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REPORT ON 1987 DIVING ACCIDENTS

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DIVERS ALERT NETWORK

Final Report on 1987 Diving Accidents

December, 1988

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PREFACE

At the inception of DAN in 1980, the charge placed upon the organization was primarily threefold:

1) To provide assistance to injured divers.
2) To collect statistics on diving casualties.
3) To provide information regarding health issues pertaining to scuba diving to the general public and physicians.

To a large extent the first goal has been accomplished. With few difficulties DAN has continued to respond quickly to up to 711 emergency calls per year. In 1987 there were 620 calls pertaining to divers experiencing acute illness as a result of their scuba diving. This service has substantially increased the efficiency of triage of these patients. The collection of statistics has become increasingly successful, particularly through the efforts of the individuals named in Appendices A & B (pp. 81-83), who have taken the time and effort to send in completed dive reports and/or provide the information over the telephone. Clearly DAN's task would be impossible without the interest and cooperation of the various individuals caring for acutely ill patients. It is estimated that the 270 completed case reports received for 1987 represent 48% of the total number of cases treated in the United States and Caribbean last year. In future years the goal will be to increase this proportion. In addition to the description of the cases and the types of information requested on the information line, an attempt has been made to examine some issues in detail. In particular, a discussion of diving accidents associated with decompression computers has been included.

The accident database was developed based on the DAN accident reporting form using a database and statistical analysis program, maintained largely through the efforts of Dr. Jess Bond and Betty Bond. The Disease Severity Code classification scheme noted on page 15 was developed by Dr. Bond.

The close cooperation of all those individuals who contributed case information is gratefully acknowledged. Sincere appreciation goes to Joel Dovenbarger, Dr. Jess Bond, and Betty Bond, who have all worked very hard on the computer database and the compilation of the data.

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Introduction to the 1987 DAN Annual Report

The data in this report largely speaks for itself. Several factors may contribute to diving accidents as supported by the data shown in the tables and graphs. Alcohol use was reported in approximately 50% of the cases. Recreational drug use was reported in 4% of the cases. Ten percent of the divers did not carry a depth gauge and 15% did not use a watch. Thirty-eight decompression incidents in which decompression computers were used were reported to DAN; most of these incidents involved diving to depths greater than 80 fsw, and 11 were to depths greater than 130 fsw.

Despite the most complete set of data on diving accidents received since the inception of DAN, the major weaknesses of data collection still exist. Although the numbers have increased and the character of the diving accidents are described more completely, appreciating the total number of divers at risk remains extremely difficult. This is as true for the dives involving decompression meters as it is for the other types of dives. For example, approximately 58% of the diving accidents were reported from individuals claiming to be within the USN table limits; does this mean that the USN tables are inappropriate for sport scuba divers, or is the risk of DCS acceptable for USN table use? There is no rational way of using these data to compare safety of different tables.

The answers will become more apparent only when we have a better idea of the **NUMBER OF INJURED DIVERS** compared to the **NUMBER OF DIVERS AT RISK** for various categories of ages, dive depths, etc.

In addition to a large number of emergency calls, 2600 calls were received on the non-emergency line in 1987. The most frequent questions were related to the ear and sinus cavities. Approximately 200 questions related to the respiratory system, of which almost half were related to asthma. Many calls raised the suspicion of unrecognized acute DCS, of which a large proportion had at least one serious neurological complaint after diving. This suggests a lack of knowledge among divers of the potential seriousness of neurological symptoms. Almost 2/3 of the callers required referral to a physician. Surprisingly perhaps, only 100 calls originated from physicians, suggesting that DAN may still not yet be sufficiently known amongst the medical community as a source of data on diving related issues.

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GENERAL INFORMATION

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DEFINITIONS

AIR EMBOLISM - A condition caused by unvented pressure due to gas expansion, forcing air from the sacs in the lungs into blood vessels surrounding them.

BLINDED DIAGNOSIS - The method by which a conclusion is reached knowing only the observable criteria and uninfluenced by personal surmise or prejudice. (Medical definition: indicating a symptom or condition perceived as a sign of disease by someone other than the person afflicted.)

BODY MASS INDEX - A widely used method for determining an individual's percent of body fat.

DECOMPRESSION SICKNESS (DCS) - Commonly referred to as the "bends", it is caused by the liberation of gas (mostly nitrogen) from the tissues in bubble form.
TYPE I DCS - Refers to "pain only" without central nervous system involvement.
TYPE II DCS - Refers to the more serious symptoms caused by the involvement of bubbles in the central nervous system.

DISEASE SEVERITY CODES - The coding system used throughout this report which is based on the method of blinded diagnosis. Refer to page 15.

FINAL DIAGNOSIS CODES - The letter codes assigned to disease categories used throughout this report which are based on the method of unblinded diagnosis.

FREQUENCY - The number of times a specified phenomenon occurs within a specified time interval.

FREQUENCY MISSING - The number of times data is not obtainable for the given number within a specified time interval. (In the case of our database, NO information was obtained for the variable being considered.)

MEAN - The mean is computed by summing the individual data points, then dividing this sum by the number of observations in the data set.

STANDARD DEVIATION - A measurement of variance from the mean.

UNBLINDED DIAGNOSIS - The conclusion is reached using the personal influences that the patient may have upon the outcome; the conclusion is reached knowing all the subjective material.

VARIABLE - The characteristic which is being observed.

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FINAL FIGURES FROM 1986 ACCIDENT FORM

The 1986 reported dive accident figures were obtained from the DAN Regional reports. The most complete reports were from the Southwest, Northeast, and Southeast regions. Additional case reports were collected through a telephone chamber survey, and also by a follow-up of emergency and nonemergency DAN calls.

The total represents the combined totals from all stateside hospital-based multiplace chambers and the majority of monoplace facilities nationwide. Reports from the Northwest, Mid-west, and Gulf regions were partial or incomplete; there was no report from the Pacific region.

Efforts were made to insure that only sports diving accidents were reported. Although the reported incidence of diving accidents rose from 462 reported cases in 1985 to 537 cases in 1986, the increase is not likely to be a significant figure; both 1983 and 1984 ended with a higher incidence of dive accidents than those reported from 1985 and 1986. Very few 1986 cases, (only 136), were obtained for analysis.

In all likelihood, the number of divers increased in 1986 due to the increased number of certifications, while the dropout rate remained roughly the same as in previous years. If the turnout at retailing trade shows and public exhibition shows in 1987 and in early 1988 is any indication, sport scuba diving seems to be at the beginning of a tremendous growth period. Certainly, the increased demand by groups around the country for DAN representation and seminars points to a concomitant increase in popularity for DAN.

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1986 DIVE ACCIDENT CASES REPORTED TO DAN

Regions	SW	NW	MW	GU	*PA	NE	SE	Totals
DCS-I		6	2	1			68	77
DCS-II	**69	11	13	8	7	33	133	**274
A-G-E	28	2				10	41	81
No diagnosis							97	97
No treatment, refused treatment, or spontaneous resolution	3					1	4	8
Regional totals	100	19	15	9	7	44	343	537
Reported through DAN	6	10	13	6	7	21	41	104

*Pacific Region (Hawaii) does not report cases through DAN.

**Represents Type I and Type II DCS combined.

Total incidents reported in 1986.....537

Total cases obtained through DAN.....104

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FINAL FIGURES FROM 1987 ACCIDENT FORMS

The Divers Alert Network received 409 case reports in 1987 for analysis. These reports were sent in by treatment facilities from around the U.S. and from the Caribbean. The breakdown of these 409 cases resulted in the following report.

Seventy-six cases were not sports diving Decompression Sickness or Arterial Gas Embolism cases, but presented similar symptoms. These 76 cases also included non-sports diving accidents and a few fatalities, none of which were used in our analysis of sports divers.

There were also 63 case histories that did not contain enough data and were excluded from the final analysis. Three of these were in litigation at the time of follow-up.

The remaining 270 cases contained sufficient information for analysis in a uniform manner. Roughly 80% of all cases studied required telephone follow-up to complete the accident form and to clarify all questionable replies on the form.

Number of Case Reports in Study by Region

Southeast	152	
Northeast	34	
Southwest	33	
Gulf	18	
Mid-west	16	
Northwest	15	
Pacific	2	
	270	Total

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76 EMERGENCY CASES REPORTED TO DAN FROM OTHER FACILITIES

The final diagnoses of these case reports were not decompression sickness or air embolism; however, all required medical evaluation in a local emergency room. They were either suffering from dive-related pulmonary barotrauma or other medical problems, or were non-sports divers or diver deaths.

Deaths — Total 10

Non-Sports Divers Referred for Treatment

Military/government	2
Scientific	1
Professional (independents)	11
Chamber personnel	3
Total	17

Pulmonary Barotrauma — Total 13

All diagnoses were made in the emergency room. All required an obervation period following admission to the hospital.

Other Medical Conditions

	*Recompressed	Not Recompressed	Total
Heart Attack		2	2
Hyperventilation	1	2	3
Carbon monoxide/ contaminated air	**3		3
Pleuritis		2	2
Pinched nerve	1		1
Psychosis	1		1
Seasick/vertigo/flu	3	1	4
Eye/blurred vision	1	1	2
Ear/sinus	1	3	4
Muscle/skeletal	6	5	11
CNS (not DCS/AGE)	1		1
Near drowning		1	1
Munchausen	1		1
		Total	36

* Sixteen patients required hyperbaric therapy before a differential diagnosis could be made.
**Three patients were treated with a carbon monoxide protocol.

NOTE: Two patients were treated prophylactically for missed decompression stops.

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1987 CASES REPORTED BY DAN REGIONAL COORDINATORS

SOUTHWEST REGION

State Location	DCS-I	DCS-II	A-G-E	DCS/A-G-E	Total
California	14	57	19	1	91
Arizona					
Nevada					
Utah	1	1			2
TOTAL	15	58	19	1	93

NORTHWEST REGION

State Location	DCS-I	DCS-II	A-G-E	DCS/A-G-E	Total
Alaska		1		1	2
Washington		*23	3		26
Oregon	4	1			5
Montana					
TOTAL	4	*25	3	1	33

*Includes Type I and II DCS

MIDWEST REGION

State Location	DCS-I	DCS-II	A-G-E	DCS/A-G-E	Total
Wisconsin			2		2
Minnesota	1				1
Michigan	1	5			6
Ohio					
Illinois		7			7
TOTAL	2	12	2		16

GULF COAST REGION

State Location	DCS-I	DCS-II	A-G-E	DCS/A-G-E	Total
Arkansas	1	3	1		5
Colorado		4	1		5
Louisiana	2	5	1	1	9
Mississippi					
Missouri		2			2
New Mexico					
Texas	12	6	2		20
TOTAL	15	20	5	1	41

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1987 CASES REPORTED BY DAN REGIONAL COORDINATORS

NORTHEAST REGION

State Location	DCS-I	DCS-II	A-G-E	DCS/A-G-E	Total
Connecticut	5	1	1		7
Maine	6				6
Maryland	9		1		10
Massachusetts					
New Hampshire		3			3
New York	5	9	1		15
Pennsylvania	3	13	2	1	19
Virginia	2				2
West Virginia					
Washington, D.C.					
TOTAL	30	26	5	1	62

SOUTHEAST REGION

State Location	DCS-I	DCS-II	A-G-E	DCS/A-G-E	Total
Alabama		6			6
Florida	47	101	36		184
Georgia	2	1	1		4
North Carolina		17	2		19
South Carolina	2	4			6
Tennessee	4		1		5
TOTAL	55	129	40		224

CARIBBEAN BASIN

Location	DCS-I	DCS-II	A-G-E	DCS/A-G-E	Total
Puerto Rico		2			2
Provo		8			8
Bahamas		6			6
Barbados		7	3		10
Panama Canal		1			1
Jamaica		5			5
Cayman	1	10	9		20
St. Thomas	2	21	3		26
Trinidad					
Bonaire	2	6			8
Curacao		2			2
Mexico	2	6	5		13
TOTAL	7	74	20		101

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1987 CASES REPORTED BY DAN REGIONAL COORDINATORS

These figures represent the total number of cases reported by the Regional Coordinators for DAN. The totals include all the cases from the stateside and the Caribbean areas, and are placed in categories according to unblinded diagnoses.

	DCS-I	DCS-II	A-G-E	DCS/A-G-E	Total
	128	344	94	4	570
*1 diver treated in 3 chambers		-2			-2
*4 divers treated in 2 chambers	-1	-2	-1		-4
	127	340	93	4	564

FREQUENCY OF DIVE ACCIDENTS BY COUNTRY

DIVE COUNTRY	Frequency	Percent
ANTILLES	1	0.4
BAHAMAS	9	3.5
BARBADOS	7	2.7
BONAIRE	1	0.4
BRIT. VIRGIN IS.	5	2.0
BRIT. WEST INDIES	7	2.7
CANADA	1	0.4
CAYMANS	3	1.2
COZUMEL	1	0.4
GRAND CAYMANS	3	1.2
GRENADA	2	0.8
HONDURAS	3	1.2
JAMAICA	6	2.3
JAPAN	1	0.4
MEXICO	15	5.9
NOT AVAILABLE	1	0.4
PUERTO RICO	1	0.4
TURKS & CAICOS	2	0.8
THAILAND	1	0.4
TOBAGO	1	0.4
USA	182	71.1
US VIRGIN IS.	1	0.4
VIRGIN ISLANDS	1	0.4
WEST INDIES	1	0.4

Frequency Missing = 14

NOTE: This information was obtained from the dive country location on the 1987 DAN questionnaire.

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FREQUENCY OF DIVE ACCIDENTS BY LOCATION

DIVE LOCATION	Frequency	Percent
ALASKA	1	0.5
ALABAMA	4	1.9
*BAHAMAS	1	0.5
*BRITISH COLUMBIA	1	0.5
*BIMINI	2	1.0
CALIFORNIA	17	8.2
*CB(unknown)	1	0.5
*CAYMAN ISLANDS	1	0.5
COLORADO	1	0.5
*COZUMEL	5	2.4
FLORIDA	80	38.6
GEORGIA	1	0.5
*GRAND CAYMANS	6	2.9
HAWAII	4	1.9
ILLINOIS	1	0.5
LOUISIANA	1	0.5
MASSACHUSETTS	2	1.0
MARYLAND	2	1.0
MICHIGAN	1	0.5
MINNESOTA	2	1.0
MISSOURI	6	2.9
*MEXICO	1	0.5
NORTH CAROLINA	11	5.3
NEW HAMPSHIRE	1	0.5
NEW JERSEY	9	4.3
*NS(unknown)	2	1.0
NEW YORK	6	2.9
OREGON	1	0.5
PENNSYLVANIA	1	0.5
RHODE ISLAND	3	1.4
SOUTH CAROLINA	6	2.9
*ST LUCIA	1	0.5
*ST VINCENT	1	0.5
*TOBAGO	1	0.5
TEXAS	5	2.4
UTAH	3	1.4
VIRGINIA	1	0.5
WASHINGTON	12	5.8
WISCONSIN	2	1.0

Frequency Missing = 63

NOTE: The information on this page was obtained from the dive state location on the DAN questionnaire.

* Locations which are not identified as states.

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DIVER PROFILE

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DIAGNOSIS CODING FOR DISEASE SEVERITY
BLINDED DIAGNOSIS

CODE = 0		ASYMPTOMATIC	
CODE = 1	DCS-I	LOCATION	SIDE
PAIN		G,H,I,J,K,L,M,N,U,V,W,X,Y,Z.	ANY
RASH		ANY	ANY
ITCHING		ANY	ANY
CODE = 2	DCS-II	LOCATION	SIDE
PAIN		F,D,Q,R,S,T,4,5.	ANY
NUMB/TINGLE		ANY	L/R
RESTLESS		ANY	ANY
HEADACHE		ANY	ANY
SKIN-SENSATION		ANY	L/R
MUSCLE-TWITCH		ANY	ANY
CODE = 3	DCS-II	LOCATION	SIDE
RINGING EARS		ANY	ANY
DIZZINESS		ANY	ANY
PAIN		O	ANY
FATIGUE		ANY	ANY
REFLEX		ANY	ANY
CODE = 4	DCS-II	LOCATION	SIDE
WEAKNESS		ANY	L/R
NUMB/TINGLE		ANY	BOTH
BREATHING		ANY	ANY
NAS/VOMIT		ANY	ANY
HEARING LOSS		ANY	ANY
SKIN-SENSATION		ANY	BOTH
PERSONALITY		ANY	ANY
WALK/STANDING		ANY	ANY
CODE = 5	DCS-II	LOCATION	SIDE
VISUAL-DIS		ANY	ANY
SPEECH-DIS		ANY	ANY
WEAKNESS		ANY	BOTH
PARALYSIS		ANY	BOTH
BLADDER		ANY	ANY
BOWEL		ANY	ANY
CODE = 6	A-G-E	LOCATION	SIDE
SEMI-CONSCIOUS		ANY	ANY
UNCONSCIOUS		ANY	ANY
PARALYSIS		ANY	L/R
CONVULSIONS		ANY	ANY

*Location of symptom is used in differential diagnosis.

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AGE INTERVALS OF DIVE ACCIDENT VICTIMS

AGE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
10-14	2	0.7	2	0.7
15-19	11	4.1	13	4.8
20-24	28	10.4	41	15.2
25-29	52	19.3	93	34.4
30-34	63	23.3	156	57.8
35-39	60	22.2	216	80.0
40-44	32	11.9	248	91.9
45-49	11	4.1	259	95.9
50-54	3	1.1	262	97.0
55-59	3	1.1	265	98.1
60-64	5	1.9	270	100.0

SEX OF DIVE ACCIDENT VICTIMS

SEX	Frequency	Percent	Cumulative Frequency	Cumulative Percent
F	65	24.1	65	24.1
M	205	75.9	270	100.0

DISEASE SEVERITY CODE CONVERSION TO DISEASE DIAGNOSIS

SEVERITY CODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0 = ASYMPTOMATIC	1	0.4	1	0.4
1 = DCS-I	31	11.5	32	11.9
2-5 = DCS-II	204	75.6	236	87.4
6 = A-G-E	34	12.6	270	100.0

DIAGNOSIS CODE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
A = DCS-I	47	17.4	47	17.4
B = DCS-II	171	63.3	218	80.7
C = A-G-E	52	19.3	270	100.0

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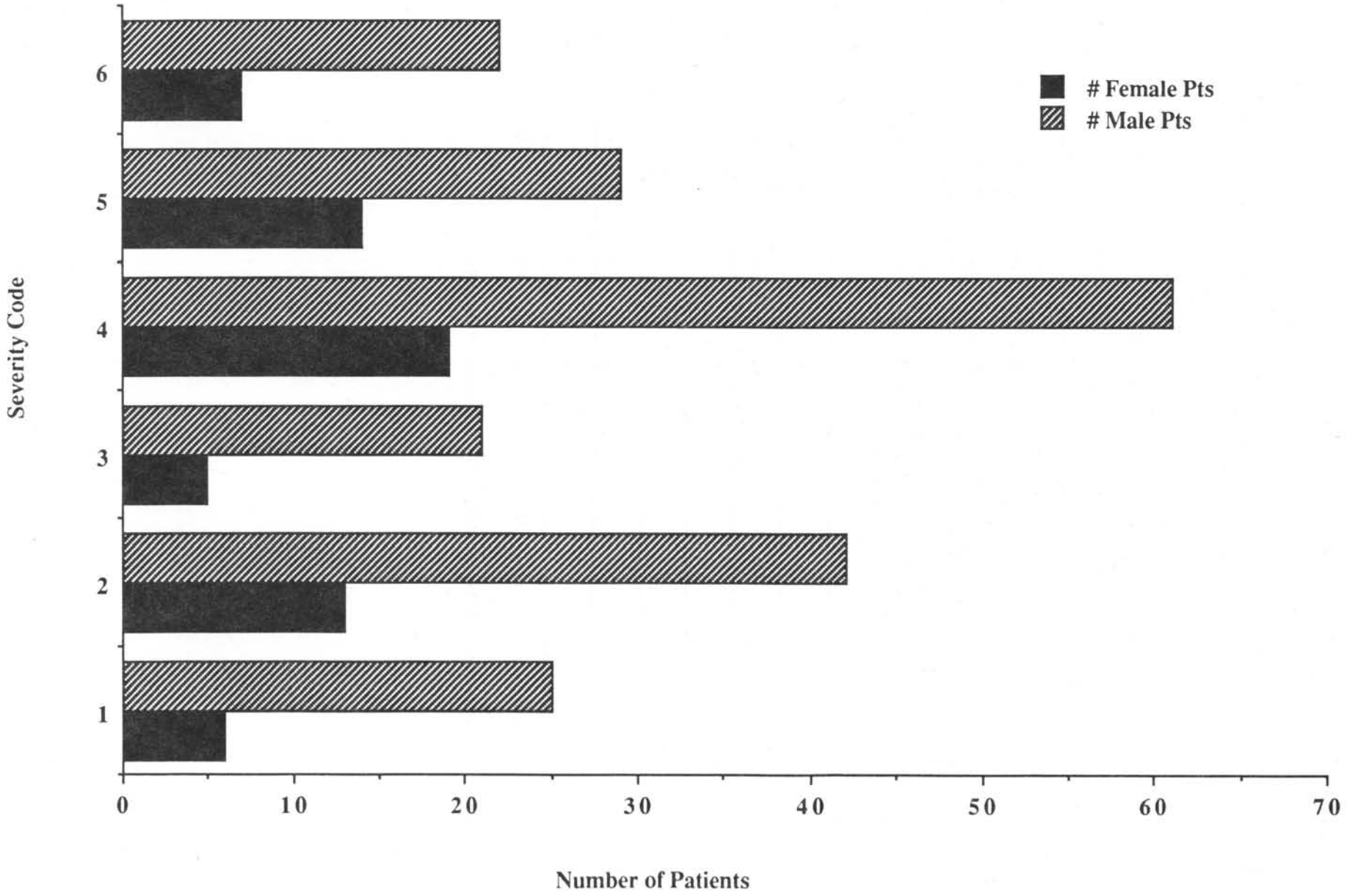
SEVERITY CODE VS. OCCURRENCE



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DIVER AGE AND SEX VS. DIVE ACCIDENT TYPE

TABLE 1 OF AGE BY SEVERITY CODE*
CONTROLLING FOR SEX=FEMALE

AGE	DISEASE SEVERITY CODE				
Frequency	(0) NO-SYMP	(1) DCS-I	(2-5) DCS-II	(6) A-G-E	Total
10-14					0
15-19					0
20-24			6		6
25-29		5	8	2	15
30-34			16	1	17
35-39			14	4	18
40-44		1	4	1	6
45-49					0
50-54			1		1
55-59			1		1
60-64			1		1
Total	0	6	51	8	65

*Refer to page 15 for Severity Code classification scheme.

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DIVER AGE AND SEX VS. DIVE ACCIDENT TYPE

TABLE 2 OF AGE BY SEVERITY CODE*
CONTROLLING FOR SEX=MALE

AGE	DISEASE SEVERITY CODE				
Frequency	(0) NO-SYMP	(1) DCS-I	(2-5) DCS-II	(6) A-G-E	Total
10-14			2		2
15-19		1	8	2	11
20-24		3	17	2	22
25-29	1	8	24	4	37
30-34		4	35	7	46
35-39		3	34	5	42
40-44		2	21	3	26
45-49		2	6	3	11
50-54		1	1		2
55-59			2		2
60-64		1	3		4
Total	1	25	153	26	205

*Refer to page 15 for Severity Code classification scheme.

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DIAGNOSIS VS. AGE RANGE OF DIVE ACCIDENT VICTIM

TABLE OF AGE BY SEVERITY CODE*

AGE / Frequency / Percent	(0) NO-SYMP	(1) DCS-I	(2-5) DCS-II	(6) A-G-E	Total
10-14			2 0.74		2 0.74
15-19		1 0.37	8 2.96	2 0.74	11 4.07
20-24		3 1.11	23 8.52	2 0.74	28 10.37
25-29	1 0.37	13 4.81	32 11.85	6 2.22	52 19.26
30-34		4 1.48	51 18.89	8 2.96	63 23.33
35-39		3 1.11	48 17.78	9 3.33	60 22.22
40-44		3 1.11	25 9.26	4 1.48	32 11.85
45-49		2 0.74	6 2.22	3 1.11	11 4.07
50-54		1 0.37	2 0.74		3 1.11
55-59			3 1.11		3 1.11
60-64		1 0.37	4 1.48		5 1.85
Total	1 0.37	31 11.48	204 75.56	34 12.59	270 100.00

*Refer to page 15 for Severity Code classification scheme.

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AVERAGE BODY MASS INDEX BY SEVERITY CODE* AND SEX

Analysis variable: Body Mass Index = Weight(kg)/Height(m)^2
F = Female M = Male

DXCODE	SEX	N Obs	Minimum	Maximum	Mean	Standard Dev
0	M	1	23.05	23.05	23.05	.
1	F	6	16.76	29.05	21.93	4.25
	M	25	0.00	40.71	23.91	6.38
2	F	13	19.13	31.32	21.51	3.25
	M	43	19.79	43.11	25.79	4.56
3	F	5	21.94	26.36	24.41	1.83
	M	21	19.57	44.92	25.82	5.06
4	F	19	19.37	29.62	23.09	2.94
	M	62	18.58	34.95	24.99	3.74
5	F	14	18.56	25.82	21.92	2.26
	M	27	20.52	30.13	23.98	2.78
6	F	8	17.43	22.31	20.41	1.63
	M	26	0.00	35.56	24.00	6.25

MEDICAL CLASSIFICATION OF OBESITY USING BODY MASS INDEX

DEFINITION	EXCESS WEIGHT(in lbs.)		BMI	
	Men	Women	Men	Women
Super morbid obesity	175	155	>50	>50
Morbid obesity	145	130	45	45
Super obesity	110	100	40	40
Medically significant obesity	80	75	35	35
Obesity	50	50	30	30
Overweight	15	25	25	25
Desirable weight	**0**	**0**	**22**	**21**
Medically significant starvation	-15	-20	15	15

NOTE: The Body Mass Index was developed by the Nutrition/Metabolism Laboratory, Cancer Research Institute, Boston, Massachusetts. See definition on page 3.

*Refer to page 15 for Severity Code classification scheme.

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DIVING EXPERIENCE BY SEVERITY CODE*
(Analysis variable : Average Dives Per Year)

DXCODE	N Obs	N	Minimum	Maximum	Mean
0	1	1	5.00	5.00	5.00
1	31	31	0.00	150.00	41.13
2	56	56	0.00	425.00	50.59
3	26	26	0.00	200.00	39.42
4	81	81	0.00	500.00	43.58
5	41	41	0.00	650.00	76.00
6	34	34	0.00	150.00	23.18

DXCODE	N Obs	Std Dev
0	1	.
1	31	36.60
2	56	73.82
3	26	49.78
4	81	69.28
5	41	125.11
6	34	38.34

*Refer to page 15 for Severity Code classification scheme.

CERTIFICATION LEVELS

	Basic	Open Water	Advanced	Dive Master	Instructor
MALES	28	75	43	10	25
FEMALES	14	22	17	5	5

	Other	None	Unknown
MALES	3	11	10
FEMALES	0	0	2

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DIVING EXPERIENCE BY DISEASE SEVERITY CODE* AND SEX

Analysis variable : Average Dives Per Year
M = Male F = Female

DXCODE	SEX	N Obs	N	Minimum	Maximum
0	M	1	1	5.00	5.00
1	F	6	6	0.00	50.00
	M	25	25	0.00	150.00
2	F	13	13	0.00	425.00
	M	43	43	0.00	200.00
3	F	5	5	0.00	50.00
	M	21	21	0.00	200.00
4	F	19	19	0.00	125.00
	M	62	62	0.00	500.00
5	F	14	14	0.00	300.00
	M	27	27	0.00	650.00
6	F	8	8	0.00	40.00
	M	26	26	0.00	150.00

DXCODE	SEX	N Obs	Mean	Std Dev
0	M	1	5.00	.
1	F	6	18.50	20.44
	M	25	46.56	37.79
2	F	13	61.38	113.86
	M	43	47.33	58.19
3	F	5	22.20	21.78
	M	21	43.52	53.96
4	F	19	33.16	32.48
	M	62	46.77	77.07
5	F	14	47.57	79.05
	M	27	90.74	142.46
6	F	8	11.50	13.69
	M	26	26.77	42.78

*Refer to page 15 for Severity Code classification scheme.

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NUMBER OF YEARS DIVING VS. AVERAGE DIVES PER YEAR BY SEX

TABLE 1 OF YEARS DIVING BY DIVES PER YEAR
CONTROLLING FOR SEX=FEMALE

YRS DIVING Frequency Percent	AVERAGE # DIVES PER YEAR 0-1 DIVES	2-10 DIVES	11-20 DIVES	21-30 DIVES	Total
< 1 YR	16 24.62	1 1.54	1 1.54	1 1.54	22 33.85
1 YR		1 1.54	2 3.08	1 1.54	7 10.77
2-4 YR		3 4.62	4 6.15	2 3.08	14 21.54
5-9 YR		1 1.54	4 6.15	2 3.08	14 21.54
10-14 YR	1 1.54		1 1.54		5 7.69
15-19 YR					3 4.62
20-29 YR					0 0.00
>= 30 YR					0 0.00
Total	17 26.15	6 9.23	12 18.46	6 9.23	65 100.00

(Continued)

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NUMBER OF YEARS DIVING VS. AVERAGE DIVES PER YEAR BY SEX

TABLE 1 OF YEARS DIVING BY DIVES PER YEAR
CONTROLLING FOR SEX=FEMALE

YRS DIVING Frequency Percent	AVERAGE # DIVES PER YEAR 31-45 DIVES	46-60 DIVES	61-100 DIVES	>100 DIVES	Total
< 1 YR	1 1.54	2 3.08			22 33.85
1 YR	1 1.54	1 1.54	1 1.54		7 10.77
2-4 YR	1 1.54	4 6.15			14 21.54
5-9 YR	2 3.08	1 1.54	2 3.08	2 3.08	14 21.54
10-14 YR	2 3.08		1 1.54		5 7.69
15-19 YR		1 1.54	1 1.54	1 1.54	3 4.62
20-29 YR					0 0.00
>= 30 YR					0 0.00
Total	7 10.77	9 13.85	5 7.69	3 4.62	65 100.00

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NUMBER OF YEARS DIVING VS. AVERAGE DIVES PER YEAR BY SEX

TABLE 2 OF YEARS DIVING BY DIVES PER YEAR
CONTROLLING FOR SEX=MALE

YRS DIVING Frequency Percent	AVERAGE # DIVES PER YEAR 0-1 DIVES	2-10 DIVES	11-20 DIVES	21-30 DIVES	Total
< 1 YR	29 14.15	3 1.46	1 0.49		35 17.07
1 YR	3 1.46	4 1.95	2 0.98	6 2.93	21 10.24
2-4 YR	2 0.98	9 4.39	12 5.85	8 3.90	46 22.44
5-9 YR		6 2.93	4 1.95	11 5.37	31 15.12
10-14 YR	3 1.46	5 2.44	1 0.49	2 0.98	28 13.66
15-19 YR	2 0.98	2 0.98		6 2.93	22 10.73
20-29 YR	2 0.98	2 0.98	1 0.49	1 0.49	18 8.78
>= 30 YR			1 0.49		4 1.95
Total	41 20.00	31 15.12	22 10.73	34 16.59	205 100.00

(Continued)

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NUMBER OF YEARS DIVING VS. AVERAGE DIVES PER YEAR BY SEX

TABLE 2 OF YEARS DIVING BY DIVES PER YEAR
CONTROLLING FOR SEX=MALE

YRS DIVING Frequency Percent	AVERAGE # DIVES PER YEAR 31-45 DIVES	46-60 DIVES	61-100 DIVES	>100 DIVES	Total
< 1 YR		2 0.98			35 17.07
1 YR	2 0.98	1 0.49	2 0.98	1 0.49	21 10.24
2-4 YR	4 1.95	2 0.98	4 1.95	5 2.44	46 22.44
5-9 YR		4 1.95	3 1.46	3 1.46	31 15.12
10-14 YR		5 2.44	6 2.93	6 2.93	28 13.66
15-19 YR	1 0.49	3 1.46	5 2.44	3 1.46	22 10.73
20-29 YR	2 0.98	2 0.98	2 0.98	6 2.93	18 8.78
>= 30 YR	1 0.49	1 0.49		1 0.49	4 1.95
Total	10 4.88	20 9.76	22 10.73	25 12.20	205 100.00

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RECENT HEALTH PROFILE VS. DISEASE SEVERITY CODE*

TABLE OF HEALTH BY DISEASE SEVERITY CODE

HEALTH / DIAGNOSIS Frequency	(1) DCS-I	(2-5) DSC-II	(6) A-G-E	Total
BLOOD PRESSURE		4	1	5
HEART		1	1	2
LUNGS		3		3
ASTHMA		6		6
DIABETES		1		1
EAR/SINUS	2	10		12
EYE		2	1	3
CIRCULATION		3		3
GASTRO/ABDOMINAL	1	7	1	9
MUSCLE/SKELETON		3		3
LIMB/JOINT/DCS		6		6
SKIN		1	1	2
ALLERGIES	2	14	2	18
SPINE/BACK		8	1	9
MENTAL/EMOTIONAL		4		4
OTHER		16	3	19
NONE	26	125	23	174
Total	31	214	34	279

*Refer to page 15 for Severity Code classification scheme.

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RECENT ILLNESS PROFILE VS. DISEASE SEVERITY CODE*

TABLE OF ILLNESS BY DISEASE SEVERITY CODE

ILLNESS DIAGNOSIS

Frequency	(1) DCS-I	(2-5) DSC-II	(6) A-G-E	Total
CHEST/LUNG	2	9	4	15
ASTHMA		8	2	10
CHEST/HEART		4	1	5
GASTRO/ABDOMINAL	2	22	4	28
BRAIN	1	1		2
SPINE/BACK	4	16		20
LIMB/JOINT/DCS	2	12	1	15
CIRCULATION		6	1	7
NEUROLOGIC/CNS		10		10
MUSCLE/SKELETON	6	28	5	39
EYE	1	3		4
MENTAL/EMOTIONAL		4		4
OTHER	2	24	5	31
NONE	15	97	19	131
Total	35	244	42	321

*Refer to page 15 for Severity Code classification scheme.

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FITNESS TO DIVE

Upon review of the past and recent medical histories of the 1987 injured divers we find that there were some who should not have been diving. This may be a controversial point to many as some dive restrictions are based on the known physiology of an illness and a theorized possible result while using scuba. This continues to be a "gray area" for sports diving, but many medical professionals are at work researching this subject.

There are some medical conditions which increase the risk of decompression sickness and others which are extremely hazardous to divers. Among the medical problems considered hazardous are diseases of body systems. These conditions are contraindicated in sport scuba diving. Some examples of systemic illnesses which disqualify one from diving are seizures, asthma, joint disease (rheumatoid arthritis), diabetes, chronic phlebitis, multiple sclerosis, degenerative bone disease, and labile hypertension. Other contraindications include alcoholism and drug dependence. Some physician-prescribed medications may also prohibit diving. Additionally, previous nervous tissue damage and existing numbness (including prior incidents of DCS) may make diagnosis difficult and lead to further nerve damage.

While there are many disqualifying illnesses, some medical conditions are only temporarily contraindicated. These conditions present problems in the normal exchange of gas in the lungs (colds), exchange of nitrogen in tissue and joints (recent surgery or trauma), and the ability of air spaces to equalize to ambient

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pressure (sinusitis, hayfever, and middle ear infection). Any illness producing these conditions may alter the body's ability to interact in the underwater environment. Common temporary disqualifications include recent bone fractures, active infections, inguinal hernias (until repaired), recent surgery, dental caries, and acute illnesses. The most ignored contraindication is the common cold, mainly because cold remedies and decongestants temporarily reduce symptoms and make it easy to dive. The largest single group of dive related medical complaints involves the ears and sinuses, usually from diving during or just after the onset of cold or allergy symptoms. However, nasal polyps, a prior broken nose, and a history of chronic ear infections, all of which require medical attention, may also produce complications in divers. As most over-the-counter medicines treat only the symptoms of an illness, the underlying problem, inflamed mucus membrane or swollen eustachian tube, may remain unchanged even with medication. A great deal of sinus and middle ear barotrauma could be avoided if a more cautious approach were taken toward diving even with a stuffy nose.

If a diver is experiencing symptoms of an illness, the safest thing to do is to wait the illness out before diving again.

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TREATMENT

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DIAGNOSTIC DATA

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DIAGNOSIS AND TREATMENT FOR DCS AND A-G-E

The individual response to hyperbaric therapy is dependent upon several factors. The two most significant influences on diver recovery are the severity of symptoms, and the delay to receiving adequate treatment. Additional concerns are the immediate delivery of oxygen and first aid at the scene.

Only 93 cases out of 255 (36%) received oxygen as a first aid or EMS measure. Oxygen and positioning can clear many symptoms prior to arrival at the hospital. Paralysis, pain, tingling and other major neurological symptoms may be completely resolved by the rapid administration of oxygen and/or the left side lying position (Trendelenberg). Recompression is still recommended as symptoms may return.

The diver who reports himself early while the symptoms are still strong is able to define the symptoms better and presents a situation allowing a more definitive diagnosis by the examining M.D. It also offers the best baseline of symptoms by which to gauge improvement.

Complicating diagnosis and treatment is the general lack of knowledge about the signs and symptoms of decompression sickness and air embolism by the diver and the emergency medical system. This is further complicated by the fact that symptoms are frequently subjective or considerably less severe when a diver reaches the emergency room. Decreased skin sensations, abnormal reflexes, and loss of function, such as paralysis, vision disturbance, or loss of bowel or bladder function may be the only objective evidence that an examining physician may find. The physician must rely on his previous experience or a consultation with a diving physician such as that provided by DAN.

It appears that there is a correlation between the time a diver calls for assistance, his time of recompression, and the final outcome he can expect.

RELIEF BEFORE RECOMPRESSION*

	DCS-I	DCS-II	A-G-E	TOTAL	% of TOTAL
Complete	2	21	6	29	10.7
Partial	7	58	12	77	28.5
Temporary	1	8	1	10	3.7
No Relief	19	108	15	142	52.6
Asymptomatic				1	.4
Frequency missing	2	9	0	11	4.1
TOTAL	31	204	34	270	100.0

*The severity code was used for data given. Refer to page 15 for Severity Code classification scheme.

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DISEASE SEVERITY CODE* VS. FINAL DIAGNOSIS CODE
(BLINDED VS. UNBLINDED DIAGNOSIS)

Frequency / Percent / Row Pct / Col Pct	FINAL DIAGNOSIS CODES DCS-I (A)	DCS-II (B)	A-G-E (C)	Total
DISEASE SEVERITY CODES 0		1 0.37 100.00 0.58		1 0.37
1	24 8.89 77.42 51.06	7 2.59 22.58 4.09		31 11.48
2	10 3.70 17.86 21.28	44 16.30 78.57 25.73	2 0.74 3.57 3.85	56 20.74
3	7 2.59 26.92 14.89	18 6.67 69.23 10.53	1 0.37 3.85 1.92	26 9.63
4	6 2.22 7.41 12.77	65 24.07 80.25 38.01	10 3.70 12.35 19.23	81 30.00
5		31 11.48 75.61 18.13	10 3.70 24.39 19.23	41 15.19
6		5 1.85 14.71 2.92	29 10.74 85.29 55.77	34 12.59
Total	47 17.41	171 63.33	52 19.26	270 100.00

*Refer to page 15 for Severity Code classification scheme.

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DISEASE SEVERITY VS. DELAY TO CALLING FOR ASSISTANCE

DXCODE / Frequency / Percent	DELAY TO CALL (in hours) 0-12	13-24	25-36	37-48	Total
NO-SYMP (0)				1 0.37	1 0.37
DCS-I (1)	13 4.81	9 3.33		4 1.48	31 11.48
DCS-II (2-5)	86 31.85	35 12.96	20 7.41	19 7.04	204 75.56
A-G-E (6)	29 10.74	2 0.74	1 0.37	1 0.37	34 12.59
Total	128 47.41	46 17.04	21 7.78	25 9.26	270 100.00

(Continued)

DXCODE / Frequency / Percent	DELAY TO CALL (in hours) 49-60	61-72	85-96	97 >	Total
NO-SYMP (0)					1 0.37
DCS-I (1)		2 0.74		3 1.11	31 11.48
DCS-II (2-5)	3 1.11	17 6.30	6 2.22	18 6.67	204 75.56
A-G-E (6)				1 0.37	34 12.59
Total	3 1.11	19 7.04	6 2.22	22 8.15	270 100.00

AVERAGE HOURS AND DAYS DELAY TO CALL FOR ASSISTANCE

	(1) DCS-I	(2-5) DCS-II	(6) A-G-E
HOURS	15	15	4
DAYS	2	1	0

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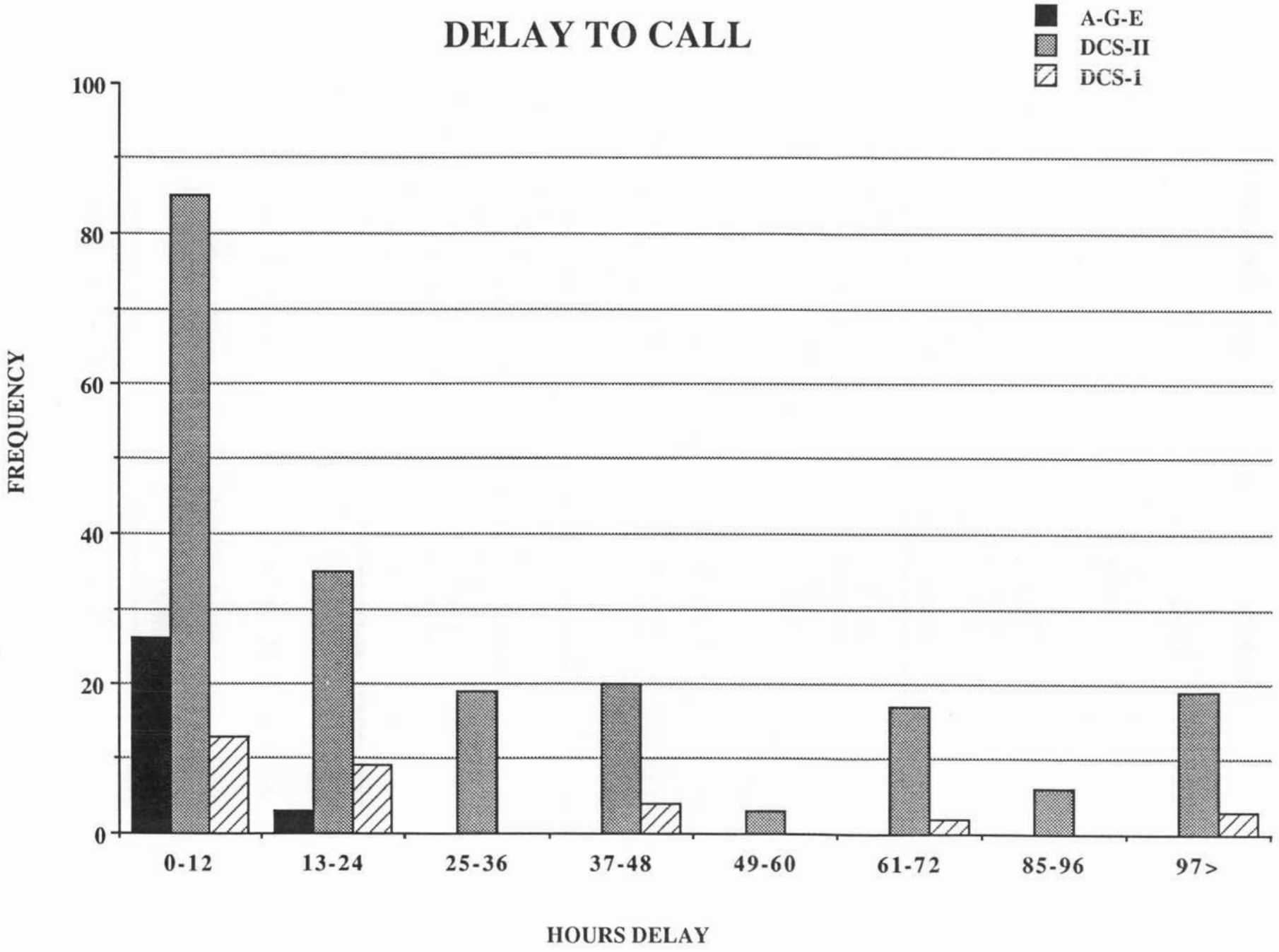

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RECOMPRESSION

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DISEASE SEVERITY VS. DELAY TO RECOMPRESSION

DXCODE / Frequency / Percent	DELAY TO RECOMPRESSION (in hours) 0-12	13-24	25-36	37-48	49-60	Total
NO-SYMP (0)				1 0.37		1 0.37
DCS-I (1)	8 2.96	10 3.70	3 1.11	1 0.37	1 0.37	31 11.48
DCS-II (2-5)	79 29.26	28 10.37	25 9.26	21 7.78	8 2.96	204 75.56
A-G-E (6)	29 10.74	3 1.11		2 0.74		34 12.59
Total	116 42.96	41 15.19	28 10.37	25 9.26	9 3.33	270 100.00

(Continued)

DXCODE / Frequency / Percent	DELAY TO RECOMPRESSION (in hours) 61-72	73-84	85-96	97 >	Total
NO-SYMP (0)					1 0.37
DCS-I (1)	3 1.11			5 1.85	31 11.48
DCS-II (2-5)	11 4.07	4 1.48	9 3.33	19 7.04	204 75.56
A-G-E (6)					34 12.59
Total	14 5.19	4 1.48	9 3.33	24 8.89	270 100.00

AVERAGE DELAY IN HOURS AND DAYS TO RECOMPRESSION

	(1) DCS-I	(2-5) DCS-II	(6) A-G-E
HOURS	18	17	7
DAYS	2	2	0

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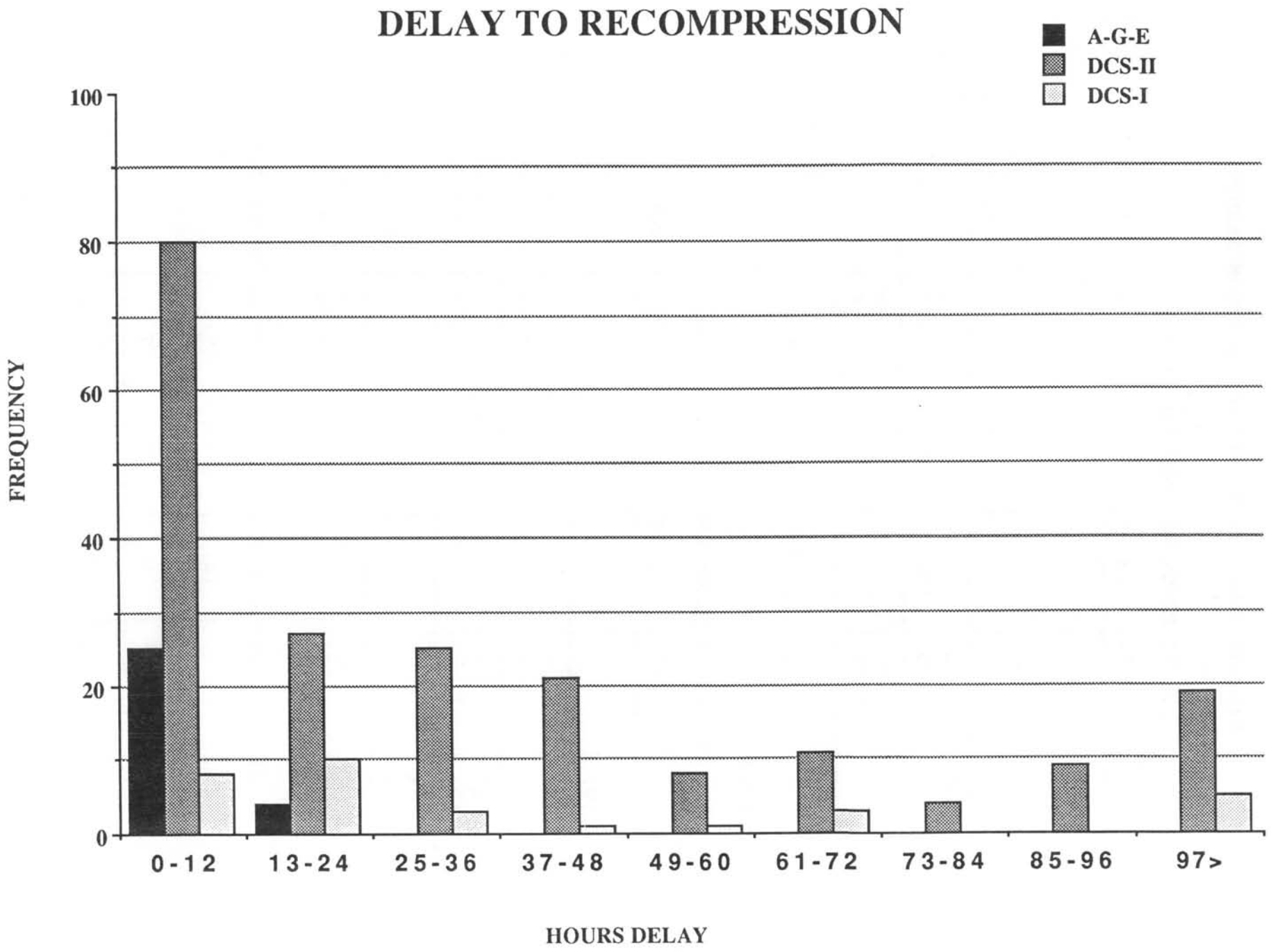

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TREATMENT FACILITY

	DCS-I	DCS-II	A-G-E
Monoplace	10	56	10
Multiplace	22	133	26
No Chamber Treatment	0	0	22
Mono & Multi Treatment	1	5	4

INITIAL TREATMENT TABLE USE

INITIAL TABLE	Frequency	Percent
USN Table 5	26	10.7
USN Table 6	119	49.0
USN Table 6A	37	15.2
USN Table 7A	3	1.2
45 fsw 90 min	7	2.9
33 fsw 120 min	5	2.1
Other	46	18.9

Frequency Missing = 27

There were 37 individuals in the DAN database who received a USN Table 6A, which is the standard treatment for air embolism. Diagnosis is generally made on the basis of the more severe symptoms and the time of onset. Only 11 of these 37 cases (29.7%) had immediate resolution after their first treatment. Only 21 cases (56.7%) had complete relief of symptoms post therapy.

RESIDUAL SYMPTOMS

RESIDUAL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
PAIN	39	15.7	39	15.7
NEUROLOGICAL	70	28.2	109	44.0
NONE	139	56.0	248	100.0

Frequency Missing = 22

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DELAY TO TREATMENT OF 10 DAYS OR GREATER

Diagnosis	Symptom Onset (in hours)	# of Days Delay to Treatment	# of Times Treated	Chamber Type	Residual Symptoms
DCS-II	1:00	11	18	Multi	None
DCS-I	1:00	11	18	Multi	None*
DCS-II	8:00	30	27	Multi	None
DCS-I	:01	10	1	Multi	None
DCS-II	24:00	14	1	Mono	Pain - 2 months
DCS-II	:05	42	4	Multi	Pain - weather
DCS-I	6:00	35	1	Multi	Pain - 2 months
DCS-II	1:00	21	1	Multi	None

*Aseptic Bone Necrosis

SPONTANEOUS RESOLUTION OR FIRST AID ONLY CASES

Diagnosis	No. of Cases	Symptom Onset (in hours)	Type of Therapy: First Aid	Oxygen	Positioning
DCS-I	1	:07	1	--	--
DCS-II	14	:00 - 26:00	5	4	2
A-G-E	7	:01 - :15	3	2	2
TOTAL	22		9	6	4

DCS-I: The only first aid administered was aspirin.

DCS-II: All of the cases treated with O_2 cleared the same day of treatment. One case recovered in less than 2 days with aspirin use. Three cases cleared without treatment.

A-G-E: One case treated with O_2 cleared the same day; the other O_2 case cleared 3-4 days after treated. Three cases cleared in less than 2 days without any therapy.

NOTE: Although decompression sickness and even gas embolism symptoms can clear without recompression therapy, it is strongly recommended that divers who have had any symptoms be treated. Long-term studies have not been done on injured sports divers, but secondary complications have occurred such as aseptic bone necrosis, arthritis-like syndromes, and short-term memory losses.

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ADJUVANT THERAPY

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PRE-HOSPITAL THERAPIES

RECEIVED OXYGEN (36.0%)	RECEIVED ORAL FLUIDS (17.2%)
96 out of 267	46 out of 267
RECEIVED ASPIRIN (26.6%)	RECEIVED TRENDELENBURG (22.5%)
71 out of 267	60 out of 267

HOSPITAL ADJUVANT THERAPIES

RECEIVED ORAL FLUIDS (37.1%)	RECEIVED ANTICOAGULANT (03.0%)
99 out of 267	8 out of 267
RECEIVED IV FLUIDS (31.8%)	RECEIVED ASPIRIN (23.6%)
85 out of 267	63 out of 267
RECEIVED OXYGEN (41.6%)	RECEIVED OTHER MEDS (16.9%)
111 out of 267	45 out of 267
RECEIVED STEROIDS (14.6%)	RECEIVED NO MEDICATION (27.3%)
39 out of 267	73 out of 267

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RISK

FACTORS

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RISK FACTORS IN DIVING ACCIDENTS

The most commonly mentioned risk factors in diving injuries were looked at to determine their frequency and establish a trend, if any. The dive accident form listed each dive condition and each positive response was counted. The numbered columns represent the number of times any two factors occurred together. The column to the far left represents the number of occurrences of a factor within the given diagnosis. The final unblinded diagnoses from the treatment facilities were used for this analysis as opposed to the severity codes 1 - 6. This increased the number of occurrences for Air Embolism and Type I DCS in comparison to the number from the severity code system, but it represents the realistic occurrence of these factors associated with what the treating physicians would have been told by the diver. It did not affect any treatment decisions.

It is difficult to place the blame for most dive accidents on any single dive condition. Indeed, a dive condition rarely appears by itself. The exception might be pulmonary barotrauma from rapid ascent, although a buoyancy problem often accompanies this condition. The frequency at which these factors occur together was looked at for all 1987 case reports.

The most common dive conditions are listed in order of numerical significance. All conditions listed were present at the time the diving took place. Those that were prior to the dive, such as a diver with a past history of smoking, were not considered relevant to the data.

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Some of the conditions required a simple "Yes" or "No" response. Of these, only the positive responses were counted. These conditions are "Rapid Ascent", "Fatigue"(or lack of sleep prior to diving), "Exertion"(during the dive), "Buoyancy Problem", "Equipment Problem", and "Previous DCS"(no previous A-G-E cases were reported).

"Low Air" and "Out of Air" were combined into one category because both conditions influence a diver's decision on how fast and when to ascend, therefore representing one factor for a potential diving injury.

A moderate to strong current was considered a factor because of the additional exertion required. However, in only half of the cases of DCS with "Current" as a factor does the factor "Exertion" also appear.

The choices given for the category "Temperature Perception" were comfortable, hot, and cold. Since cold is the only noted factor for DCS or A-G-E in this category, it was the only response considered significant.

Alcohol was considered a factor for two reasons: its dehydrating effects on the cardiovascular system, and its possible alteration of a diver's mental and physical performance with consumption during the dive day. One or both of these effects might contribute to a diving injury. Only divers drinking during their dive day or having more than two drinks the night before were considered.

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ANALYSIS OF RISK FACTORS BY UNBLINDED DIAGNOSIS

CONDITIONS OF THE 52 A-G-E CASES REPORTED

# of Cases	Condition	Ascent	Fatigue	Current	Outside Tables
24	Rapid ascent	--	9	8	8
18	Fatigue	9	--	8	4
16	Current	8	8	--	4
14	Buoyancy problem	11	4	3	2
11	Exertion on dive	7	4	7	3
11	Low/No air	7	2	4	6
10	Cold	6	4	4	1
8	Alcohol	5	6	4	6
8	Equipment problem	5	2	2	1
7	Smoker	5	5	3	4
2	Previous DCS	1	1	1	2

CONDITIONS OF THE 47 TYPE I DCS CASES REPORTED

# of Cases	Condition	Current	Exertion	Fatigue	Outside Tables
22	Current	--	12	6	8
20	Exertion on dive	12	--	11	11
18	Fatigue	6	11	--	10
11	Cold	6	7	6	2
11	Alcohol	8	5	4	3
9	Rapid ascent	6	5	4	6
8	Equipment problem	5	2	4	3
7	Previous DCS	4	4	2	3
6	Smoker	2	3	2	3
6	Buoyancy problem	3	3	4	3
4	Low/No air	2	3	4	2

CONDITIONS OF THE 171 TYPE II DCS CASES REPORTED

# of Cases	Condition	Current	Fatigue	Exertion	Outside Tables
73	Current	--	28	37	31
64	Fatigue	28	--	31	26
58	Exertion on dive	37	31	--	26
42	Rapid ascent	17	18	20	16
31	Cold	17	18	22	9
31	Equipment problem	18	12	11	13
29	Alcohol	13	15	10	8
26	Previous DCS	9	9	11	11
31	Smoker	11	13	9	9
22	Buoyancy problem	11	11	9	8
16	Low/No air	9	8	11	9

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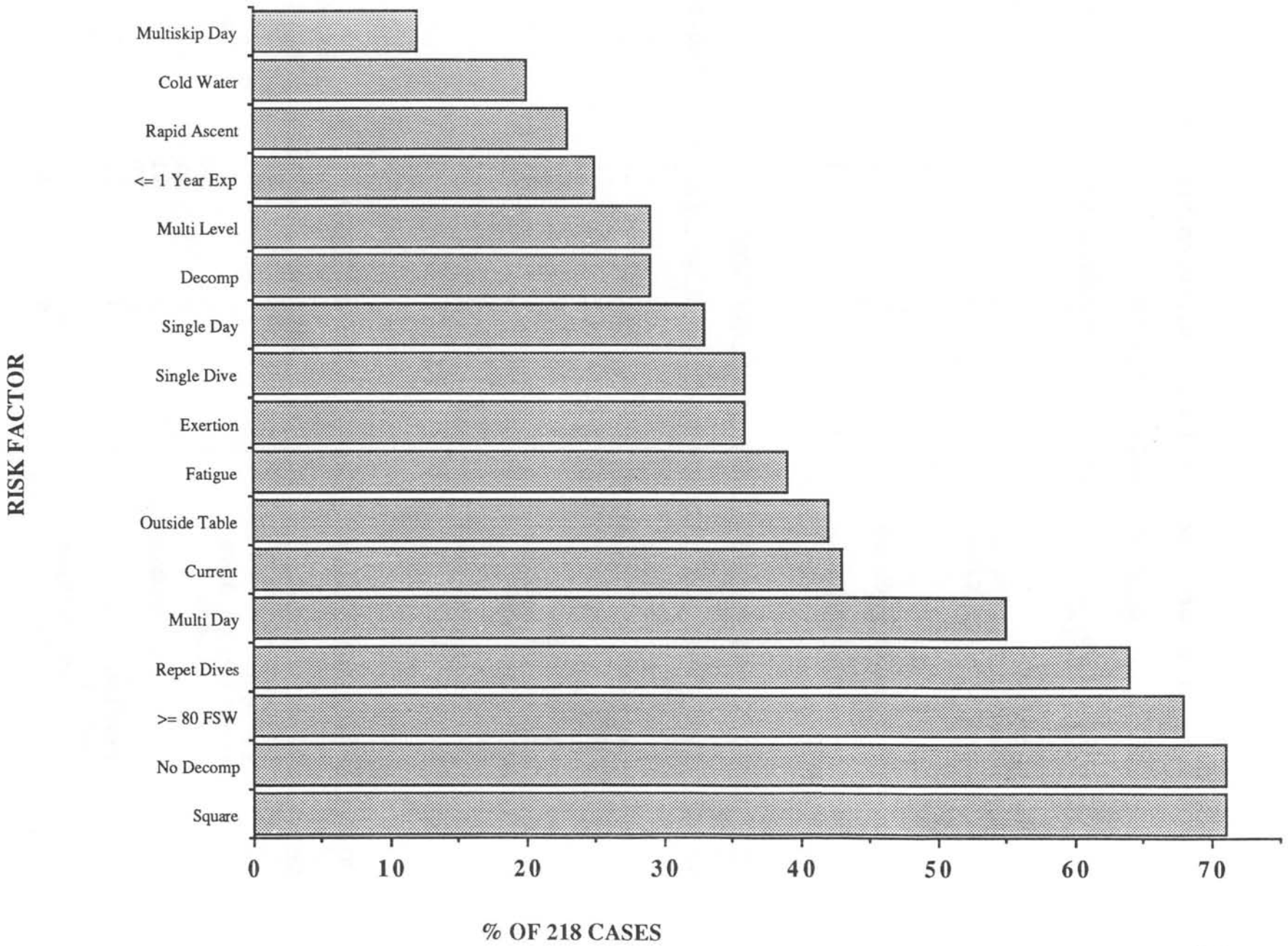
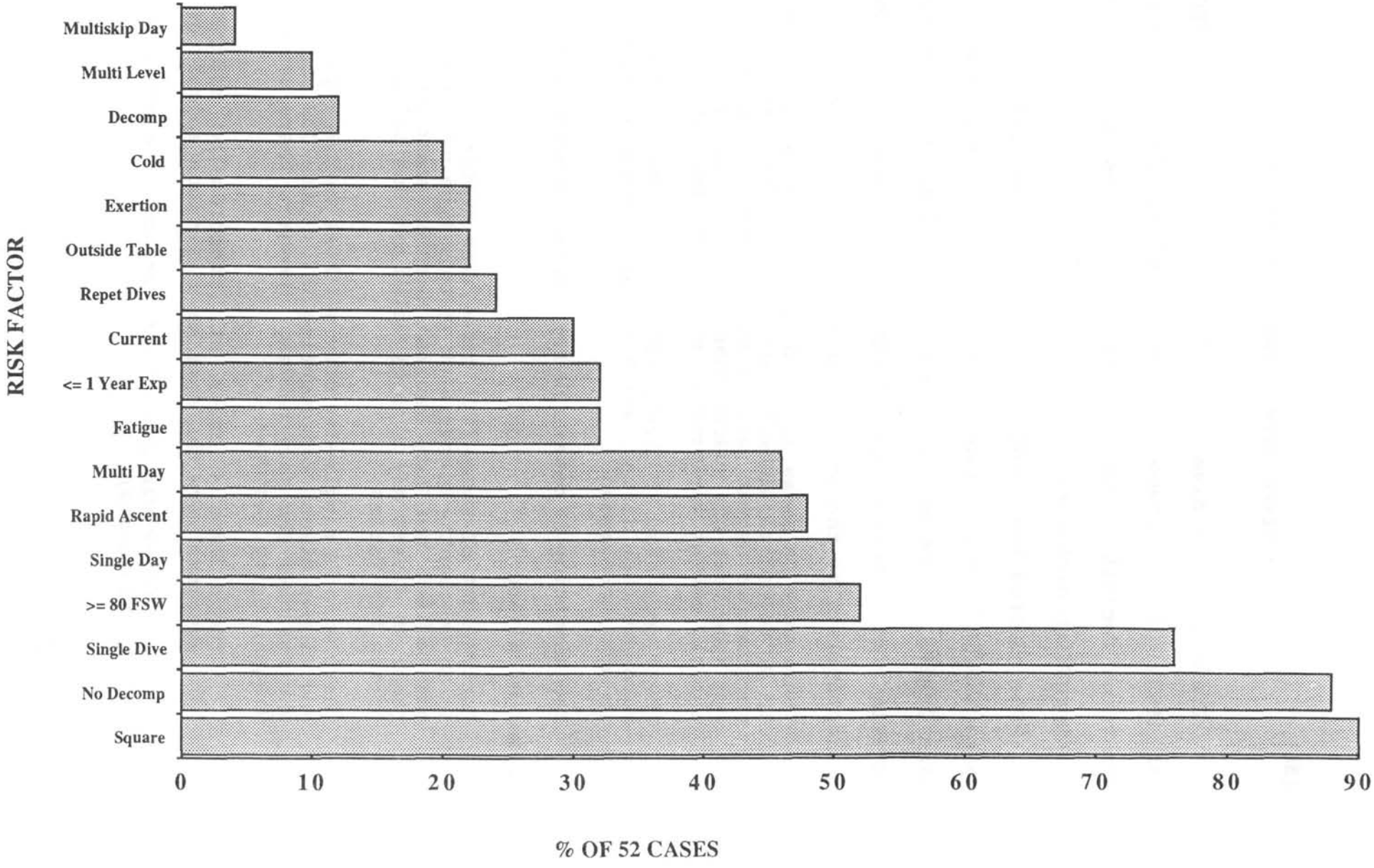
DCS RISK PROFILE



A-G-E RISK PROFILE



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DIVES WITHIN THE NAVY TABLES

There were 270 dive accident cases reviewed and reported on for 1987. 52 of these were diagnosed as gas embolism by the treatment facility. The remaining 218 cases were diagnosed as decompression sickness.

One hundred and twenty-six (58%) of these 218 cases reported using the US Navy dive tables correctly and were within the depth-time limits. However, a close examination of these 126 cases reveals some styles of diving which may increase their susceptibility to the occurrence of DCS.

> There were 28 cases of rapid ascent in this population. This is a technical default since a rapid ascent exceeds the recommended ascent rate of 60 feet/minute. Opinions differ, but some feel the sudden change in ambient pressure caused by a rapid ascent may provoke bubbles to form in the tissue.
>
> There were also 22 divers within the US Navy tables but doing decompression diving, which has an inherently higher risk and is not recommended.

The remaining 76 cases (35.5%) can be broken down into certain styles of diving:

> Forty-eight of these [76] cases were multi-day divers. There is an inherently higher risk in this type of diving as it does not reflect the Navy tables' testing protocol. Therefore, these 48 divers may also be ruled out due to incorrect usage of the USN Tables.
>
> There were 28 single-day divers (those making repetitive dives and single dives) representing 14% of the DCS population who followed the Navy tables. However, there were other disqualifying factors:
>
> > There were 4 cases of decompression sickness whose symptoms were the same as a previous episode of DCS.
> >
> > One diver was diving with an absolute contraindication (sarcoidosis).

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One diver was diving with a temporary restriction (flu with diarrhea).

Two flew after a single dive and developed symptoms during flight. DAN suggests waiting a full 24 hours prior to flying post-dive.

One dove to 140 feet which is beyond the sports diving limit.

The remaining 19 sports divers were following recommended protocol within the USN table limitations for single day diving, (both repetitive and single dives).

BREAKDOWN OF CASES WITH 3 RISK FACTORS OR MORE

Case #	1	2	3	4	5	6	7	8	9	10	11	12	13
Depth >=80'	*		*	*	*			*		*		*	*
Push limits	*	*			*		*	*				*	*
Cold	*			*	*	*	*	*					
Current	*		*			*			*				
Exertion	*	*	*	*		*		*		*	*	*	
Fatigue			*	*	*		*				*		*
Alcohol		*							*	*			
Repetitive	*	*			*	*	*		*		*		
Medical Hx		*		*									

These remaining 19 sports divers may have been within the USN table limits but illustrate two important trends which influence dive injuries.

The first is the failure of the diver to avoid dangerous practices which can influence decompression sickness; thirteen of the divers within table limits had at least three significant risk factors involved in their dive.

The second trend is the question of individual susceptibility and relative chance occurrence of DCS in certain individuals.

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ASTHMA AND DIVING

Eleven asthma cases were reported with injuries in 1987. Four of these cases were embolisms, three with rapid ascent. Two were diagnosed as Type II DCS, but suspicious of embolism.

To evaluate each case, factors were looked at that would be present in all divers, as well as factors that would tend to complicate an asthmatic condition. For air consumption, running low or running out of air was looked at. Any problem with buoyancy was considered a factor as was rapid ascent for any reason. If any of these conditions existed during the dive, a "Y" is placed under that case, and an "N" if not. If the dive was within the USN Tables, a "Y" is used, and an "N" if not. Missing data is designated by "--". There were no smokers in this group. Some listing allergies as a health problem may have been asthmatic but were not considered unless asthma was specified. Case #3 had a medical history of pneumonia and bronchitis with symptoms occurring three months prior to diving. Case #8 had epiglottiditis two months prior to the injury.

It is difficult to determine the exact extent of the effects of asthma on this group of diving injuries. Cases 9 through 11 show no relationship between their asthma and their injuries. Cases 1 through 6 show a relatively immediate onset, but had rapid ascents with the exception of cases 4 and 6.

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ASTHMA CASES

Type & Case #	Prev/Current History	First Symptom	Onset	Within Tables	Air Consump	Buoyancy Problem	Rapid Ascent	Water Temp
A-G-E 1	Previous	Dizziness/ Disoriented	00:04	Y	Y	--	Y	72
A-G-E 2	Both	Unconscious	00:00	Y	N	N	Y	44
A-G-E 3	Both	Hip and chest pain	00:01	Y	N	Y	Y	80
A-G-E 4	Previous	Numb/tingling Paralysis	00:01	Y	N	N	N	--
DCS-II 5	Previous	Headache	00:02	Y	Y	Y	Y	83
DCS-II 6	Previous	Back pain/ numb/tingling	00:05	N	N	N	N	70
DCS-II 7	Previous	Extreme fatigue	00:30	N	N	N	Y	58
DCS-II*8	Both	*Numb/tingling	01:00	Y	N	Y	Y	Cold
DCS-II 9	Both	Nausea, vomiting, fatigue	04:00	Y	N	N	N	72
DCS-II 10	Both	Numb/tingling	06:00	Y	N	N	N	80
DCS-II 11	Both	Numb/tingling	32:00	N	N	N	N	80

*Complained of chest pain 3 hours later

DIVING EXPERIENCE FOR ASTHMA CASES

Type & Case #	Yrs diving	Ave dives per year	Type & Case #	Yrs diving	Ave dives per year
*A-G-E 1	snorkel only	0	DCS-II 6	10	2
A-G-E 2	1	15	DCS-II 7	2	16
A-G-E 3	2	12	DCS-II 8	5	24
A-G-E 4	>1	0	DCS-II 9	1	2
DCS-II 5	2	14	DCS-II 10	2	50
			DCS-II 11	2	25

*Non-certified diver breathing scuba air from buddy's octopus regulator.

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POST-DIVE ALTITUDE EXPOSURE

Exposure to altitudes post-dive has long been considered a factor for Decompression Sickness. To evaluate the occurrence of this exposure, all true responses were looked at on the DAN accident questionnaire. The results of these responses were broken down by injury type (DCS-I, DCS-II, and A-G-E), and by interval of time from last dive to exposure to altitude. The unblinded method of diagnosis was employed in this analysis. Of a total of 90 responses, 83 were involving air flight, and 50 of these involved flying within a 24-hour period from the last dive and are broken down as follows:

Eight Embolism cases marked true for flying were actually air evacuated for treatment within 24 hours.

There were five Type I DCS cases; two were air evacuated for treatment within 24 hours. The remaining three had symptom onsets during or shortly after their flight.

The remaining 37 cases with flight in 24 hours or less were Type II DCS. Five of those were air evacuations. One case flew post-treatment. Seven cases flew post dive that already had some symptoms of Decompression Sickness; four of these were within the USN Tables. Of the 24 remaining cases, 22 were within the USN Tables.

Seven of the 90 responses marked true were exposure to elevations; five of these were exposed in 24 hours or less.

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FREQUENCY OF EQUIPMENT USED BY SEVERITY CODE*

USING A DEPTH GAUGE (90.67%)

NO-SYMP (0)	1	out of	1
DCS-I (1)	30	out of	31
DCS-II (2-5)	185	out of	203
A-G-E (6)	27	out of	33
TOTAL	243	out of	268

USING A TIME DEVICE (85.39%)

NO-SYMP (0)	1	out of	1
DCS-I (1)	25	out of	31
DCS-II (2-5)	175	out of	202
A-G-E (6)	27	out of	33
TOTAL	228	out of	267

USING A BOUYANCY VEST (92.91%)

NO-SYMP (0)	1	out of	1
DCS-I (1)	30	out of	31
DCS-II (2-5)	187	out of	203
A-G-E (6)	31	out of	33
TOTAL	249	out of	268

*Refer to page 15 for Severity Code classification scheme.

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LIST OF EQUIPMENT FAILURES

	Total Number of Cases	A-G-E Cases
Regulator	13	3
Buoyancy vest	5	1
Weight belt	8	1
Dry suit	3	0
Decompression computer	0	0
Inflator hose	5	0
Other:		
Unknown	1	0
Pressure gauge	2	1
Watch	2	0
Back pack	1	1
Wet suit problems	1	1
TOTAL	41	8

The total number of equipment failures was 41 in the accident population of 270 cases. This represents 15.2% of the total cases reviewed. The total number of arterial embolisms involving an equipment problem was eight; the remainder were all decompression sickness. There were 29 rapid ascents made because of an equipment problem (70% of the 41 cases). Twenty-two of those rapid ascents occurred due to a problem in the first four items on the above list where there were 29 equipment problems (22/29 = 75%). Five of the eight embolisms also occurred in these categories.

There would seem to be a direct cause and effect between some equipment failures and arterial embolism. The relationship between equipment problems and decompression sickness is less clear and no firm conclusion can be drawn.

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DECOMPRESSION

COMPUTERS

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DIVE COMPUTER USE: OVERALL STATISTICS

N Obs	Variable	N	Minimum	Maximum	Mean
39	AGE	39	24.00	62.00	36.21
	# DIVES PREV 24 HRS	39	0	10.00	1.85
	# DIVES PREV 7 DAYS	39	0	19.00	3.69
	1ST DIVE DEPTH	39	50.00	186.00	109.31
	BMI	37	0	40.71	25.43
	DXCODE	39	1.00	5.00	3.08

N Obs	Variable	Standard Dev
39	AGE	8.58
	# DIVES PREV 24 HRS	2.07
	# DIVES PREV 7 DAYS	4.94
	1ST DIVE DEPTH	30.89
	BMI	5.82
	DXCODE	1.36

PROFILES BY TYPE OF DIVE

Type of Dive	Number of cases	Number within USN Tables	Percent within USN Tables
Single dive	7	4	57
Repetitive Dive	24	18	75
Single day diving	11	10	91
Multiday Diving	20	12	60
Decompression dive	16	12	75
Non-decompress dive	15	10	67
Square dive	10	7	70
Multilevel dive	21	15	71

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BREAKDOWN OF 41 CASES USING DIVE COMPUTERS

41 case reports in which decompression computers were used:
- Disqualifications:
  - 6 - misused computer
  - 2 - were A-G-E cases
  - 1 - used mixed gas (36% Nitrox)
  - 1 - unspecified dive profile

31 cases used in study:
- 22 cases outside USN tables (71%)

Single Day Diving - 11 cases
- Single dive - 2 cases
  - 2 multilevel and decompression
  - 2 cases outside USN tables
- Repetitive dive - 9 cases
  - 1 square with no decompression
  - 4 square with decompression
  - 3 multilevel with no decompression
  - 1 multilevel with decompression
  - 8 cases outside USN tables

Multiday Diving - 20 cases
- Single dive - 5 cases
  - 1 square with o decompression
  - 3 multilevel with no decompression
  - 1 multilevel with decompression
  - 2 outside USN tables
- Repetitive dive - 15 cases
  - 2 square with no decompression
  - 2 square with decompression
  - 5 multilevel with no decompression
  - 6 multilevel with decompression
  - 10 outside USN tables

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DIVE COMPUTER RESULTS: DIAGNOSIS VS. DEPTH OF DIVE

TABLE OF SEVERITY CODE* BY DEPTH OF 1ST DIVE

Frequency / Percent / Row Pct / Col Pct	DEPTH OF 1ST DIVE					
	0-50 feet	51-60 feet	71-80 feet	81-90 feet	91-100 feet	Total
SEVERITY CODE 1				2 5.13 25.00 22.22	2 5.13 25.00 40.00	8 20.51
SEVERITY CODE 2			1 2.56 20.00 25.00	1 2.56 20.00 11.11		5 12.82
SEVERITY CODE 3			1 2.56 14.29 25.00	3 7.69 42.86 33.33	1 2.56 14.29 20.00	7 17.95
SEVERITY CODE 4	1 2.56 7.14 100.00	1 2.56 7.14 100.00	2 5.13 14.29 50.00	3 7.69 21.43 33.33	2 5.13 14.29 40.00	14 35.90
SEVERITY CODE 5						5 12.82
Total	1 2.56	1 2.56	4 10.26	9 23.08	5 12.82	39 100.00

*NOTE: There were no divers in the 61-70 ft. depth range.

(Continued)

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DIVE COMPUTER RESULTS: DIAGNOSIS VS. DEPTH OF DIVE

TABLE OF SEVERITY CODE* BY DEPTH OF 1ST DIVE

Frequency / Percent / Row Pct / Col Pct	DEPTH OF 1ST DIVE				
SEVERITY CODES	101-110 feet	111-120 feet	121-130 feet	131-999 feet	Total
1			3 7.69 37.50 75.00	1 2.56 12.50 12.50	8 20.51
2	1 2.56 20.00 33.33	1 2.56 20.00 25.00		1 2.56 20.00 12.50	5 12.82
3			1 2.56 14.29 25.00	1 2.56 14.29 12.50	7 17.95
4	2 5.13 14.29 66.67	3 7.69 21.43 75.00			14 35.90
5				5 12.82 100.00 62.50	5 12.82
Total	3 7.69	4 10.26	4 10.26	8 20.51	39 100.00

*Refer to page 15 for Severity Code classification scheme.

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DECOMPRESSION SICKNESS IN DIVE COMPUTER AND TABLE USE

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The Divers Alert Network received reports of 557 diving accidents treated in 1987 from participating treatment chambers. The reports included both decompression sickness and air embolism cases.

Two hundred twenty reports of decompression sickness provided sufficient information to use in the diving accident database. One hundred eighty accidents (82%) occurred after dives using the US Navy Standard Air Decompression Tables. One hundred forty-two (79%) of these cases using the tables had Type II symptoms.

Forty DCS reports involved dives using computers. Nine cases were omitted from further analysis: symptoms of air embolism were present or the computers were used improperly. Of the 31 remaining cases, 21 (68%) had symptoms of Type II decompression sickness. The brand of computer was not considered in the analysis.

The total number of dives in 1987 was estimated at 8,100 dives for the table divers, and 1,609 dives for the computer divers. The mean number of dives per diver was 51 for computer divers and 45 for table divers leading to annual occurrence estimates of 1.9% for computers and 2.2% for tables within the DAN population.[1] Given the uncertainty of the estimates, these numbers are indistinguishable and possibly overestimate actual risk.

Further insight into the possible occurrence of decompression sickness during computer and table diving may be derived from the analyses of dive profile attributes.

Were all the dives in each profile "square" with bottom times taken at single depths or were they "multilevel" with time spent at several depths? Were the dives "no-stop" with direct ascent to the surface or did they use stage or continuous decompression as some computers allow? Was there a single dive or were the dives repetitive? Did all dives take place on a single day or were there multiple days of diving?

Profiles were also examined to determine if they fell within the limits of the Navy tables and to determine the depths of the deepest and the last dive.

Attribute analysis for decompression sickness that occurred with table diving revealed that 79% were square dives, 75% were no-stop, 65% were

1. This percentage applies only to the injured divers reported to DAN. No conclusions can be drawn concerning previous dive years, nor can any conclusions be made about the general dive population.

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multiday, and 60% were repetitive. In our study, single day diving, single dives, decompression dives, and multilevel dives were least often associated with decompression sickness.

A similar analysis for computers indicated that 77% of all decompression sickness occurred during repetitive diving, 74% occurred during multiday diving, 68% during multilevel dives, and 52% during decompression dives. Decompression sickness was least frequent with no-stop, square, single day, single dive profiles in the DAN data.

The greatest difference between decompression sickness with table use and with computer use was for square and multilevel diving. There was 47% more decompression sickness for square diving with tables and 47% more decompression sickness for multilevel diving with computers. This might indicate greater decompression risk for multilevel diving with computers or merely less multilevel diving with tables.

The next greatest difference between computers and tables was for no-stop diving and decompression diving. There was 27% more decompression sickness for no-stop diving with tables than with computers. This could be the result of more decompression diving with computers or of the tables' longer no-stop exposure limits.

Repetitive and multiday diving were common in the database for both computers and tables, but there was 17% more repetitive diving in decompression sickness with computers. Repetitive dives are clearly more hazardous than single dives, as the first dive in every series of repetitive dives is a single dive.

The least difference between computers and tables, only 9%, was for single and multiday diving. As the first day of a multiday dive is a single day dive, this probably reflects a gradual accumulation of bubbles over several days of intensive diving. The category "multiday skip" refers to multiday dives with no diving the day before the decompression incident. One might infer from this category that a day off may provide some protection from decompression sickness.

"Was the dive within the limits of the Navy tables?" While the Navy tables are a familiar benchmark, this question sometimes presumes decompression safety to have well-defined limits and decompression sickness to be inevitable if these limits are violated. Such is not the case, neither for the Navy tables nor for any tables yet to be devised. Of the 180 decompression incidents in the database using the Navy tables, 63% were within the table limits. For the computer dives, 26% were within the table limits. Had the restrictions for both computer and table diving been observed, it is likely that less decompression sickness would have occurred, but obeying the Navy tables alone does not guarantee freedom from risk.

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The distribution of decompression sickness over depth is shown here for table diving. Because decompression diving and repetitive diving were so frequent in the DAN diving accident database, both the deepest and the last dive depths were studied. For single dives, of course, the deepest and last depth are the same. The left-most point represents all dives shallower than 60 feet, and the right-most point is all dives to 130 feet or deeper. Intermediate points are at the centers of 10 foot depth ranges. The line representing the deepest dive was a more important risk factor than the depth of the last dive for our population. The alternate hypothesis leads to a conclusion of greater risk at shallow depth. A similar effect occurred for computer diving.

When the deepest dive lines for table and computer decompression sickness appear together, it is evident that decompression sickness occurred more often at greater depths for diving with computers than for diving with tables in our sample population.

This distinction is seen more clearly when the relative differences between tables and computers are examined in each depth range. For depths of less than 60 feet, there was 13% more decompression sickness with tables than with computers. This difference fell to 9% between 60 and 69 feet, and to 6% between 70 and 79 feet. From 100 to 109 feet, 11% more decompression sickness occurred with computers than with tables.

Is it safe to dive with a decompression computer?

Without knowledge of how many safe dives were made, it is impossible to answer this question with certainty. Our annual risk estimates of 1.9% for computers and 2.2% for tables suggested that the decompression sickness risk of table and computer diving was the same, but closer examination revealed that the occurrence of decompression sickness was distributed differently over depth and dive profile. Relatively more decompression sickness occurred with computer use on multilevel and decompression dives, but dives shallower than 100 feet had relatively less decompression sickness with computers for all types of diving. We already know that depth is a significant risk factor, and it is almost a cliche to suggest that computer diving would be safer if depths greater than 100 feet were avoided.

For both computers and tables, repetitive and multiday diving are common risk factors. At the present, a more conservative approach to these types of diving would seem to be indicated in the use of both computers and the Navy tables.

DAN is indebted to the cooperation of reporting facilities and physicians for their support and efforts in completing and forwarding the accident questionnaires which helped to make this report possible.

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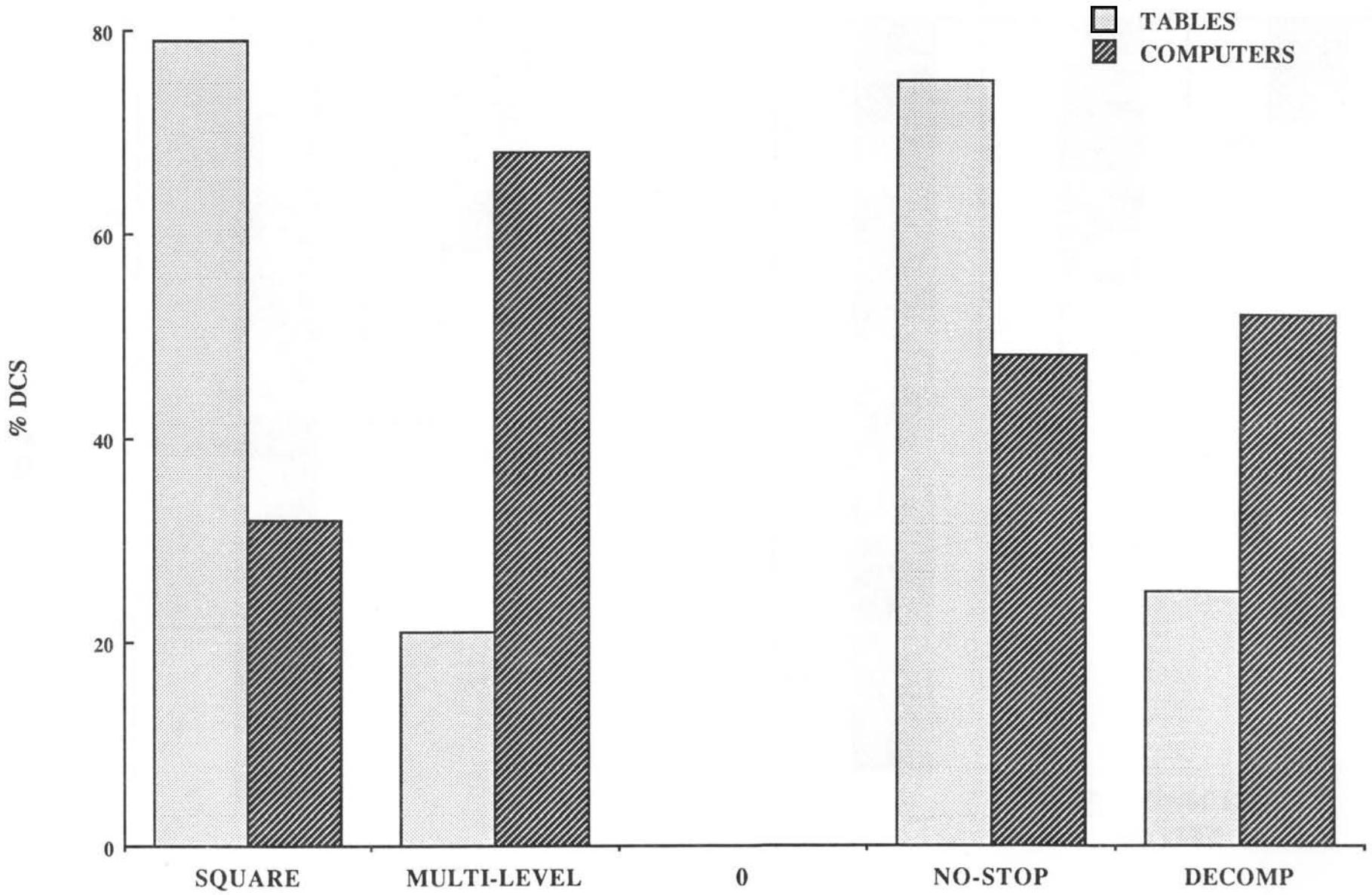
TABLES VS. COMPUTERS



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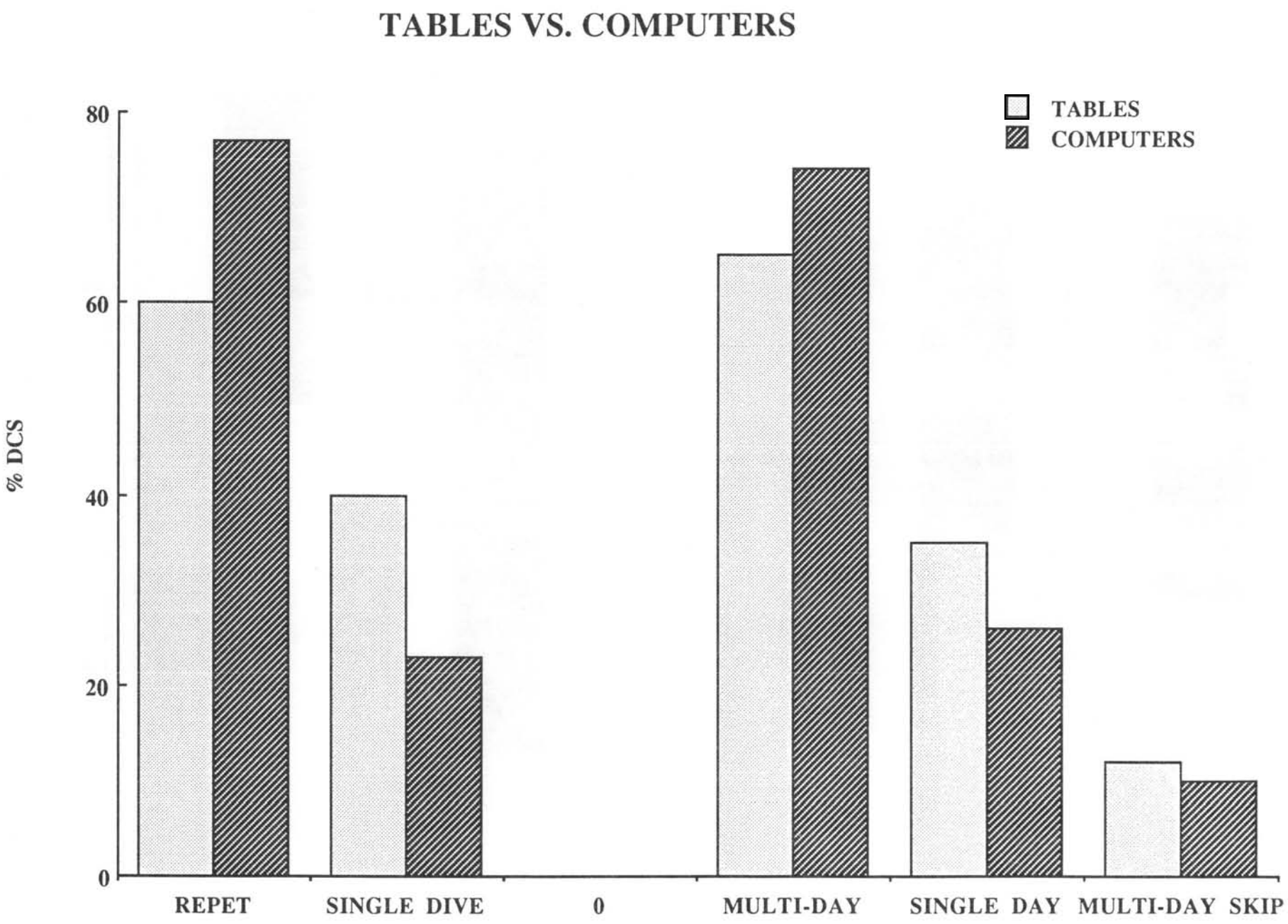

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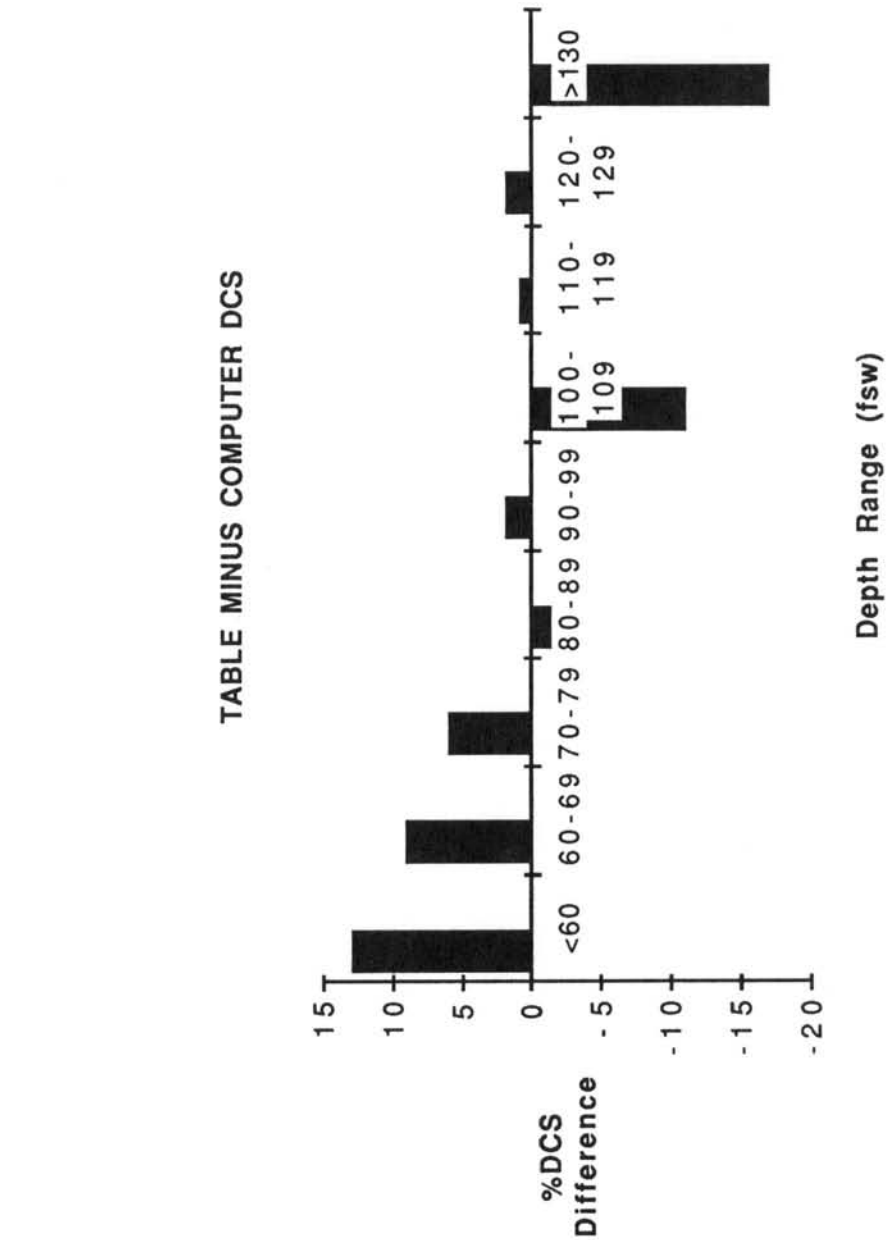

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SUMMARY REMARKS

There are several points worth discussion upon reviewing the compiled data in this report. One of the most striking pieces of information is the general lack of knowledge at all levels of scuba diving about the symptoms involved in a dive injury. This situation is further complicated by a concurrent lack of knowledge about what the treatment should be by the diver and by the emergency medical personnel at the site of the accident. This lack of knowledge directly affects the care and treatment of almost all injured U.S. divers; that is to say that the average diver is not prepared to handle a dive emergency.

In the worst case scenario, where the diver presented with the major symptoms of a gas embolus and was treated with the USN table 6A, the average delay to call for assistance was 3 hours, and the average delay to transfer (ground, boat, air), examination, and recompression was an additional 3 hours.

In the best outcome of these cases, with complete relief occurring after a single treatment, the average delay to call was 2 hours and delay to treatment was 4 hours. This was in the best of situations where a chamber was close at hand and readily accessible.

The divers who had residual pain or neurological symptoms after treatment was completed waited an average of 8 hours to call for assistance, and the average delay to treatment was 14 hours.

The sport scuba diver must seek further information and

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education about the nature of injuries in their sport. If a diver presents with any symptoms he should be evaluated as soon as possible. A medical professional is not needed at every dive site, just someone who knows that every injury of any nature requires the appropriate medical care.

The next point of major consequence is the immediate application of oxygen in the dive accident scenario. An overall oxygen use of thirty-seven percent in dive accidents is not good enough when we consider the potential benefit oxygen has for the victim. The effect of the immediate delivery of 100% oxygen has an unquestioned benefit in true dive injuries. The dive accident victim can only benefit from the delivery of oxygen, and there is no injury which could result from short-term oxygen use. (You can dry out the victim's airway with unhumidified oxygen, but this is usually a consequence of longer term use. Occasional breaks for oral fluids will help avoid this problem.)

In summary, we must continue to emphasize the following: better recognition of the signs and symptoms of diving injuries, improved field management by both the diver and the emergency medical personnel, and appropriate administration of oxygen, thus shortening the delay to medical assistance and treatment and improving the chances for a successful outcome.

The individual diver can have a tremendous effect on the future handling of dive injuries and the outcome of diving accidents. The number of injuries yearly compared to the estimated

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number of divers (1.6 million)* does not produce the motivation to ensure that each diver is prepared to handle a diving injury. If more divers participated in rescue or medic courses they could have a significant impact on virtually every diver in the U.S. who is injured while diving simply by using proper procedures.

As people have become better acquainted with the Divers Alert Network and the services DAN provides, our opportunity to educate the sport diving population has expanded. The DAN non-emergency phone lines are logging an incredible number of calls from people seeking information relating to risk factors and fitness to dive, which both relate to accident prevention. More and more, DAN is promoting education as the key to safer diving practices and has taken the lead in promoting dive safety. DAN is continually searching for new ways to educate the sport diving population to methods of accident prevention and management through seminars, articles and publications in dive magazines and medical literature, our own Alert Diver newsletter, and most recently by distribution of the statistics and comments in this booklet concerning a population of injured divers from the year 1987.

The key to reducing the number of dive injuries and/or limiting the severity of dive injuries is to be informed about both the means to prevent an accident from occurring, and in the event of an accident, what immediate measures must be taken in order to

*National Sporting Goods Retailer

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maximize the victim's chance for a total recovery.

The Divers Alert Network will continue to respond to the safety needs of sports diving and will try to insure that it remains one of the safest recreational sports in the United States.

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ACKNOWLEDGMENTS

The Divers Alert Network 1988 Report on 1987 dive accidents was assembled through the hard work, creative ideas, and energy of many DAN and Hyperbaric staff members.

Numerous hours were spent sorting medical questions, making late evening telephone follow-up calls, doing data entry, creating graphs, proofreading, and editing material.

The authors wish to thank the following people and acknowledge their efforts and contributions:

Betty Bond - Project Assistant

Dr. Sherif Afifi
Dr. Andy Bean
Chris Bennett
Chris Bensen
Albert Boso
Valery Bronner
Carmen Hurst
Dave Martel
Glenn Martin
Anthony Ross
Jeffery Rust
Tony Scheer
Sherry Strickland

This report was made possible in part with the financial backing of DAN supported by DEMA, NOAA, and the diving public. Additional assistance was provided to DAN by NASDS, NAUI, PADI, PADI-JAPAN, PDIC, SSI, the UHMS, and the YMCA. We gratefully acknowledge this support. Most of all, DAN wishes to thank the dive clubs, dive stores, and 26,000 scuba divers who are current members of the Divers Alert Network for their faithful support and dedication to scuba diving safety.

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