weakness	5	12.5
Nausea	3	7.5
Urinary retention	1	2.5
Total presenting symptoms	99	247
Total patients	40	100

All patients had more than one symptom

TABLE 8

MAJOR PRESENTING SYMPTOMS (CAGE)

	Presumptive		Confirmed	
	Cases	%	Cases	%
Loss of comsciousness	5	50	2	20
Weakness	2	20	2	20
Sensory	2	20	1	10
Bilateral visual loss	1	10	1	10
Total	**10**		**6**	

tic recompression had been performed. He had denied epilepsy during his diving medical examination. One novice diver and one resort course student both panicked at depth, losing their air supply. Both were "found" unconscious in the water. The resort course student, having received minimal instruction, had been left alone at depth while the instructor surfaced. This practice cannot be condoned. Another patient, who presented with sensory loss, was a novice diver undergoing a refresher course. She had been certified in another country, despite her history of panic attacks requiring specialist medical attention. She panicked in the water. Her ascent to the surface was slowed by an instructor. Immediately on surfacing she experienced the onset of generalised paraesthesiae and difficulty in walking. Examination was unremarkable. The treatment of this diver was difficult due to her mental state. Her history was inconsistent, her symptoms altering and a trial of recompression was of no benefit. The ultimate diagnosis was not felt to be CAGE. However she was advised she was permanently unfit to dive due to her psychological instability.

Six confirmed cases of CAGE were treated. One occurred in a swimming pool during the first training session.[8] Despite an early recompression a left hemiparesis was the final result. The outcome was similarly poor in an instructor who embolised, was retrieved from the water unconscious and after delayed recompression had evidence of an incomplete spinal cord lesion at the level of T6.

Delay in seeking treatment

In 60% of cases of DCS initial contact with the Hyperbaric Unit was not made for at least 24 hours after the development of symptoms. (Table 9). Most of the divers related their symptoms to anything but an exposure to increased atmospheric pressure. Typically notification of CAGE occurred early, the delay of 60 hours related to an incident in Fiji.

Our time from notification of a problem until recompression (Table 10) is acceptable considering the distances involved. Road transfers from Cairns involve a travel time of between four to five hours. Flying time to Brisbane or Port Moresby is approximately three and a half hours in the Beechcraft Super King Air.

TABLE 9

TIME FROM ONSET OF SYMPTOMS TO NOTIFICATION

Decompression sickness

	Cases	%
Less than 3 hours	5	12.5
3 to 6 hours	7	17.5
6 to 12 hours	3	7.5
12 to 24 hours	9	22.5
24 to 48 hours	2	5
48 to 72 hours	3	7.5
72 to 96 hours	3	7.5
Over 96 hours	7	17.5
Unknown	1	2.5
Total	**40**	**100**

CAGE

	Cases	%
Less than 30 minutes	4	40
30 to 60 minutes	1	10
1 to 2 hours	1	10
Over 8 hours	1	10
Over 24 hours	1	10
Over 60 hours	1	10
Unknown	1	10
Total	**10**	**100**

TABLE 10

TIME FROM NOTIFICATION TO RECOMPRESSION

	DCS		CAGE	
	Cases	%	Cases	%
Less than1 hour	-	-	1	10
1 to 3 hours	13	32.5	1	10
3 to 6 hours	7	17.5	4	40
6 to 9 hours	6	15	-	-
9 to 12 hours	3	7.5	1	10
12 to 24 hours	10	25	1	10
Unknown	1	2.5	-	-
Not recompressed	-	-	2	20
Total	**40**		**10**	

Treatment

Initial treatment in all except one case was an RN Table 62. In 17 cases (34%) this was extended. Two presumptive CAGE cases were not treated and one had an 18 m soak. In recent times we have acquired the necessary

equipment for the delivery of mixed gases (e.g. heliox) which will expand our therapeutic options in the more difficult case.

Thirty nine patients were given between 1 and 10 follow up soaks for residual symptoms. (Table 11). These repeat treatments were continued for as long as definite improvement of symptoms or signs occurred.

Treatment results

TABLE 11

FOLLOW UP OXYGEN SOAKS

	DCS		CAGE	
Soaks	Cases	%	Cases	%
0	512.5	6	60	
1	14	35	1	10
2	7	17.5	2	20
3	5	12.5	-	-
4	3	7.5	-	-
5	2	5	-	
6	1	2.5	-	-
7	3	7.5	-	-
10	-	-	1	10
Total	**40**		**10**	

The majority of our cases (26 DCS and 4 CAGE) were asymptomatic after treatment. Thirteen DCS cases were left with mild impairment after treatment. A 19 year old female with DCS has a severe residual proprioceptive deficit and 4/5 weakness of her right leg. Two CAGE victims with severe residual impairment have been mentioned earlier.

The success of our treatment should be measured in terms of outcome and the presence of residual fixed deficits.

Conclusions

In this review inexperience, repetitive diving and multiple ascents were identified as predisposing factors for decompression illness. In my opinion it is inexcusable to have students developing DCS during their certification course. The instructor agencies have the responsibility of fulling informing their students of the risks of repetitive diving and of stressing that any exposure to increased ambient pressure may produce a dysbaric illness. They should also emphasize that the issue of a certification card does not equate with expertise.

All divers should be fully conversant with the symptoms and signs of the decompression illnesses and be aware of the need to obtain medical advice early. Delays in seeking treatment can result in permanent physical sequelae.

It must be stated that no computer or decompression table is infallible and divers should exercise caution and dive well within the no-stop time limits for any depth. It is also wise to have a rest day in the middle of an extended diving expedition to facilitate the off-gassing of nitrogen from slow tissues.

Fifty cases are insufficient to draw significant conclusions regarding the reliability of decompression schedules or the correct treatment table. However if all Hyperbaric Units in Australia report such information it can be collated and used to further diving safety in this country.

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