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EFFECTS OF AGE AND EXPOSURE ON THE HEALTH STATUS OF US
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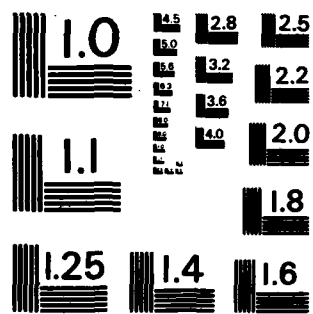
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EFFECTS OF AGE AND EXPOSURE ON THE HEALTH STATUS
OF U. S. NAVY DIVERS

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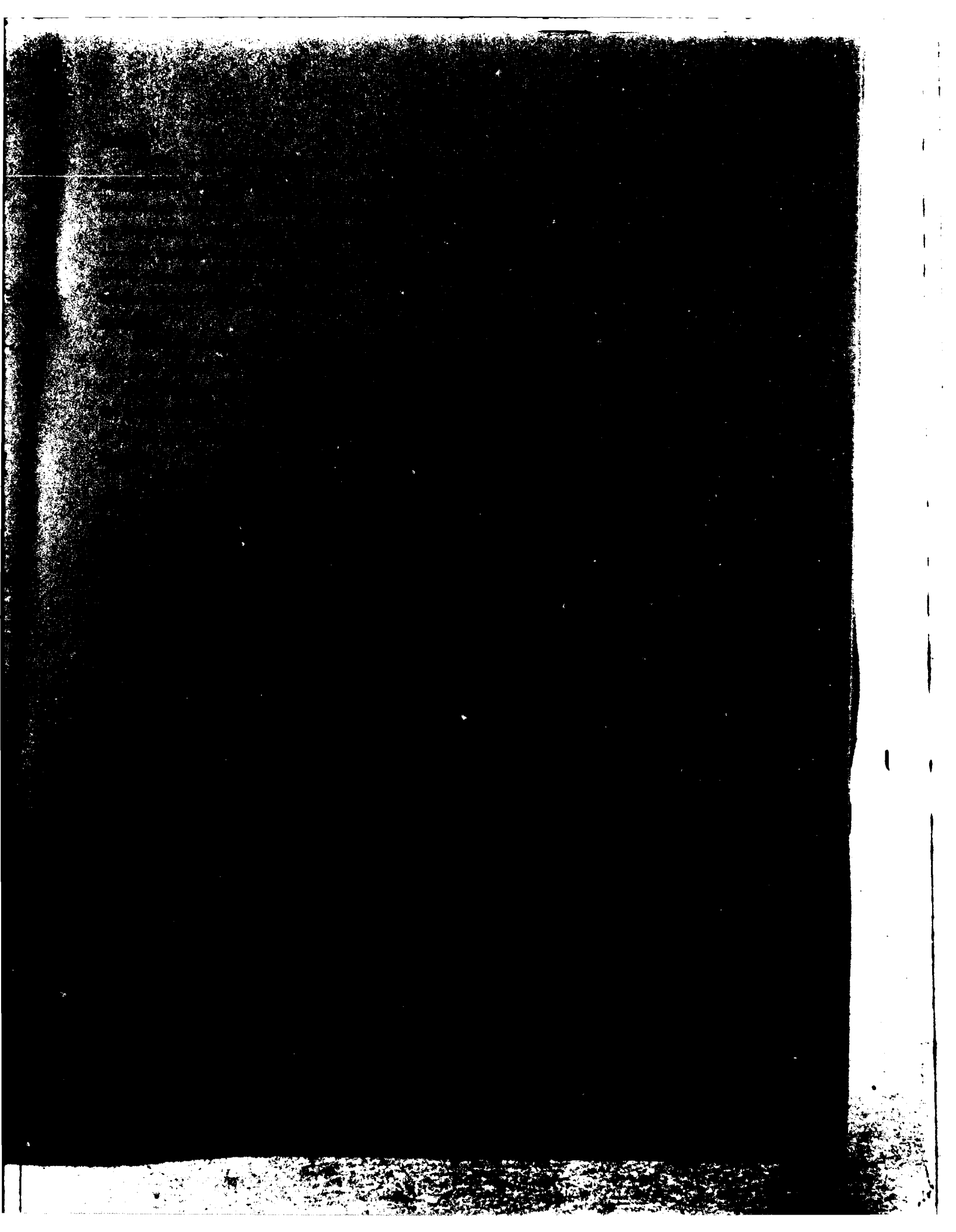
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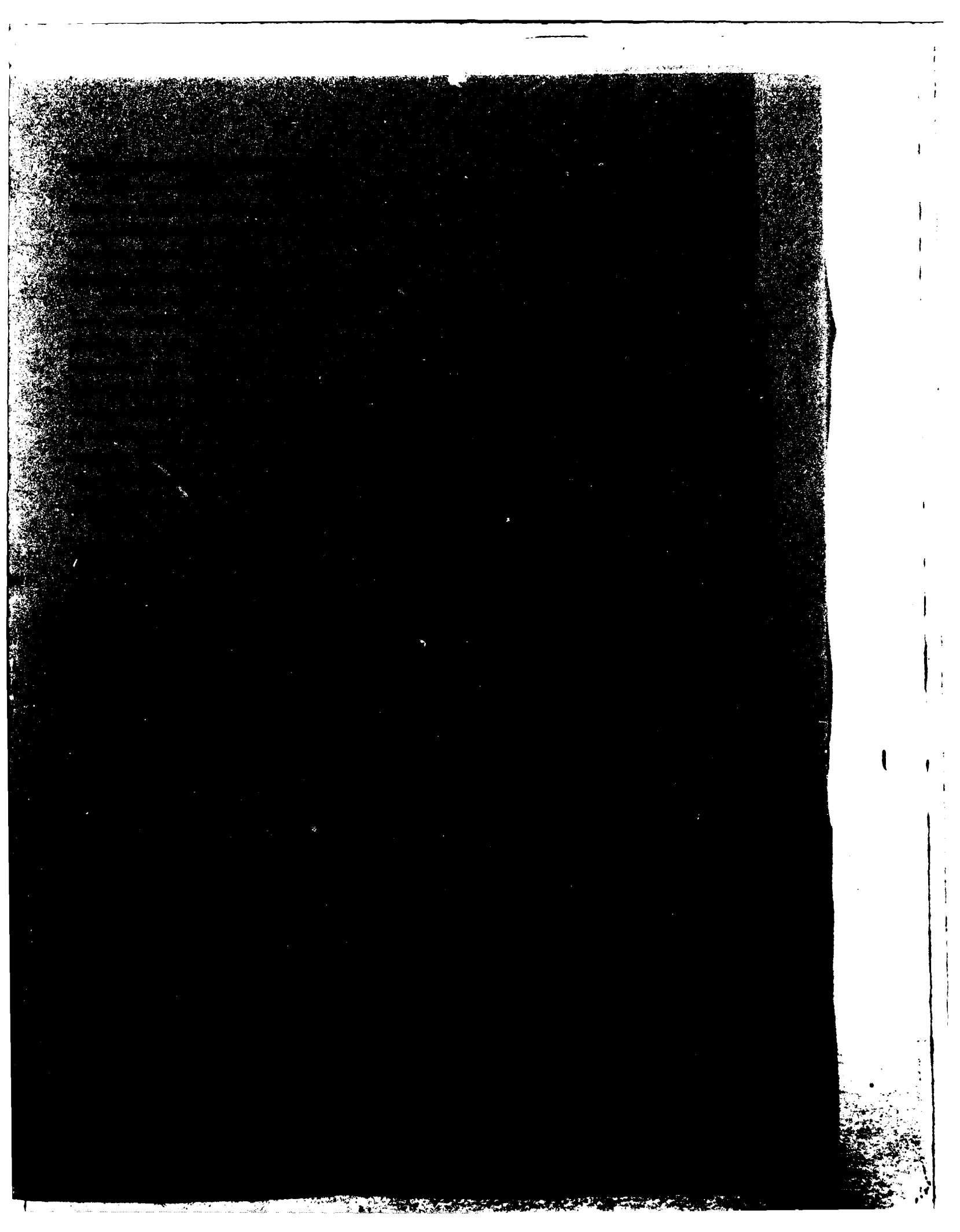
To expedite communication of our research, this is a preprint of a paper submitted to Undersea Biomedical Research and should be cited as a personal communication.

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Effects of Age and Exposure on the Health Status of

U. S. Navy Divers

Diving is considered to be one of the most hazardous of occupations, primarily because divers must perform their duties in an unnatural environment for humans (1). In the course of their underwater excursions, divers are exposed to an alien environment of physical and psychological stressors that are potentially injurious. The major environmental stressors include: water immersion and moisture, water temperature, hyperbaric environment, hyperbaric gas toxicities, buoyancy and sea turbulence, and environmental pressure change.

To ensure their safety against these stressors, divers must depend on complex life-protection equipment and vigilant coworkers. In the event of equipment failure, an incorrect decision, a change in the underwater surroundings, or even a lapse in concentration, the diver could be injured or suffer a disorder that might be manifest immediately (e.g., nitrogen narcosis or high pressure nervous syndrome) or many years later, such as dysbaric osteonecrosis or the "silent bend" (2,3). At least 20 specific types of illnesses and injuries including otitis externa, pneumothorax, decompression sickness, barotrauma, and air embolism, have been identified in the literature as associated with diving (4,5).

Of all diving-related disorders, the most significant is that of decompression sickness which entails both the less serious or Type I manifestations and Type II with its much graver ramifications (6,7). The symptoms of Type I decompression sickness involve musculoskeletal pain but also can include, either singly or in conjunction with joint or limb pain, fatigue and cutaneous and lymphatic manifestations, such as itching and swelling. Type II manifestations of decompression sickness are of a more serious nature because of central nervous system, respiratory, or peripheral neuropathy involvement. Immediate oxygen recompression is the treatment of choice for most cases of decompression sickness (8). Among U. S. Navy divers, for example, almost all cases of decompression sickness were of the pain-only type (Type I) which were completely relieved with hyperbaric therapy (9). If treated immediately, the symptoms of decompression sickness may disappear without residua (10). Although decompression schedules have been developed to obviate decompression sickness by controlling the rate of ascent, no schedule has yet been established that completely meets this objective, especially for those circumstances where the requirement of recompressing to tremendous depths must be met or where the diver experiences an increase in pain (11).

Not only does adherence to decompression schedules greatly reduce the risk of decompression sickness, there also is evidence that such a compliance might prevent the occurrence of dysbaric osteonecrosis, a long-term insidious consequence of exposure to compressed air at pressures substantially greater than normal levels (12). Incidence of this disease, which has been reported even after only one exposure to the hyperbaric environment, seems to be associated primarily with differences in diving practices (13-17).

High prevalence rates of bone cysts (18, 19) as well as the secondary disease of arthritis (20) also have been identified in the literature as attributable to diving. The identification of all of the aforementioned disorders suggests that circumstances associated with diving can have an

adverse influence on the body's musculoskeletal, respiratory, circulatory, and nervous systems as well as the diver's mental and emotional well-being.

The objectives of this study were 1) to examine the morbidity (hospitalization) rates of U.S. Navy divers for disorders specifically demonstrated to be diving related as well as diseases in organ systems identified above as being susceptible to diving-related conditions, 2) to determine the effect of age on divers' morbidity, and 3) to establish the extent to which exposure (number of dives) was associated with hospitalization rates. Results of this research endeavor will provide divers and health care personnel with knowledge of the health risks associated with diving.

METHODOLOGY

Participants

The population for this study included all U.S. Navy enlisted divers who had performed at least one recorded dive during the time period from January 1968 through December 1979 ($n = 11,584$ enlisted men). It should be noted that diving is not a primary Navy occupational specialty but a secondary assignment, and divers are drawn from many Navy occupations. Information on the extent of diving exposure was obtained from the diving log forms (Diving Log--Accident Injury Report) which were collected and compiled onto computer files by the Naval Safety Center in Norfolk, Virginia. This file was forwarded to the Naval Health Research Center, San Diego, California, where the more than 618,000 logged dives were processed into individual records for the 11,584 divers.

Procedure

The diver file was matched against the two chronological data files of medical inpatient history and naval service history which are maintained at the Naval Health Research Center. Information selected from the medical inpatient file, which is a compilation of all records of hospitalization, consisted of age at the time of hospitalization and diagnoses for each hospitalization. A maximum of three diagnoses for as many as ten hospital admissions were tallied during the time frame from January 1968 through December 1979. However, only those diagnoses identified in the literature as associated with diving or hypothesized as stress related (21) were included in the tabulations for this study. These diagnoses were collapsed into 31 subcategories which in turn were subsumed under the six categories of Diseases of the Musculoskeletal System, Diseases of the Circulatory System, Diseases of the Nervous System and Sense Organs, Diseases of the Respiratory System, Stress-related Disorders, and Environmentally Induced Disorders. A complete listing of the more than 200 disorders studied is presented in the appendix. The diagnostic nomenclature used was the Eighth Revision of the International Classification of Diseases Adapted for Use in the United States (ICDA-8). Most of the diagnoses in the following major ICDA-8 categories were excluded from the analyses because they were considered to be unrelated to diving: infective and parasitic diseases; congenital anomalies; neoplasms; digestive disorders; endocrine, metabolic, and nutritional disease; accidental injuries; supplementary classifications; diseases of the blood and blood-forming organs; diseases of the genitourinary system; and diseases of the skin and subcutaneous tissue.

Data extracted from the service history file were birth year, year entered service, and reason and date of separation from active duty. To assess the impact of age and exposure on health, the diver population was divided into subpopulations on the basis of age (17-22, 23-28, 29-34, 35-40, and 41 years and older) and number of dives performed (1-20, 21-100, and more than 100 dives). Populations at risk over the 12 years of the study were computed using year entered service and year separated from service in conjunction with age and exposure level. That is, frequency distributions were compiled for each age and exposure category and each year based on dates of entry and departure of the diver population. The mid-points for the number of divers on duty at the beginning of each time interval (year) and at the end of the time interval were determined, and these values were averaged over the entire 12-year period. To calculate annual hospitalization rates per 10,000 strength, the numbers of hospitalizations for the six major diagnostic categories and 31 subcategories recorded from 1968-79 for each subpopulation were divided by the mean population at risk, multiplied by 10,000, and divided by the 12 years of this study.

Ninety-five percent confidence intervals, based on Poisson distributions for rarely occurring events, were computed for the lowest and highest levels of both the age and exposure variables. These confidence intervals were computed to determine whether or not disease rate differences were associated with the aging process and increasing levels of diving exposure.

To eliminate the effects of the aging process on increasing levels of diving experience, rates for the three exposure levels were age adjusted using the indirect method of age adjustment (22). Comparisons were conducted between frequencies of disease for each exposure level and those expected which were based on the distribution of disease in the overall diver population. Miettinen probabilities were calculated to determine the significance of differences between observed and expected frequencies (23).

RESULTS

Figure 1 is a graphic presentation of total hospitalization rates for the selected disease categories across the intervals of age and diving experience. As shown, overall rates increased significantly ($p < .05$) with age but did not vary with level of exposure.

Hospitalization Rates by Age

Musculoskeletal Disorders. Table 1 presents the hospitalization rates by age for the six diagnostic categories and 31 subcategories. Significant differences in rates between the older groups and the youngest group are indicated. Of the six major diagnostic classifications, musculoskeletal disorders accounted for the most hospitalizations. Overall, older groups had significantly higher rates than the youngest group. Diseases of the spinal column and back was the only specific subcategory that showed a significant increase with age. Differences across age groups were minimal for joint diseases and disorders of the connective tissue and muscle. No cases of dysbaric osteonecrosis were noted in this population during the 1968-79 time period.

Stress-related Disorders. Age proved to be a significant factor in explaining differences in rates for stress-related disorders. Alcohol/drug abuse, however, accounted for almost all of the increase in rates with age. The oldest diver group had significantly higher hospitalization rates

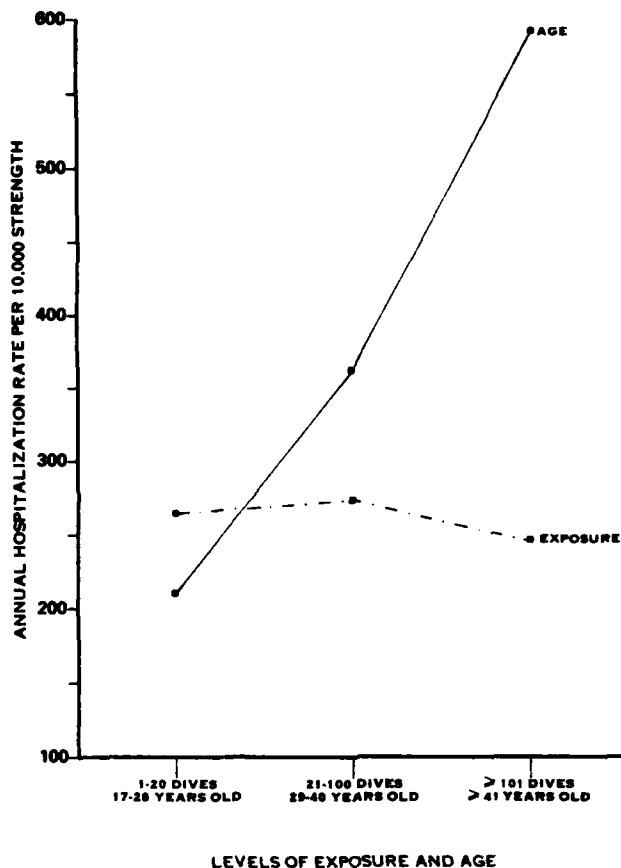


Figure 1. Hospitalization rates for diving-related disorders by age and exposure level.

than 17-22 year-olds for diabetes mellitus and no recorded hospital admissions for transient situational disturbances, neuroses, and psychoses.

Diseases of the Respiratory System. Differences in hospitalization rates between youngest and oldest diver groups were nonsignificant for the disorders in this category with the exception of the significantly higher hospitalization rate among oldest divers for disorders of the respiratory tract.

Diseases of the Nervous System and Sense Organs. No significant differences across age intervals were observed for this diagnostic category and the five subcategories. Otitis externa/other ear problems occurred with greatest frequency among divers aged 17 to 22.

Diseases of the Circulatory System. As would be expected, the highest overall rate for circulatory disorders was observed for divers over 40 years of age, which differed significantly from the rate of the youngest group. Hospitalizations for cardiovascular disease accounted for

TABLE 1

COMPARISON OF ANNUAL HOSPITALIZATION RATES AMONG U. S. NAVY
DIVERS BY AGE AND DIAGNOSTIC CATEGORY, 1968-79

Diagnostic Category	Rate ^a by Age				
	17-22	23-28	29-34	35-40	> 41
Diseases of the Musculoskeletal System	87.3	116.9	187.2	201.7*	262.8*
Diseases of the Joint	38.4	46.9	52.4	34.8	42.6
Disorders of the Spinal Column and Back	17.5	31.2	64.4	88.7*	142.1*
Diseases of the Connective Tissue and Muscle	15.6	21.0	36.1	29.6	35.5
Diseases of the Bone	8.1	11.6	19.8	24.3*	21.3
Arthritis/Rheumatism	7.8	6.2	14.6	24.3*	21.3
Stress-related Disorders	30.6	45.1	67.9	99.1*	106.6*
Alcohol/Drug Abuse	10.0	17.4	41.2	71.3*	71.0*
Transient Situational Disturbances	5.9	12.9	6.0	7.0	0
Neuroses	7.2	4.5	11.2	7.0	0
Psychoses	3.1	5.8	0	- ^b	0
Ulcers	3.4	3.1	8.6	10.4	-
Diabetes Mellitus	0.9	1.3	-	-	21.3*
Diseases of the Respiratory System	27.8	46.9	30.9	26.1	63.9
Diseases of the Respiratory Tract	12.5	17.4	12.9	12.2	49.7*
Deflected Nasal Septum	9.0	19.6	12.0	7.0	0
Sinusitis	3.1	4.9	2.6	-	0
Pleurisy/Respiratory Tuberculosis	-	1.3	-	-	0
Spontaneous Pneumothorax	1.6	2.7	-	0	0
Emphysema	1.2	-	-	0	-
Diseases of the Nervous System and Sense Organs	25.6	20.1	35.2	27.8	35.5
Diseases of the Nervous System	11.2	9.4	18.9	15.6	0
Otitis Externa/Other Ear Disorders	10.6	5.4	4.3	-	-
Deafness	3.1	3.1	3.4	-	-
Neuritis/Neuralgia/Sciatica	-	1.3	6.9	7.0	0
Facial Paralysis/Cerebral Paralysis	0	-	-	0	-
Diseases of the Circulatory System	15.6	18.3	24.9	38.3*	120.8*
Cardiovascular Disease	4.4	4.0	6.9	17.4*	78.2*
Hypertension/Other Cerebrovascular Disease	1.6	3.6	7.7	15.6*	-
Other Diseases of the Circulatory System	4.7	4.5	6.9	-	21.3
Phlebitis/Thrombophlebitis	3.7	3.6	2.6	0	0
Embolism: Cerebral, Arterial, Venous, etc.	1.2	2.7	-	-	-
Environmentally Induced Disorders	8.7	12.9	4.3	8.7	-
Decompression Sickness	4.0	7.6	2.6	5.2	0
Effects Other External Causes/					
Drowning/Hypothermia	3.1	2.7	-	-	-
Effects of Gas	1.6	2.7	-	-	0
Barotraumas	0	0	0	0	0
Mean Population at Risk	2,672	1,867	970	479	117

^aHospitalization rates are numbers of admissions per 10,000 population per year.

^bRates are not presented for diagnoses with a frequency of less than 3.

*Rate is significantly greater ($p < .05$) than that for 17-22 year olds.

TABLE 2

COMPARISON OF ANNUAL HOSPITALIZATION RATES AMONG U.S. NAVY DIVERS BY NUMBER OF DIVES AND DIAGNOSTIC CATEGORY, 1968-79

Diagnostic Category	Rate ^a by Number of Dives		
	1-20	21-100	>101
Diseases of the Musculoskeletal System	120.7	130.4	122.5
Diseases of the Joint	46.0	40.1	41.9
Disorders of the Spinal Column and Back	35.1	37.8	40.0
Diseases of the Connective Tissue and Muscle	20.8	24.9	19.3
Diseases of the Bone	8.3	18.9*	9.7
Arthritis/Rheumatism	10.5	8.7	11.7
Stress-related Disorders	57.5	43.5	35.5*
Alcohol/Drug Abuse	23.0	23.1	23.9
Transient Situational Disturbances	11.5	6.8	3.9
Neuroses	11.2	3.8*	3.2*
Psychoses	5.8	1.5	- ^b
Ulcers	4.5	6.4	3.2
Diabetes Mellitus	1.6	1.9	-
Diseases of the Respiratory System	34.8	36.3	31.0
Diseases of the Respiratory Tract	13.7	16.2	14.2
Deflected Nasal Septum	13.4	12.5	10.3
Sinusitis	3.5	3.8	3.9
Pleurisy/Respiratory Tuberculosis	-	-	-
Spontaneous Pneumothorax	2.9	1.1	-
Emphysema	-	1.9	-
Diseases of the Nervous System and Sense Organs	26.2	27.2	20.6
Diseases of the Nervous System	10.5	13.6	10.3
Otitis Externa/Other Ear Disorders	8.9	6.8	5.8
Deafness	3.5	3.4	2.6
Neuritis/Neuralgia/Sciatica	2.6	2.6	-
Facial Paralysis/Cerebral Paralysis	-	-	-
Diseases of the Circulatory System	20.4	24.6	21.9
Cardiovascular Disease	8.0	6.0	7.1
Hypertension/Other Cerebrovascular Disease	3.8	5.3	5.8
Other Diseases of the Circulatory System	3.5	7.2	5.8
Phlebitis/Thrombophlebitis	3.2	4.2	1.9
Embolism: Cerebral, Arterial, Venous, etc.	1.9	1.9	-
Environmentally Induced Disorders	5.1	11.3	14.2*
Decompression Sickness	2.9	4.9	9.0
Effects Other External Causes/Drowning/Hypothermia	-	4.9	2.6
Effects of Gas	1.6	1.5	2.6
Barotraumas	0	0	0
Mean Population at Risk	2,609	2,205	1,292

^aHospitalization rates are numbers of admissions per 10,000 population per year.

^bRates are not presented for diagnoses with a frequency of less than 3.

*Rate differs significantly from divers with 1-20 dives.

the majority of older divers' hospital admissions for this category. Other significant results identified an increased risk of cardiovascular disease and hypertension/other cerebrovascular disease among divers beginning at age 35 as contrasted with rates for the youngest age group.

Environmentally Induced Disorders. There were no significant differences in rates across age intervals for this category and the four subcategories. Decompression sickness accounted for the highest percentage of the total rates for this category.

In summary, divers over age 40 had significantly higher hospitalization rates than divers aged 17-22 for the categories of musculoskeletal disorders (primarily disorders of the spinal column and back), stress-related disorders (primarily alcohol/drug abuse), and circulatory diseases.

Hospitalization Rates by Exposure Level

Hospitalization rates by number of dives recorded are presented in Table 2. Of all comparisons, only the category of environmentally induced disorders (primarily decompression sickness) showed a linear increase in incidence with diving exposure. Divers with records of 21-100 dives had a significantly higher rate than less experienced divers for diseases of the bone. Hospitalization rates for the category of stress-related disorders and the subcategory of neuroses were significantly higher for the least experienced group as compared with the most experienced group.

Age-adjusted Hospitalizations by Exposure Level

Age-adjusted frequencies by exposure level and diagnosis are shown in Table 3. These results indicated whether the number of hospitalizations for each exposure level were significantly higher or lower than expected based on the experience of all divers and with the effect of age controlled.

For the category of diseases of the musculoskeletal system, the most experienced group (\geq 101 dives) had fewer admissions than expected. Divers with records of 21 to 100 dives were observed to have significantly more hospitalizations than expected for diseases of the bone. No other comparisons yielded significant probabilities for this disease category.

For the category of stress-related disorders, the least experienced group (1-20 dives) had significantly more hospitalizations than expected while the most experienced divers had fewer hospitalizations than expected. Specifically, hospitalizations for alcohol/drug abuse, transient situational disturbances, neuroses, and psychoses occurred with greater frequency than expected among inexperienced divers. Fewer hospitalizations than expected were observed for neuroses among more experienced divers and for transient situational disturbances among the most experienced personnel.

Conversely, inexperienced divers had significantly fewer hospitalizations than expected for the category of environmentally induced disorders whereas the most experienced group had significantly more hospitalizations than expected, especially for decompression sickness.

For the categories of respiratory, nervous system, and circulatory disease, none of the computations yielded a significant probability thereby indicating no effect of diving exposure.

TABLE 3

COMPARISON OF EXPECTED AND OBSERVED HOSPITALIZATION FREQUENCIES AMONG U. S. NAVY
DIVERS BY AGE-ADJUSTED LEVELS OF DIVING AND DIAGNOSTIC CATEGORY, 1968-79

Diagnostic Category	Number of Dives and Hospitalizations					
	1-20 Dives		21-100 Dives		>101 Dives	
	Ex-pected	Ob-served	Ex-pected	Ob-served	Ex-pected	Ob-served
Diseases of the Musculoskeletal System	357	378	340	345	216	190*
Diseases of the Joint	132	144	114	106	69	65
Disorders of the Spinal Column and Back	98	110	104	100	70	62
Diseases of the Connective Tissue and Muscle	63	65	60	66	38	30
Diseases of the Bone	35	26	34	50**	22	15
Arthritis/Rheumatism	29	33	28	23	17	18
Stress-related Disorders	134	180**	132	115	84	55**
Alcohol/Drug Abuse	59	72*	66	61	45	37
Transient Situational Disturbances	25	36*	22	18	13	6*
Neuroses	21	35**	18	10*	11	5*
Psychoses	11	18*	8	4	4	1
Ulcers	13	14	14	17	9	5
Diabetes Mellitus	5	5	4	5	2	1
Diseases of the Respiratory System	108	109	90	96	55	48
Diseases of the Respiratory Tract	46	43	39	43	23	22
Deflected Nasal Septum	39	42	32	33	20	16
Sinusitis	12	11	9	10	6	6
Pleurisy/Respiratory Tuberculosis	2	2	2	2	2	2
Spontaneous Pneumothorax	5	9	5	3	3	1
Emphysema	4	2	3	5	1	1
Diseases of the Nervous System and Sense Organs	76	82	69	72	41	32
Diseases of the Nervous System	34	33	31	36	20	16
Otitis Externa/Other Ear Disorders	25	28	20	18	10	9
Deafness	10	11	9	9	5	4
Neuritis/Neuralgia/Sciatica	5	8	7	7	5	2
Facial Paralysis/Cerebral Paralysis	2	2	2	2	1	1
Diseases of the Circulatory System	63	64	63	65	37	34
Cardiovascular Disease	19	25	21	16	12	11
Hypertension/Other Cerebrovascular Disease	12	12	14	14	9	9
Other Diseases of the Circulatory System	16	11	14	19	9	9
Phlebitis/Thrombophlebitis	11	10	8	11	5	3
Embolism: Cerebral, Arterial, Venous, etc.	5	6	6	5	2	2
Environmentally Induced Disorders	29	16**	24	30	15	22*
Decompression Sickness	15	9	13	13	8	14*
Effects Other External Causes/Drowning/Hypothermia	8	2*	7	13**	4	4
Effects of Gas	6	5	4	4	3	4
Barotraumas	0	0	0	0	0	0

*p < .05; **p < .01.

DISCUSSION

The purpose of this study was to identify salient health risks among U.S. Navy divers and to examine the influence of age and diving experience on the incidence of these illnesses. Of the diagnoses under study, divers suffered the most from musculoskeletal disorders; the musculoskeletal category alone accounted for more than 40% of all hospital admissions recorded for the six categories. In comparisons of hospitalization rates by age and exposure, the results indicated that the aging process had a significant impact on the overall incidence of musculoskeletal conditions whereas a high level of diving exposure was associated with significantly fewer hospitalizations than expected. The risk for the specific conditions in this category, except back disorders, seemed to be an occupational hazard common to all divers--even young divers with a history of few dives. Such results suggested that exposure to increased barometric pressure among divers of all ages and experience levels may cause changes in and around the joints and muscles which could lead to a restriction of the diver's movements and a hospitalization for treatment. In other words, members of the Navy's diving community seemed to be at risk for joint and muscle disorders, regardless of their age or diving experience.

Also of importance was the finding that no hospitalizations were reported for dysbaric osteonecrosis. However, of the 16 men diagnosed with this disease in a sample 934 divers surveyed by Hunter et al. (15), none had been hospitalized and only one diver reported suffering any symptoms of this disease. Findings of that study added further credence to the use of the term, "silent bend," as a synonym for dysbaric osteonecrosis (3). The prevalence of this very serious disease, therefore, could not be determined on the basis of Navy divers' medical inpatient records.

Total hospitalization rates for the second-ranked category of stress-related disorders as well as alcohol/drug abuse were shown to differ significantly by age, with an increase in rates observed beginning at age 35. Individuals hospitalized for alcohol/drug abuse tended to be older with diving histories that varied across all levels of exposure although more hospitalizations than expected were observed among inexperienced divers. Inexperienced divers also had higher rates than expected for neuroses, transient situational disturbances, and psychoses. Because hospitalizations for these reasons occurred with greatest frequency among the inexperienced, a plausible explanation would be that such a hospitalization resulted in a disqualification from diving. An examination of dates of hospitalization and diving termination, however, indicated that a hospitalization for these disorders seemed to have little bearing on whether or not an individual continued diving; almost 40% of these divers had records showing either active duty status or a time differential of more than one year between the dates of hospitalization and last year of diving. Other age-related results revealed a significantly higher rate among divers aged 41 and older for diabetes mellitus, which seemed to imply that such a diagnosis probably resulted in a disqualification from diving. Comparisons of dates of hospitalization and last year of diving among young, inexperienced divers supported this hypothesis by pointing up a close correspondence in these dates.

For the third and fourth-ranked categories of respiratory and nervous system disorders, there were no noteworthy results other than a tendency among younger and/or inexperienced divers to have higher, although nonsignificant, rates than other divers for otitis externa/other ear problems and spontaneous pneumothorax. The influence of age or diving experience, therefore, was not evident as a factor in illnesses of these classifications.

Although rates for the category of circulatory disorders ranked fifth across the six classifications, this cluster of diseases occupied the second position out of the six categories among divers aged 41 years and older. Beginning at age 35, cardiovascular disease, hypertension, and other cerebrovascular disease accounted for the largest proportion of the circulatory disease hospitalizations. Level of diving exposure was found to be unrelated to any of the specific disorders.

Hospitalization rates for environmentally induced disorders were observed to be quite low across age intervals with the lowest noted among divers aged 41 years and older. Perhaps these older divers were more cautious, performed less hazardous dives, or were in better physical condition than younger divers, which has been postulated by other researchers (24). Other results showed that experienced divers had the highest rates for this category and significantly more hospitalizations than expected for decompression sickness. These results indicated that experienced divers probably were performing more of the deeper dives of considerable duration which also would increase their risk of decompression sickness. In general, the overall low rates for this category reflected favorably on the effectiveness of the diver training program developed by the Navy, especially when one realizes that there were only 68 hospitalizations recorded for these disorders during a 12-year period of approximately 618,000 dives.

To summarize, the aging process accounted for a significant elevation in rates for musculoskeletal conditions (e.g., diseases of the back), alcohol/drug abuse, and circulatory diseases. Very few disorders examined in this study appeared to be associated with either high or low levels of diving experience. Inexperienced divers had significantly more hospitalizations than expected for several stress-related disorders whereas experienced divers had significantly more hospitalizations than expected for environmentally induced conditions, especially decompression sickness. Of greatest concern was the finding that divers of almost all ages and exposure levels were at risk of suffering a musculoskeletal disorder.

As noted at the outset, divers must be in excellent physical condition in order to perform their work. However, because of the potentially hazardous nature of diving and the increased barometric pressure to which they are subjected, divers are at risk of suffering several disorders that require hospitalization. The implications of this study's results included the necessity 1) of determining the extent of these risks in comparison with other Navy enlistees; 2) of specifying other variables than age and exposure levels, such as life style factors, which contribute to these risks; 3) of identifying specific diving hazards that can be changed to reduce the risks; and 4) of developing intervention and prevention programs to be implemented as an initial step in reducing divers' hospitalization rates and in maintaining their otherwise excellent health status. A research project is currently being conducted to establish the extent of these risks by compar-

ing divers' hospitalization rates with a matched sample of Navy enlistees who have identical birth years and occupational specialties but no diving experience. Also, another study has been initiated to identify correlates of divers' ill health as well as diving accidents, death, and performance impairment. Results of these ongoing projects will provide the basis for accomplishing the four objectives just listed. The outcome of such research efforts and programs will be to further enhance the health and safety of all divers.

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APPENDIX

I. Diseases of the Musculoskeletal System and Connective Tissue

A. Diseases of the joint

1. Internal derangement of joint (658^a)
2. Affection of sacroiliac joint/all types (660)
3. Ankylosis of joint/all types (661)
4. Other diseases of joint (663)
5. Symptoms referable to limbs and joints (736)

B. Disorders of the spinal column and back

1. Displacement of intervertebral disc (659)
2. Vertebrogenic pain syndrome (662)
3. Curvature of spine (669)
4. Sprains and strains of sacroiliac region (791)
5. Sprains and strains of other and unspecified parts of back (792)

C. Diseases of connective tissue and muscle

1. Malignant neoplasm of bone (147)
2. Malignant neoplasm of connective and other soft tissue (148)
3. Lipoma (188)
4. Other benign neoplasm of muscular and connective tissue (189)
5. Neoplasm of unspecified nature of skin and musculoskeletal system (205)
6. Polmyositis and dermatomyositis (651)
7. Synovitis, bursitis, and tenosynovitis (665)
8. Infective myositis and other inflammatory diseases of tendon fascia (666)
9. Other diseases of muscle, tendon, and fascia (667)
10. Diffuse disease of connective tissue (668)

D. Diseases of the bone

1. Tuberculosis of bones and joints (016)
2. Benign neoplasm of bone and cartilage (187)
3. Osteomyelitis and periostitis (654)
4. Osteitis deformans (655)
5. Osteochondrosis (656)
6. Other diseases of bone (657)
 - a. Aseptic necrosis, bone (657.06)
7. Other congenital anomalies of limbs (691)
8. Other congenital anomalies of musculoskeletal system (692)
9. Other congenital malformations of bone and joint (693)

E. Arthritis, rheumatism

1. Acute arthritis due to pyogenic organisms (645)
2. Acute nonpyogenic arthritis/all types (646)
3. Rheumatoid arthritis and allied conditions (647)
4. Osteoarthritis and allied conditions (648)
5. Other specified forms of arthritis (649)
6. Arthritis, unspecified (650)
7. Other nonarticular rheumatism (651)
8. Rheumatism, unspecified (652)

II. Stress-related Disorders

A. Alcohol/Drug Abuse

1. Alcoholic psychosis (265)
2. Alcoholism (277)
3. Simple drunkenness (278)
4. Drug dependence (279)
5. Improper use of drugs (280)
6. History of opiate or synthetic morphine-like analgesic abuse past 8 months (281)
7. History of other drug abuse--past 8 months (282)
8. No history of drug abuse--past 8 months (283)
9. Other drug addiction (284)

B. Transient situational disturbances (287)

C. Neuroses (274)

^aICDA-8 diagnostic code.

D. Psychoses

1. Senile and presenile dementia (264)
2. Psychosis associated with intracranial infection (266)
3. Psychosis associated with other cerebral condition (267)
4. Psychosis associated with other physical conditions (268)
5. Schizophrenia (269)
6. Affective psychosis (270)
7. Paranoid states (271)
8. Other psychosis (272)
9. Unspecified psychosis (273)

E. Ulcers

1. Ulcers of stomach (498)
2. Ulcers of duodenum (499)
3. Peptic ulcer, site unspecified (500)
4. Gastrojejunal ulcer (501)

F. Diabetes mellitus (223)

III. Diseases of the Respiratory System

A. Diseases of the respiratory tract

1. Other diseases of upper respiratory tract (475)
2. Other diseases of respiratory system (486)
3. Symptoms referable to respiratory system (732)

B. Deflected nasal septum (471)

C. Sinusitis

1. Acute sinusitis (445)
2. Chronic sinusitis (446)
3. Chronic sinusitis/unspecified type (470)

D. Pleurisy/Respiratory tuberculosis

1. Trigeminal neuralgia (328)
2. Brachial neuritis (329)
3. Sciatica (330)
4. Polyneuritis and polyradiculitis (331)
5. Other and unspecified forms of neuralgia and neuritis (332)

E. Facial paralysis/cerebral paralysis

1. Other cerebral paralysis (321)
2. Facial paralysis (327)

V. Diseases of the Circulatory System

A. Other diseases of the circulatory system

1. Other diseases of circulatory system (443)
2. Other congenital anomalies of circulatory system (682)
3. Symptoms referable to cardiovascular and lymphatic system (731)

B. Cardiovascular disease

1. Ischemic heart disease (396)
2. Other forms of heart disease (397, 434)
3. Arteriosclerosis (423)
4. Aortic aneurysm (425)
5. Other aneurysm (426)
6. Other peripheral vascular disease (427)
7. Polyarteritis nodosa and allied conditions (430)
8. Other disease of arteries and arterioles (431-432)
9. Disease of capillaries (433)

C. Phlebitis and Thrombophlebitis

1. Phlebitis and thrombophlebitis of intracranial venous sinuses (308)
2. Phlebitis and thrombophlebitis (436)
3. Portal vein thrombosis (437)
4. Other venous embolism and thrombosis (438)

D. Embolism

1. Cerebral thrombosis (414)
2. Cerebral embolism (415)
3. Cerebral embolism and thrombosis (416)
4. Pulmonary embolism and infarction (435)
5. Air embolism (943.01)
6. Fat embolism (943.02)

E. Hypertension and other cerebrovascular disease

1. Malignant hypertension (380)
2. Essential malignant hypertension (381)
3. Essential benign hypertension (382)
4. Hypertensive heart disease (383)
5. Hypertensive renal disease (384)
6. Hypertensive heart and renal disease (385)
7. Hypertensive cardiovascular disease with arteriolar nephrosclerosis (386)
8. Other hypertensive disease without mention of heart disease (387)
9. Other unspecified hypertensive cardiovascular disease (388)
10. Hypertension with arteriolar nephrosclerosis (389)
11. Subarachnoid hemorrhage (390)
12. Cerebral hemorrhage (412)
13. Occlusion of precerebral arteries (413)
14. Transient cerebral ischemia (417)
15. Angiospasm of the cerebral arteries (418)
16. Acute but ill-defined cerebrovascular disease (419)
17. Generalized ischemic cerebrovascular disease (420)
18. Other ill-defined vascular lesions affecting the central nervous system (421)
19. Other ill-defined cerebrovascular disease (422)

VI. Environmentally Induced Disorders

A. Decompression sickness

1. Effects of air pressure/caisson disease (941.05)

B. Effects of other external cause/drowning, hypothermia

1. Toxic effect of other substances nonmedicinal as to source/venom (934.05)
2. Effects of reduced temperature and excessive dampness/frostbite of other and unspecified sites (938.04/938.06)
3. Effects of other external causes/drowning and nonfatal submersion, and motion sickness (942.02-942.04, 942.09-942.10)

C. Effects of gas

1. Toxic effect of carbon monoxide (931)
2. Toxic effect of other gases, fumes, or vapors (932.06)

D. Barotraumas

1. Effects of air pressure/barotrauma, otitic and sinus (941.01/941.02)

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disorders (e.g., decompression sickness) were significantly higher among experienced divers. Divers seemed to be at risk for joint and muscle disorders, regardless of their age or diving experience. Several recommendations were presented which were designed to further enhance the health and safety of all divers.



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