

ACKNOWLEDGEMENTS

Gratitude is extended to the members of the Undersea Medical Society, Inc., who gave advice for this effort, and especially to those who selected material in each special area.

Special thanks go to Mrs. Carolyn Paddon for all the management aspects of this rather complicated effort. The assistance of the staff of the National Library of Medicine is greatly appreciated.

Key documents of overall interest were suggested by Drs. Peter Bennett, Brian G. D'Aoust, and J. Vorosmarti, Jr. (United States) and by J. Adolfson, Carl M. Hesser, and H. Ornhagen (Sweden).

The total compilation and arrangement of the five volumes is the result of the effort of Dr. Charles W. Shilling.

The editing was the work of Mrs. Catherine B. Carlston.

DISCLAIMER

Obviously, neither the Undersea Medical Society nor the authors of the various sections claim that the articles, reports or book chapters they have selected are the only ones that have helped to advance the field. They do feel, however, that their selection is a valid sample of the work as it has progressed from the beginning to its present level.

FOREWORD

The Undersea Medical Society, Inc. has an educational mission as part of its charter. This present effort is directed toward this mission. It is always wise to trace the development of a particular idea for better understanding and intelligent progression to the next step. Therefore, medical experts in each of the many fields of diving medicine have selected those articles, reports, or chapters of books which they regard as important to the development and better understanding of their particular fields of interest.

I am pleased to have been president of the Society during the development of this effort since I consider it a major step in recording the progress that has been made in each of the various components of the medical aspects of deep sea diving.

John M. Hallenbeck, M.D.
President
Undersea Medical Society

PREFACE

The original idea for this project came from Dr. William Fife, who pointed out that it was extremely difficult to find some of the old, yet important documents covering the development of our knowledge in hyperbaric medicine and deep-sea diving medicine.

After consultation with numerous research scientists and a presentation to the Executive Committee of the Undersea Medical Society, Inc., it was universally agreed that collection of the seminal or key documents in the many different special areas of diving medicine would be a significant contribution to diving literature.

The National Library of Medicine agreed to support this effort. A proposal was submitted and approved; the present publication is the result.

The following are the special areas selected for in-depth treatment.

Caisson and Tunnel Work
Chronic CO₂ Toxicity
Cold Water Exposure and Thermal Balance
Decompression Theory
Diving Gases (Other Than Hydrogen)
Diving Medicine: The High Pressure Neurologic Syndrome
Drowning and Near-Drowning
Dysbaric Osteonecrosis
Gas Embolism
Hydrogen-Oxygen Diving
Hyperbaric Oxygen Therapy
Inert Gas Narcosis
Otology in Diving (The Ear in Diving)
Oxygen Toxicity
Pathophysiology and Treatment of Decompression Sickness
Pulmonary Function
Saturation Diving
Underwater Performance
Vision

Individuals, expert in each of the above fields, were contacted and a letter written to them with the following explanatory paragraphs:

The UMS has a grant from the National Library of Medicine to collect, annotate and reproduce the "key" or "seminal" documents leading to our present knowledge of the broad field of deep-sea diving.

Would you, in the field of _____ pick five or ten articles that you feel have been the key pieces of research reporting that have led us to our present state of knowledge for this field? All we ask is that you write a short paragraph or running description of why they were selected. "I selected this research report because it was the very first article mentioning this condition." "I selected this article because the pathology of the condition is so well described and illustrated," and so on.

If you will then send us your short write-up telling why the five to ten documents have been selected, we will obtain the originals as best we can, photograph them and reproduce them without further annotation. Translation may be necessary for some of the more difficult languages. Of course, you will be credited with this contribution to the anticipated three-volume set. Although there would be reluctance on the part of most authors to mention their own work, since each person selected is considered to be the leading expert in the field, it is obvious that some of your papers must be included. We are extremely anxious to make this as international as possible; therefore, work from other countries would certainly be desirable.

Each individual, or individuals, is given credit at the beginning of the presentation of the particular subject area.

C. W. Shilling, M.D.
Executive Secretary
Undersea Medical Society, Inc.

PUBLISHERS GRANTING PERMISSION

The following corporate bodies have kindly given permission for the reproduction of material printed in their journals.

Specific note of permission is given in references following each of the nineteen sections.

Academic Press, Inc.
111 Fifth Avenue
New York, New York 10003

Academisch Ziekenhuis
Grimburgwal 10
1012 GA
Amsterdam, The Netherlands

Aerospace Medical Association
Washington National Airport
Washington, D.C. 20001

American Academy of Ophthalmology
& Otolaryngology
15 Second St., S.W.
Rochester, Minnesota 55901

American Academy of Orthopaedic
Surgeons
10 Shattuck St.
Boston, Massachusetts 02115

American Association for the
Advancement of Science
1515 Massachusetts Ave., N.W.
Washington, D.C. 20005

American College of Chest Physicians
911 Busse Highway
Park Ridge, Illinois 60068

American College of Physicians
4200 Pine St.
Philadelphia, Pennsylvania 19104

American College of Surgeons
Franklin H. Martin Memorial Foundation
55 E. Erie St.
Chicago, Illinois 60611

American Heart Association
7320 Greenville Ave.
Dallas, Texas 75231

American Institute of Physics
335 E. 45th St.
New York, New York 10017

American Medical Association
535 N. Dearborn St.
Chicago, Illinois 60610

American Physiological Society
9650 Rockville Pike
Bethesda, Maryland 20814

American Psychological Association
1400 North Uhle St.
Arlington, Virginia 22201

Annals Publishing Company
4949 Forest Park Blvd.
St. Louis, Missouri 63108

Annual Reviews, Inc.
4130 El Camino Way
Palo Alto, California 94306

AMTE Physiological Laboratory
Fort Road, Alverstoke
Gosport, Hants, PO12 2DU
England

Association of Military Surgeons of the
United States
P.O. Box 104
Kensington, Maryland 20795

Bern Rogers, Publishers
1 E. 1st St.
Duluth, Minnesota 55802

The Biochemical Society (London)
7 Warwick Court
High Holborn
London WC1R 5DP
England

- British Medical Association
B.M.A. House
Tavistock Square
London WC1H 9JR, England
- Bulletin Medsubhyp
Société Française de Médecine
Subaquatique et Hyperbare
C⁰/P² Corriol, Faculté de Médecine
Bvd Jean-Moulin
13385 Marseille Cedex 4, France
- Cambridge University Press
32 East 57th St.
New York, New York 10022
- Cambridge University Press
200 Euston Rd.
London NW1 2DB, England
- Canadian Anaesthetists' Society Journal
Univ. of Toronto Press
5201 Dufferin St.
Downsview, Ont., Canada
- Dun-Donnelly Publishing Corp.
666 Fifth Avenue
New York, New York 10019
- Elsevier/North-Holland, Inc.
52 Vanderbilt Ave.
New York, New York 10017
- Federation of American Societies for
Experimental Biology
9650 Rockville Pike
Bethesda, Maryland 20814
- Fifth International Hyperbaric Congress
Proceedings
Simon Fraser University
Burnaby 2, B.C., Canada
- Forsvarets Sjukvårdsstyrelse
Riddergatan 13
Stockholm 14, Sweden
- Heldref Publications
4000 Albemarle St., N.W.
Washington, D.C. 20016
- Human Factors Society, Inc.
Johns Hopkins University Press
Baltimore, Maryland 21208
- Institute of Naval Medicine
Alverstoke, Gosport, Hants P012 2DL
England
- Journal of Occupational Medicine
150 North Wacker Drive
Chicago, Illinois 60606
- S. Karger AG
Arnold-Boecklin-Strasse 25
CH-4011 Basel, Switzerland
- Lancet
7 Adam St.
London WC2N 6AD, England
- J. B. Lippincott Co.
E. Washington Square
Philadelphia, Pennsylvania 19105
- E & S Livingstone, Ltd.
23 Ravelston Terrace
Edinburgh, EH4 3TL
Scotland
- Longman Group, Ltd.
Westgate House
The High
Harlow, Essex CM20 1NE
England
- Macmillan Journals, Ltd.
4 Little Essex St.
London WC2R 3LF
England
- Maroc-Médical
Direction de la Revue
287, Bd de la Liberté
Casablanca, Morocco
- Marine Technology Society
1730 M St., N.W.
Washington, D.C. 20036
- Masson et Cie, Editeurs
120 Bd. St. Germain
75280 Paris, Cedex 06
France
- Massachusetts Medical Society
10 Shattuck St.
Boston, Massachusetts 02115

Mayo Foundation and Clinic
 Rochester, Minnesota 55901
 Medical Research Council
 Royal Naval Personnel Research
 Committee
 Ministry of Defence
 40-48 High Holborn
 London WC1V 6HE
 England
 Minerva Medica
 Corso Bramante, 83
 10126 Turin, Italy
 National Academy of Sciences
 2101 Constitution Ave., N.W.
 Washington, D.C. 20418
 National Geographic Magazine
 17th & M Sts.
 Washington, D.C. 20036
 National Research Council of Canada
 Ottawa K1A 0R6
 Canada
 Offshore Technology Conference
 6200 North Central Expressway
 Dallas, Texas 75206
 Oliver & Boyd, Ltd.
 Tweeddale Court
 14 High St.
 Edinburgh, EH1 1YL
 Scotland
 Ophthalmic Publishing Co.
 233 E. Ontario St., Suite 1401
 Chicago, Illinois 60611
 Pergamon Press
 Headington Hill Hall
 Oxford OX3 0BW
 England
 Plenum Publishing Co.
 233 Spring St.
 New York, New York 10013
 Rockefeller University Press
 1230 York Avenue
 New York, New York 10021
 The Royal College of Surgeons of
 England
 35-43 Lincoln's Inn Fields
 London WC2A 3PN
 England
 Royal Society of London
 6 Carlton House Terrace
 London SW1Y 5AG
 England
 W. B. Saunders Co.
 218 West Washington Square
 Philadelphia, Pennsylvania 19105
 Chales B. Slack, Inc.
 6900 Grove Rd.
 Thorofare, New Jersey 08086
 Société Française de Médecine du Sport
 17, rue du 8-mai 1945
 F75010, Paris
 France
 Society for Experimental Biology
 Department of Zoology
 University of Hull
 Hull HU6 7RX
 N. Humberside, England
 Springer-Verlag
 175 Fifth Avenue
 New York, New York 10010
 Springer-Verlag
 Postfach 105 280
 D-6900 Heidelberg
 West Germany
 Stevens Publishing Corporation
 4901 Bosque Blvd.
 Waco, Texas 76710
 Texas Reports on Biology and Medicine
 University of Texas Medical Branch
 Galveston, Texas 77550
 Undersea Medical Society, Inc.
 9650 Rockville Pike
 Bethesda, Maryland 20814
 John Wiley & Sons, Ltd.
 Baffins Lane, Chichester
 Sussex PO19 1UD
 England
 Williams & Wilkins
 428 E. Preston St.
 Baltimore, Maryland 21202
 Zeitschrift für Radiologische Technik
 Birkenwaldstr. 44 Postfach 347
 7000 Stuttgart 1
 West Germany

CONTRIBUTORS

Although the name of the contributor appears with the material selected, the names are arranged here alphabetically for easy reference.

Arthur J. Bachrach, Ph.D.
Albert R. Behnke, M.D.
Ralph W. Brauer, Ph.D.
James M. Clark, M.D.
Jefferson C. Davis, M.D.
Peter O. Edel
Joseph C. Farmer, M.D.
Robert Gelfand, M.E.
John M. Hallenbeck, M.D.
R. W. Hamilton, Jr., Ph.D.
Brian A. Hills, Ph.D.
Jo Ann S. Kinney, Ph.D.
Karl E. Schaefer, M.D.
T. G. Shields, M.D.
Barbara B. Tabelaing, M.D.
Dennis N. Walder, M.D.
Paul Webb, M.D.

TABLE OF CONTENTS

Foreword	vii
Preface	ix
Publishers Granting Permission	xi
1. Caisson and tunnel work—A. R. Behnke, Jr.	I-1-1
Behnke, A. R.	
Excerpts, medical aspects of work in pressurized tunnel operations.	I-1-5
Behnke, A. R.	
New approaches to medical aspects of work in compressed air.	I-1-13
Bert, P.	
High pressures.	I-1-28
Bornstein, A.	
Physiologie and Pathologie des Lebens in verdichteter Luft.	I-1-64
Heller, R., Mager W., v. Schrotter H.	
Vorlaufige Mittheilung uber Caissonarbeiter.	I-1-70
Hempleman, H. V.	
The new decompression tables, Appendix I.	I-1-73
Jarcho, S.	
Historical milestones: Alphonse Jaminet on caisson disease (1871).	I-1-92
Jones, J. P., Jr., Behnke, A. R.	
Prevention of dysbaric osteonecrosis in compressed air workers.	I-1-95
Keays, F. L.	
Compressed-air illness.	I-1-106
Kooperstein, S. I., Schuman, B. J.	
Acute decompression illness	I-1-121
Nashimoto, I., Mano, Y.	
Experimental studies on oxygen decompression.	I-1-127
Sealey, J. L.	
Safe exit from the hyperbaric environment.	I-1-132
Thorne, I. J.	
Caisson disease.	I-1-135
Walder, D. N.	
Some problems of working in an hyperbaric environment.	I-1-139
Walder, D. N., McCallum, R. I.	
An objective appraisal of the Blackpool (UK) and Washington State (USA) decompression tables.	I-1-160

2. Chronic CO ₂ toxicity—Karl E. Schaefer	I-2-1
Clark, J. M., Sinclair, R. D., Welch, B. E.	
Rate of acclimatization to chronic hypercapnia in man.	I-2-6
Consolazio, W. V., et al.	
Effects on man of high concentrations of carbon dioxide in relation to various oxygen pressures during exposures as long as 72 hours.	I-2-16
Guillerm, R., Radziszewski, E.	
Effects on man of 30-day exposure to a P _{tCO₂} of 14 torr (2%); application to exposure limits.	I-2-42
Luft, U. C., Finkelstein, S., Elliott, J. C.	
Respiratory gas exchange, acid-base balance, and electrolytes during and after maximal work breathing 15 mm Hg P _{tCO₂}	I-2-66
Schaefer, K. E.	
Studies of carbon dioxide toxicity. Chronic CO ₂ toxicity in submarine medicine.	I-2-78
Schaefer, K. E.	
Physiological stresses related to hypercapnia during patrols on submarines.	I-2-113
Schaefer, K. E., Nichols, G., Jr., Carey, C. R.	
Calcium phosphorus metabolism in man during acclimatization to carbon dioxide.	I-2-146
Schaefer, K. E., Nichols, G., Jr., Carey, C. R.	
Acid-base balance and blood and urine electrolytes of man during acclimatization to CO ₂	I-2-152
Schaefer, K. E., et al.	
CO ₂ -induced kidney calcification.	I-2-164
Schaefer, K. E., et al.	
Phasic changes in bone CO ₂ fractions, calcium, and phosphorus during chronic hypercapnia.	I-2-175
Sinclair, R. D., Clark, J. M., Welch, B. E.	
Comparison of physiological responses of normal man to exercise in air and in acute and chronic hypercapnia.	I-2-185
Van Ypersele de Strihou, C., Brasseur, L., De Coninck, J.	
The "carbon dioxide response curve" for chronic hypercapnia in man.	I-2-194
3. Cold water exposure and thermal balance—Paul Webb	I-3-1
Beckman, E. L.	
Thermal protective suits for underwater swimmers.	I-3-5
Behnke, A. R., Yaglou, C. P.	
Responses of human subjects in immersion in ice water and to slow and fast rewarming.	I-3-21
Carlson, L. D., et al.	
Immersion in cold water and body tissue insulation.	I-3-38
Golden, F. St. C.	
Accidental hypothermia	I-3-46
Hayward, J. S., Eckerson, J. D., Collis, M. L.	
Thermal balance and survival time prediction of man in cold water.	I-3-57

Kang, D. H., et al.	
Energy metabolism and body temperature of the ama.	I-3-69
Molnar, G. W.	
Survival of hypothermia by men immersed in the ocean.	I-3-74
Pugh, L. G. C., Edholm, O. G.	
The physiology of channel swimmers.	I-3-89
Raymond, L. W., et al.	
Body temperature and metabolism in hyperbaric helium atmospheres.	I-3-97
Varène, P., et al.	
Energy balance of man in simulated dive from 1.5 to 31 ATA.	I-3-104
Webb, P., Annis, J. F.	
Respiratory heat loss with high density gas mixtures.	I-3-113
Webb, P.	
Body heat loss in undersea gaseous environments.	I-3-166
4. Decompression theory—B. A. Hills	I-4-1
Behnke, A. R.	
Decompression sickness following exposure to high pressures.	I-4-5
Behnke, A. R., Shaw, L. A.	
The use of oxygen in the treatment of compressed air illness.	I-4-42
Boycott, A. E., Damant, G. C. C., Haldane, J. S.	
Prevention of compressed air illness.	I-4-55
Hawkins, J. A., Shilling, C. W., Hansen, R. A.	
A suggested change in calculating decompression tables for diving.	I-4-160
Hempleman, H. V.	
Investigation into the decompression tables. Report III, part A. A new theoretical basis for the calculation of decompression tables.	I-4-172
Hempleman, H. V.	
Decompression procedures for deep, open sea operations.	I-4-184
Hills, B. A.	
Relevant phase conditions for predicting occurrence of decompression sickness.	I-4-196
Hills, B. A.	
A quantitative correlation of conditions for the occurrence of decompression sickness for aerial and underwater exposures.	I-4-202
Hills, B. A.	
Unsaturation in living tissue relative to the pressure and composition of inhaled gas and its significance in decompression theory.	I-4-208
Keller, H., Bühlmann, A. A.	
Deep diving and short decompression by breathing mixed gases.	I-4-219
Workman, R. D.	
Calculations of decompression tables for nitrogen-oxygen and helium- oxygen dives.	I-4-223
5. Diving gases (other than hydrogen)—R. W. Hamilton	II-5-1
Behnke, A. R., Willmon, T. L.	
USS SQUALUS. Medical aspects of the rescue and salvage operations, and the use of oxygen in deep-sea diving.	II-5-5

Blenkarn, G. D., et al.	
Urticaria following the sequential breathing of various inert gases at a constant ambient pressure of 7 ATA: a possible manifestation of gas-induced osmosis.	II-5-17
D'Aoust, B. G., et al.	
Venous gas bubbles: Production by transient, deep isobaric counterdiffusion of helium against nitrogen.	II-5-24
Gerstman, L. J., Gamertsfelder, G. R., Goldberger, A.	
Breathing mixture and depth as separate effects on helium speech.	II-5-27
Goodman, M. W., et al.	
Hyperbaric respiratory heat loss study.	II-5-28
Graves, D. J., et al.	
Bubble formation in physical and biological systems: a manifestation of counterdiffusion in composite media.	II-5-114
Momsen, C. B.	
Report on the use of helium-oxygen mixtures for diving.	II-5-118
Sayers, R. R., Yant, W. P., Hildebrand, J. H.	
Possibilities in the use of helium-oxygen mixtures as a mitigation of caisson disease.	II-5-187
Schreiner, H. R., Hamilton, R. W., Jr., Langley, T. D.	
Neon: An attractive new commercial diving gas.	II-5-205
Webster, A. P.	
Some theoretical aspects of the use of multiple-gas mixtures for deep-sea diving.	II-5-222
6. Diving medicine: The high pressure neurologic syndrome—	
R. W. Brauer	II-6-1
Bennett, P. B.	
Psychometric impairment in men breathing oxygen-helium at increased pressures.	II-6-5
Bennett, P. B.	
Performance impairment in deep diving due to nitrogen, helium, neon, and oxygen.	II-6-7
Bennett, P. B., et al.	
Suppression of the high pressure nervous syndrome in human deep dives by He-N ₂ -O ₂	II-6-22
Bennett, P. B., Towse, E. J.	
The high pressure nervous syndrome during a simulated oxygen-helium dive to 1500 ft.	II-6-39
Brauer, R. W., et al.	
Syndrome neurologique et électrographique des hautes pressions.	II-6-50
Brauer, R. W., et al.	
N ₂ , H ₂ , and N ₂ O antagonism of high pressure neurological syndrome in mice.	II-6-53
Brauer, R. W., et al.	
Experimental studies on the high pressure hyperexcitability syndrome in various mammalian species.	II-6-68

Brauer, R. W., Way, R. O., Perry, R. Separation of anesthetic and convulsant effects in mice breathing He and H ₂ containing atmosphere at 50 to 150 ATM.	II-6-82
Brauer, R. W., Way, R. O., Perry, R. A. Narcotic effects of helium and hydrogen in mice and hyperexcitability phenomena at simulated depths of 1500 to 4000 feet of sea water.	II-6-83
Chouteau, J., Imbert, G. La limitation hypoxique de la plongée profonde de longue durée.	II-6-99
Ebbecke, U. Über das Verhalten des Zentralnervensystems (Rückenmarksfrosh) unter der Einwirkung hoher Drucke.	II-6-107
Fructus, X., Agarate, C., Rostain, J. C. Reflexions sur la courbe de compression des plongées très profondes.	II-6-113
Kylstra, J. A., et al. Hydraulic compression of mice to 166 atmospheres.	II-6-122
Lever, M. J., et al. Effects of hydrostatic pressure on mammals.	II-6-124
Miller, K. W. Inert gas narcosis, the high pressure neurological syndrome, and the critical volume hypothesis.	II-6-132
Miller, K. W., et al. Animals at very high pressures of helium and neon.	II-6-135
Peterson, R. E., Wright, W. B. Pulmonary mechanical functions in man breathing dense gas mixtures at high ambient pressures—predictive studies III.	II-6-136
Regnard, M. P. Phénomènes objectifs que l'on peut observer sur les animaux soumis aux hautes pressions.	II-6-148
Rostain, J. C., Lemaire, C. Évolution du tremblement au repos et pendant l'effort au cours de plongées profondes en atmosphère hélium-oxygène.	II-6-154
Zaltsman, G. L. Nachalnye proyavleniya gelievovo narkoza u chelovyeka.	II-6-158
 7. Drowning and near-drowning—Barbara B. Tabelaing	II-7-1
Bergquist, R. E., et al. Comparison of ventilatory patterns in the treatment of fresh-water near-drowning in dogs.	II-7-5
Campbell, L. B., Gooden, B. A., Horowitz, J. D. Cardiovascular responses to partial and total immersion in man.	II-7-12
Conn, A. W., et al. Cerebral salvage in near-drowning following neurological classification by triage.	II-7-23
Fuller, R. H. The 1962 Welcome prize essay. Drowning and the post-immersion syndrome. A clinicopathologic study.	II-7-33

Giammona, S. T., Modell, J. H. Drowning by total immersion. Effects on pulmonary surfactant of distilled water, isotonic saline, and sea water.	II-7-48
Halmagyi, D. F. J., Colebatch, H. J. H. Ventilation and circulation after fluid aspiration.	II-7-53
Keatinge, W. R., et al. Sudden failure of swimming in cold water.	II-7-59
Modell, J. H., et al. Effects of ventilatory patterns on arterial oxygenation after near-drowning in sea water.	II-7-63
Modell, J. H., Davis, J. H. Electrolyte changes in human drowning victims.	II-7-72
Modell, J. H., et al. Physiologic effects of near drowning with chlorinated fresh water, distilled water and isotonic saline.	II-7-79
Modell, J. H., Graves, S. A., Ketover, A. Clinical course of 91 consecutive near-drowning victims.	II-7-88
Modell, J. H., et al. The effects of fluid volume in seawater drowning.	II-7-96
Nemiroff, M. J. Resuscitation following cold-water near-drowning.	II-7-109
Nemiroff, M. J. Accidental cold-water immersion and survival characteristics.	II-7-110
Nemiroff, M. J., Saltz, G. R., Weg, J. C. Survival after cold-water near-drowning: the protective effect of the diving reflex.	II-7-111
Redding, J. S., Voigt, G. C., Safar, P. Treatment of seawater aspiration.	II-7-112
Reidbord, H. E., Spitz, W. U. Ultrastructural alterations in rat lungs: changes after intratracheal perfusion with freshwater and seawater.	II-7-116
Siebke, H., Breivik, H., Rod, T., Lind, B. Survival after 40 minutes' submersion without cerebral sequelae.	II-7-125
Swann, H. G., Brucer, M., Moore, C., Vezien, B. L. Fresh water and sea water drowning: a study of the terminal cardiac and biochemical events.	II-7-128
8. Dysbaric osteonecrosis--D. N. Walder	II-8-1
Allen, T. H., Davis, J. C., Hodgson, C. J. US Air Force experience in hypobaric osteonecrosis.	II-8-6
Bassoe, P. Compressed air disease.	II-8-10
Catto, M. Pathology of aseptic bone necrosis.	II-8-12
Chryssanthou, C. P. Dysbaric osteonecrosis in mice.	II-8-14
Cox, P. T. Simulated caisson disease of bone.	II-8-32

Davidson, J. K.	
Dysbaric osteonecrosis.	II-8-38
Decompression Sickness Panel Report, M.R.C.	
Bone lesions in compressed air workers with special reference to men who worked on the Clyde Tunnels 1958 to 1963.	II-8-104
Golding, F. C., et al.	
Decompression sickness during construction of the Dartford Tunnel.	II-8-133
Gregg, P. J., Walder, D. N.	
Early diagnosis of dysbaric osteonecrosis.	II-8-149
Grützmacher, K. T.	
<i>Veränderungen am Schultergelenk als Folge von Drucklufterkrankung</i> (Changes of the shoulder as a result of compressed-air sickness).	II-8-158
Harrison, J. A. B.	
Aseptic bone necrosis in naval clearance divers: radiographic findings.	II-8-161
Harvey, C. A., Sphar, R. L.	
Dysbaric osteonecrosis in divers. A survey of 611 selected navy divers. ...	II-8-164
Hills, B. A.	
Treatment and general hyperbaric limitations.	II-8-167
James, C. C. M.	
Late bone lesions in caisson disease.	II-8-178
Kahlstrom, S. C., Burton, C. C., Phemister, D. B.	
Aseptic necrosis of bone. I. Infarction of bones in caisson disease resulting in encapsulated and calcified areas in diaphyses and in arthritis deformans.	II-8-186
Ohta, Y., Matsunaga, H.	
Bone lesions in divers.	II-8-204
Smith, K. H., Stegall, P. J., Huang, T. W.	
Histopathology of aseptic bone necrosis in miniature swine.	II-8-219
Twynam, G. E.	
A case of caisson disease.	II-8-220
9. Gas embolism—T. G. Shields.	III-9-1
de la Torre, E., Meredith, J., Netsky, M. G.	
Cerebral air embolism in the dog.	III-9-5
Evans, D.E., Hardenberg, E., Hallenbeck, J. M.	
Cardiovascular effects of arterial air embolism.	III-9-16
Greene, K. M.	
Causes of death in submarine escape training casualties: analysis of cases and review of the literature.	III-9-30
Hallenbeck, J. M., Furlow, T. W., Jr.	
Impaired microvascular perfusion and secondary deterioration in dysbaric cerebral air embolism.	III-9-60
Macklin, M., Macklin, C. C.	
Malignant interstitial emphysema as an important occult complication in many respiratory diseases and other conditions.	III-9-73
Malhotra, M. S., Wright, H. C.	
The effects of a raised intrapulmonary pressure on the lungs of fresh unchilled cadavers.	III-9-75

Peirce, E. C.	
Cerebral gas embolism (arterial) with special reference to iatrogenic accidents.	III-9-83
Schaefer, K. E., et al.	
Mechanisms in development of interstitial emphysema and air embolism on decompression from depth.	III-9-107
van Allen, C. M., Hrdina, L. S., Clark, J.	
Air embolism from the pulmonary vein.	III-9-122
Van Genderen, L., Waite, C. L.	
Evaluation of the rapid recompression high pressure oxygenation approach to the treatment of traumatic cerebral embolism.	III-9-155
Waite, C. L., et al.	
Cerebral air embolism: 1. Basic studies.	III-9-168
10. Hydrogen-oxygen diving—Peter O. Edel	III-10-1
Case, E.M., Haldane, J. B. S.	
Human physiology under high pressure.	III-10-5
Edel, P. O.	
Report on Project Hydrox II.	III-10-32
Edel, P. O., et al.	
Preliminary studies of hydrogen-oxygen breathing mixtures for deep sea diving.	III-10-116
Lazarev, N. V.	
The intensity of the narcotic action of hydrogen at high pressure.	III-10-131
Michaud, A., et al.	
Findings from an animal experiment on dives using hydrogen-oxygen blends.	III-10-135
Miller, K. W.	
Inert gas narcosis and animals under high pressure.	III-10-169
Seguin, A. P., Lavoisier, A. L.	
Premier mémoire sur la respiration des animaux.	III-10-186
Zetterstrom, A.	
Deep-sea diving with synthetic gas mixtures.	III-10-205
11. Hyperbaric oxygen therapy—Jefferson C. Davis	III-11-1
Boerema, I., et al.	
High atmospheric pressure as an aid to cardiac surgery.	III-11-5
Boerema, I., et al.	
Life without blood. A study of the influence of high atmospheric pressure and hypothermia on dilution of the blood.	III-11-24
Brummelkamp, W. H., Hogendijk, J., Boerema, I.	
Treatment of anaerobic infections (Clostridial myositis) by drenching the tissues with oxygen under high atmospheric pressure.	III-11-38
Churchill-Davidson, I., Sanger, C., Thomlinson, R. H.	
High-pressure oxygen and radiotherapy.	III-11-39
Haldane, J.	
The relation of the action of carbonic oxide to oxygen tension.	III-11-44

Hunt, T. K., Zederfeldt, B., Goldstick, T. K. Oxygen and healing.	III-11-61
Lambertsen, C. J. Medical implications of high oxygen pressures.	III-11-62
Raskin, A., et al. The effects of hyperbaric and normobaric oxygen on cognitive impairment in the elderly.	III-11-80
Silver, I. A. The measurement of oxygen tension in healing tissue.	III-11-87
12. Inert gas narcosis—Albert R. Behnke, Jr.	III-12-1
Adolfson, J., Muren, A. Air breathing at 13 atmospheres. Psychological and physiological observations.	III-12-7
Behnke, A. R., Thomson, R. M., Motley, E. P. The psychologic effects from breathing air at 4 atmospheres pressure.	III-12-14
Behnke, A. R., Yarbrough, O. D. Physiologic studies of helium.	III-12-19
Behnke, A. R., Yarbrough, O. D. Respiratory resistance, oil-water solubility, and mental effects of argon, compared with helium and nitrogen.	III-12-36
Bennett, P. B., Ackles, K. N. The narcotic effects of hyperbaric oxygen.	III-12-43
Bennett, P. B., Ackles, K. N., Cripps, V. J. Effects of hyperbaric nitrogen and oxygen on auditory evoked responses in man.	III-12-44
Bennett, P. B., Blenkarn, G. D. Arterial blood gases in man during inert gas narcosis.	III-12-45
Bennett, P. B., Glass, A. Electroencephalographic and other changes induced by high partial pressures of nitrogen.	III-12-49
Bennett, P. B., Papahadjopoulos, D., Bangham, A. D. The effect of raised pressures of inert gases on phospholipid membranes.	III-12-50
Bennett, P. B., Towse, E. J. Performance efficiency of men breathing oxygen-helium at depths between 100 feet and 1500 feet.	III-12-51
Bjurstedt, H., Severin, G. The prevention of decompression sickness and nitrogen narcosis by the use of hydrogen as a substitute for nitrogen (the Arne Zetterström method for deep-sea diving).	III-12-61
Carpenter, F. G. Anesthetic action of inert and unreactive gases on intact animals and isolated tissues.	III-12-71
Clements, J. A., Wilson, K. M. The affinity of narcotic agents for interfacial films.	III-12-76

Cullen, S. C., Gross, E. G. Anesthetic properties of xenon in animals and human beings with additional observations on krypton.	III-12-83
Damant, G. C. C. Physiological effects of work in compressed air.	III-12-84
End, E. The use of new equipment and helium gas in a world record dive.	III-12-87
Hesser, C. M. Measurement of inert gas narcosis in man.	III-12-98
Hill, L., Phillips, A. E. Deep-sea diving.	III-12-105
Johnson, F. H., Flagler, E. A. Hydrostatic pressure reversal of narcosis in tadpoles.	III-12-122
Kiessling, R. J., Maag, C. H. Performance impairment as a function of nitrogen narcosis.	III-12-123
Lever, M. J., et al. Pressure reversal of anesthesia.	III-12-148
Meyer, K. H., Gottlieb-Billroth, M. Theory of narcosis by inhalation anaesthesia.	III-12-152
Meyer, K. H., Hopff, H. Narcosis by inert gases under pressure.	III-12-171
Miller, K. W. The opposing physiological effects of high pressures and inert gases.	III-12-186
Paton, W. D. M. Experiments on the convulsant and anaesthetic effects of oxygen.	III-12-192
Shilling, C. W., Willgrube, W. W. Quantitative study of mental and neuromuscular reactions as influenced by increased air pressure.	III-12-193
Stern, S. A., Frisch, H. L. Dependence of inert gas narcosis on lipid "free volume."	III-12-201
Wulf, R. J., Featherstone, R. M. Correlation of van der Waals constants with anesthetic potency.	III-12-202
 13. Otology in diving (The ear in diving)—Joseph C. Farmer, Jr. ...	 IV-13-1
Behnke, A. R. Physiologic effect of pressure changes with reference to otolaryngology. ...	IV-13-6
Braithwaite, W. R., Berghage, T. E., Crothers, J. C. Postural equilibrium and vestibular response at 49.5 ATA.	IV-13-16
Brandt, J. F., Hollien, H. Underwater hearing thresholds in man as a function of water depth.	IV-13-31
Edmonds, C., Freeman, P., Tonkin, J. Fistula of the round window in diving.	IV-13-34
Farmer, J. C., Jr. Diving injuries to the inner ear.	IV-13-39
Farmer, J. C., Jr., Thomas, W. G. Auditory and vestibular function in diving.	IV-13-59
Fluur, E., Adolfsen, J. Hearing in hyperbaric air.	IV-13-60

Freeman, P., Edmonds, C. Inner ear barotrauma.	IV-13-63
Lambertsen, C. J., Idicula, J. A new gas lesion syndrome in man, induced by "isobaric gas counterdiffusion."	IV-13-64
Landolt, J. P., et al. Vestibulocochlear dysfunction in squirrel monkeys in simulated diving experiments.	IV-13-75
Shilling, C. W., Everley, I. A. Auditory acuity in submarine personnel, Part III.	IV-13-83
Vail, H. H. Traumatic conditions of the ear in workers in an atmosphere of compressed air.	IV-13-106
14. Oxygen toxicity—James M. Clark	IV-14-1
Becker-Freyseng, H. Physiological and pathophysiological effects of increased oxygen tension.	IV-14-6
Bert, P. Barometric Pressure; Researches in Experimental Physiology.	IV-14-28
Donald, K. W. Oxygen poisoning in man.	IV-14-81
Fridovich, I. Superoxide dismutases.	IV-14-93
Gerschman, R., et al. Oxygen poisoning and x-irradiation: a mechanism in common.	IV-14-106
Haugard, N. Cellular mechanisms of oxygen toxicity.	IV-14-110
Kistler, G. S., Caldwell, P. R. B., Weibel, E. R. Development of fine structural damage to alveolar and capillary lining cells in oxygen-poisoned rat lungs.	IV-14-115
Lambertsen, C. J., et al. Oxygen toxicity. Effects in man of oxygen inhalation at 1 and 3.5 atmospheres upon blood gas transport, cerebral circulation and cerebral metabolism.	IV-14-139
Smith, J. L. The pathological-effects due to increase of oxygen tension in the air breathed.	IV-14-155
Stadie, W. C., Riggs, B. C., Haugard, N. Oxygen poisoning:	IV-14-172
15. Pathophysiology and treatment of DCS.—John M. Hallenbeck ..	IV-15-1
Behnke, A. R., et al. The circulatory and respiratory disturbances of acute compressed-air illness and the administration of oxygen as a therapeutic measure.	IV-15-5
Bert, P. Effect of sudden decrease of pressure beginning with several atmospheres.	IV-15-14
Catchpole, H. R., Gersh, I. Pathogenetic factors and pathological consequences of decompression sickness.	IV-15-51

Chryssanthou C., et al. Studies on dysbarism: III. A smooth muscle-acting factor (SMAF) in mouse lungs and its increase in decompression sickness.	IV-15-89
Cockett, A. T. K., Nakamura, R. M., Franks, J. J. Recent findings in the pathogenesis of decompression sickness (dysbarism).	IV-15-95
Hallenbeck, J. M., Bove, A. A., Elliott, D. H. Mechanisms underlying spinal cord damage in decompression sickness.	IV-15-96
Haymaker, W. Decompression sickness.	IV-15-107
Philp, R. B. A review of blood changes associated with compression-decompression: relationship to decompression sickness.	IV-15-181
Van der Aue, O. E., Duffner, G. J., Behnke, A. R. The treatment of decompression sickness: An analysis of one hundred and thirteen cases.	IV-15-215
Wells, C. H., et al. Rheologic impairment of the microcirculation during decompression sickness.	IV-15-223
Workman, R. D. Treatment of bends with oxygen at high pressure.	IV-15-231
Yarbrough, O. D., Behnke, A. R. Treatment of compressed air illness utilizing oxygen.	IV-15-239
16. Pulmonary function—Robert Gelfand	IV-16-1
Albano, G. Ventilatory mechanics	IV-16-5
Bradley, M. E., et al. Respiratory and cardiac responses to exercise in subjects breathing helium- oxygen mixtures at pressures from sea level to 19.2 atmospheres.	IV-16-33
Hamilton, R. W., Jr. Physiological responses at rest and in exercise during saturation at 20 atmospheres of He-O ₂	IV-16-35
Lambertsen, C. J. Prediction of physiological limits to human undersea activity and extension of tolerance to high pressure.	IV-16-49
Lambertsen, C. J., et al. Human tolerance to He, Ne, and N ₂ at respiratory gas densities equivalent to He-O ₂ breathing at depths to 1200, 2000, 3000, 4000, and 5000 feet of seawater (Predictive Studies III).	IV-16-72
Lambertsen, C. J., et al. Practical underwater work performance at pressures to 1200 and 1600 FSW.	IV-16-86
Mead, J., et al. Significance of the relationship between lung recoil and maximum expiratory flow.	IV-16-104
Miller, J. N., Wangenstein, O. K., Lanphier, E. H. Ventilatory limitations on exertion at depth.	IV-16-119

Rohrer, F.	
Physiologie der Atem Bewegung.	IV-16-126
Salzano, J., et al	
Arterial blood gases, heart rate, and gas exchange during rest and exercise in men saturated at a simulated seawater depth of 1000 feet.	IV-16-153
Schaefer, K. E., Carey, C. R., Dougherty, J. H., Jr.	
Pulmonary function and respiratory gas exchange during saturation- excursion diving to pressures equivalent to 1000 feet of seawater.	IV-16-163
Spaur, W. H., et al.	
Dyspnea in divers at 49.5 ATA: mechanical, not chemical in origin.	IV-16-165
Wood, L. D. H., Bryan, A. C.	
Effect of increased ambient pressure on flow-volume curve of the lung.	IV-16-181
 17. Saturation Diving—R. W. Hamilton	 V-17-1
Behnke, A. R.	
Effects of high pressures; prevention and treatment of compressed air illness.	V-17-5
Bond, G. F.	
New developments in high pressure living.	V-17-30
Bond, G. F.	
Sealab I and Sealab II chronicles.	V-17-35
Cook, R. B., Van Dyke, C.	
Medical watch standers guide for saturation diving.	V-17-36
Cousteau, J. Y.	
At home in the sea.	V-17-56
Fructus, X., Chouteau, J.	
Aspects physiologiques de la vie sous-pression. L'operation Pré- continent I.	V-17-69
Hamilton, R. W., et al.	
NOAA OPS I and II: Formulation of excursion procedures for shallow undersea habitats.	V-17-85
Hamilton, R. W., Jr., et al.	
Saturation diving to 650 feet.	V-17-93
Hock, R. J., Bond, G. F., Mazzone, W. F.	
Physiological evaluation of SeaLab II: Effects of two weeks exposure to an undersea 7-atmosphere helium-oxygen environment.	V-17-101
Krasberg, A. R.	
Saturation diving: vertical excursion techniques.	V-17-110
Link, E. A.	
Our man-in-sea project.	V-17-120
O'Neal, H. A., et al.	
Project Sealab summary report. An experimental eleven-day undersea saturation dive at 193 feet.	V-17-122
Sténuit, R.	
Life and work under pressure.	V-17-130
Workman, R. D., Bond, G. F., Mazzone, W. F.	
Prolonged exposure of animals to pressurized normal and synthetic atmospheres.	V-17-137

18. Underwater performance—A. J. Bachrach	V-18-1
Bachrach, A. J.	
Underwater performance	V-18-5
Baddeley, A. D.	
Influence of depth on the manual dexterity of free divers: a comparison between open sea and pressure chamber testing.	V-18-6
Bain, E. C., Berghage, T. E.	
Evaluation of SINDBAD tests.	V-18-11
Bowen, H. M.	
Diver performance and the effects of cold.	V-18-83
Fletcher, D. E., et al.	
Perceptual memory, cognitive and psychomotor functions.	V-18-103
Hill, L., Greenwood, M.	
The influence of increased barometric pressure on man.	V-18-161
Pesch, A. J., Hill, R. G., Klepser, W. K.	
Performance comparisons of scuba divers vs submersible manipulator controllers in undersea work.	V-18-174
Reilly, R. E., Cameron, B. J.	
An integrated measurement system for the study of human performance in the underwater environment.	V-18-186
Weltman, G., Egstrom, G. H.,	
Perceptual narrowing in novice divers.	V-18-283
19. Vision—J. A. S. Kinney	V-19-1
Beehler, C. C., et al.	
Ocular hyperoxia.	V-19-6
Behnke, A. R., Forbes, H. S., Motley, E. P.	
Circulatory and visual effects of oxygen at 3 atmospheres pressure.	V-19-11
Cusick, P. L., Benson, O. O., Jr., Boothby, W. M.	
Effect of anoxia and of high concentrations of oxygen on the retinal vessels: preliminary report.	V-19-19
Duntley, S. Q.	
Light in the sea.	V-19-23
Gallagher, T. J., et al.	
The effects of various oxygen partial pressures on scotopic and photopic vision.	V-19-43
Hulburt, E. O.	
Optics of distilled and natural water.	V-19-106
Kelley, J. S., et al.	
Visual function in divers at 15 to 26 atmospheres pressure.	V-19-114
Kinney, J. A. S., Luria, S. M., Weitzman, D. O.	
Visibility of colors underwater.	V-19-117
Luria, S. M., Kinney, J. A. S.	
Underwater vision.	V-19-125
Montabana, D. J., Lambertsen, C. J.	
Visual function.	V-19-134

Noell, W. K.	
Effects of high and low oxygen tension on the visual system.	V-19-151
Patz, A., Hoeck, L. E., De La Cruz, E.	
Studies on the effect of high oxygen administration in retrolental fibroplasia. I. Nursery observations.	V-19-167
Author Index	A-1
Subject Index	S-1