Resources for Continuing Education

Dick Clarke, CHT

EDUCATION AND INFORMATION RESOURCES FOR HYPERBARIC MEDICINE

MEDICAL SOCIETIES AND ORGANIZATIONS

American College of Emergency Physicians, Section of Hyperbaric Medicine
The section of Hyperbaric Medicine is chartered to provide a forum in which its members (limited to emergency medicine physicians) can develop a knowledge base, share information, and serve as a resource to others interested in this area of emergency medicine. The section further encourages the development of specialized training sessions for residents as well as hyperbaric research.

Contact:
ACEP Section of Hyperbaric Medicine
Post Office Box 61991
Dallas, Texas 75261
Telephone: 972-550-0911
Web site: www.ACEP.org

Publications:
Periodic member newsletter

Meetings:
Annual Section Meeting, held during the annual Scientific Assembly of the American College of Emergency Physicians

American College of Hyperbaric Medicine
A professional society dedicated to appropriate utilization, standards of care, education, training, certification, and recognition of hyperbaric oxygen therapy as a distinct medical specialty. Offers Physician Board Certification UHM.

Contact:
6737 West Washington Street
Suite 3265
West Allis, Wisconsin 53214
Telephone: 414-269-5340
Email: admin@achm.org
Web site: www.achm.org

European Underwater and Baromedical Society (EUBS)
The aim of the EUBS is to advance the science of undersea medicine and related scientific disciplines, including work in hyperbaric medicine and compressed air. The EUBS holds an annual scientific meeting, conducts periodic workshops, and publishes a journal.

Contact:
Membership Secretary
34 Midstocket Road
Aberdeen, Scotland AB15 5JD
Telephone: 44-1224-66-3121 (x. 54656)
Email: webmaster@eubs.org
Web site: www.eubs.org

Publications:
Diving and Hyperbaric Medicine, published in conjunction with the South Pacific Undersea and Hyperbaric Medical Society - Impact Factor 1.1
Proceedings of the Annual Meeting

Undersea and Hyperbaric Medical Society (UHMS)
The UHMS has a 55-year history, an international membership and a committee that maintains an 'approved uses' listing of hyperbaric treatment indications.

Contact:
Undersea and Hyperbaric Medical Society
631 US Highway 1, Suite 307

North Palm Beach, Florida 33408
Telephone: 1.919.490.5140
Email: uhms@uhms.org
Web site: www.uhms.org

Publications:
PRESSURE Newsletter; bi-monthly
Undersea and Hyperbaric Medicine Journal; quarterly - Impact Factor Just 0.33

Meetings:
Annual scientific meeting, typically in June, various domestic and international venues
Annual UHMS Chapter Meetings

NURSING AND TECHNOLOGY ORGANIZATIONS

Baromedical Nursing Association (BNA)
The BNA was formed in 1985. Its goal is to recognize and promote the specialty of hyperbaric nursing. Key activities include promotion of the Association's professional activities within the health care system; defining and fostering standards of practice; promoting broad-based educational initiatives; supporting research that validates and consolidates hyperbaric nursing practices; and certifying hyperbaric nurses.

1995 the BNA established a Certification Board. The Board subsequently introduced nursing certification in 1996. Three levels of certification exist:

- Certified Hyperbaric Registered Nurse (CHRN) - 2 Years Nursing experience; minimum of one-year active HBO experience in last 2 years to include 480 hours of direct patient care attended by CHRN preceptor
- Advanced Certified Hyperbaric Registered Nurse (ACHRN)
- Certified Hyperbaric Registered Nurse Clinician (CHRNC) ***Contact:***
  Baromedical Nurses Association
  P.O. Box 53
  Grotha, Florida 34734
  Telephone: 407-361-4715
  Email: baromedicalnurses@gmail.com
  Web site: www.hyperbaricnurses.org

National Board of Diving and Hyperbaric Medical Technology (NBDHMT)

The NBDHMT was formed in 1981 as the National Association of Diver Medic Technicians. The initial mission of this organization was the development of a standardized training curriculum for the commercial diving industry's remote duty diver medics. Several years later the mission's scope was expanded to include a diver medic certification program. The scope was further increased to allow students from military, civilian government, scientific, and research disciplines to train and certify. In 1991, the name changed to indicate the incorporation of a certification program for hyperbaric technologists. Since then, more than 3,000 health care professionals have been certified as hyperbaric technologist (CHTs). CHT operate hospital-based hyperbaric delivery systems. The NBDHMT also serves as the administrative headquarters of the CHRN program.

Contact:
National Board of Diving and Hyperbaric Medical Technology
9 Medical Park, Suite 440
Columbia, South Carolina 29203
Telephone: +1 (803) 434-7802
Fax: +1 (866) 451-7231
Email: nbdhmt@aol.com
Web site: www.nbdhmt.org

Certification Programs:
Diver Medic Technician (DMT)
Certified Hyperbaric Technologist (CHT)

SPECIALTY ORGANIZATIONS

Divers Alert Network (DAN)
DAN is the recreational SCUBA diver's safety organization, supported by its membership, which is open to divers and others interested in diving safety. DAN'S mission is to provide expert information and advice for the benefit of the diving public. DAN'S primary functions are the provision of emergency medical advice and assistance for diving accidents, and promotion of diving safety. DAN also promotes and supports diving research and related education. DAN'S concept, mission, and goals have recently become international in scope. The International Divers Alert Network (IDAN) has regional centers in Europe, Japan, Southern Africa, and Australasia.

Contact:
The Divers Alert Network
6 West Colony Place
Durham, North Carolina 27705
Telephone: 919-684-2948
Emergency case management (24/7) 919-684-9111
Fax: 919-490-6630
Web site: www.dan.org

Diving Research Projects with member participation:
Flying after Diving
Diving with Diabetes
Doppler/Project Dive Exploration

Specialty, Advanced, and Continuing Education Programs Diving Medicine
The National Oceanic and Atmospheric Administration/Undersea and Hyperbaric Medical Society Physician Training Course in Diving Medicine held annually. This two-week diving medicine-training course co-sponsored by the UHMS is presently held in San Diego, CA.

Contact:
Undersea and Hyperbaric Medical Society
631 US Highway 1, Suite 307
North Palm Beach, Florida 33408
Telephone: +1 919-490-5140
Fax: +1 919-490-5149
Email: UHMS@UHMS.org
Website: www.uhms.org

DAN Diving Accident and Hyperbaric Course
Twice yearly courses at major dive sites in the Caribbean, Mexico and Bahamas.

Contact:
Office of Continuing Education
6 West Colony Place
Durham, North Carolina 27705
Telephone: +1 919-684-2948
Email dan@dan.org
Web site: www.dan.org

ISAM Diving Medical Course
Four courses annually at a variety of both popular and remote dive sites.

Contact:
Ms. Bridget Thomas
International Society of Aquatic Medicine
6240 Turtle Hall Drive
Wilmington, North Carolina 28409
Telephone: 910-452-1452
Fax: 910-799-5209

Email: divingdocs@aol.com
Web site: www.divingdocs.org

WEB-BASED INFORMATION AND EDUCATION

www.hboevidence.wikis.unsw.edu.au

A repository of all known randomized clinical trials related to hyperbaric medicine. This site is maintained by Dr. Mike Bennett, an Australian hyperbaric medicine practitioner, anesthesiologist, and clinical epidemiologist. As of 2019, there are over 200 citations.

www.clinicaltrials.gov

An international database of privately and publicly funded clinical studies provided by the US National Library of Medicine and recognized by the International Committee of Medical Journal Editors.

FELLOWSHIP PROGRAMS

Fellowship training in Undersea and Hyperbaric Medicine recognizes special commitment and expertise in Undersea and/or Hyperbaric Medicine. In the United States, those eligible for Fellowship training must be Board Certified in 'a specialty' sanctioned by the American Board of Medical Specialties (ABMS) by the American Board of Medical Specialties (ABMS) and must be in active practice in undersea and/or hyperbaric medicine. Following graduate medical training, physicians and medical specialists can identify themselves as board eligible. They have three to seven years, depending on the ABMS Member Board, to take a specialty certification exam.

One of the requirements to achieve Board Certification in UHM, according to the American Board of Preventive Medicine (ABPM), is to complete a full time ACGME accredited Fellowship in Undersea and Hyperbaric Medicine, during which approximately 25% of the Fellows time was spent in actual management of Undersea/Hyperbaric Medicine cases.

- Board Certification Requirement (ABMS): https://www.abms.org/board-certification/board-certification-requirements/
- Board Eligible (ABMS): https://www.abms.org/board-certification/board-certification-requirements/
- Am I eligible? (ABPM): https://www.theabpm.org/am-i-eligible/

Advocate Aurora

MILWAUKEE, WI

Contact: Laurie Gesell, MD
Email: laurie.gesell@gmail.com
Informational recruitment flyer (pdf): Click here
Fellowship Information Website: https://www.aurorahealthcare.org/education/gme/undersea-hyperbaric-medicine
Advocate Aurora Wound Care & Hyperbaric Medicine
website: https://www.aurorahealthcare.org/services/wound-care-hyperbaric-medicine

The Aurora Health Care Undersea and Hyperbaric Medicine Fellowship Program is a one-year, ACGME-accredited training program with two fellowship positions per year. We have 14 hyperbaric programs in our hospital system, two of which are training sites. Our primary teaching center is at our multi-place hyperbaric facility located at Aurora St. Luke's Medical Center in Milwaukee. Our secondary teaching site offers monoplace hyperbaric training, which is located at our Kenosha medical center. Fellows in the program can expect to see clinical cases involving the full spectrum of hyperbaric and undersea medicine indications, including those of an emergent and critical nature. Fellows will also take call with our overnight emergent team. In addition, fellows will gain experience in wound care and can expect to be a part of our multidisciplinary limb salvage teams. We have multiple board-certified fellowship trained attendings on our core faculty, who have created a comprehensive curriculum and didactic series for the training year. Our fellows will also attend out-of-state continuing medical education (CME) training courses as part of their fellowship experience.

Duke University Medical Center

DURHAM, NC

Contact: Bruce Derrick, MD
Email: **bruce.derrick@duke.edu**
(919) 684-6726
Home Page: dukedivemedicine.org

Hyperbaric fellows work in the Center for Hyperbaric Medicine and Environmental Physiology, an integral part of Duke University Medical Center. Four slots are available each year, 2 of which are associated thru Intermountain Healthcare. Applicants must be eligible for licensure as a trainee in the state of North Carolina and they must have completed an ACGME certified residency program and be board eligible in their specialty. The fellowship is highly competitive, and the training is designed to prepare the fellow to become a leader in the field of Undersea and Hyperbaric Medicine through the development of clinical competence and research expertise.

Hennepin County Medical Center

MINNEAPOLIS, MN

Contact: Thomas Masters, MD
Email: thomas.masters@hcmed.org
612-873-7420
Home Page: http://www.hcmc.org/education/fellowships/hyperbaric-fellowship/index.htm

Since opening our first hyperbaric chamber in 1964, Hennepin County Medical Center has pioneered the field of undersea and hyperbaric medicine. Our fellowship is an ACGME accredited one year program whose graduates fulfill the requirements to sit for the American Board of Medical Specialists' certification examination for special competency in Undersea and Hyperbaric Medicine. The Primary Hospital: Hennepin County Medical Center, Minneapolis, MN is a Level I Trauma Center and referral center for all hyperbaric emergencies for western Wisconsin, the eastern Dakotas, Iowa and all of Minnesota. Fellows practice in our new state-of-the art Center for Hyperbaric Medicine, which opened in 2012. More information can be found at our website:

Louisiana State University

NEW ORLEANS, LA

Contact: Alexandra Eagles
Email: aeagle@lsuhsc.edu
(504) 366-7638
Home Page: www.medschool.lsuhsc.edu/emergency_medicine/fellowship_hyperbarics.aspx

Fellowship in Diving and Hyperbaric Medicine

Louisiana, LSU Health Sciences Center/Charity Hospital, New Orleans. One year fellowship includes extensive opportunities in clinical and animal research, publishing, and teaching experiences. Divers

Alert Network and Gulf Coast Commercial Diving Referral Center. Clinical teaching locations include multiplace and monoplace units. Interim Program Director: Dr. Micah W. Siegel

SUNY Upstate Medical University

SYRACUSE, NY

Contact: Courtney Hines, HBO Fellowship Coordinator
E-Mail: HinesC@upstate.edu
Phone: (315) 464-4363
Home Page: http://www.upstate.edu/emergency/education/fellowships/hyperbaric.php

This ACGME accredited fellowship program at SUNY Upstate Medical University offers comprehensive training for a physician who is board-eligible in any ABMS or Osteopathic specialty. The program provides intensive training in clinical hyperbaric medicine while including all aspects of wound care and diving medicine. There are didactic lectures based on core curriculum and participation in research within hyperbaric medicine. Opportunities also exist for clinical activity to maintain skills in trainees' primary specialty.

University of Pennsylvania

PHILADELPHIA, PA

Contact: Kevin Hardy, MD and Wendy Kelly
E-Mail: wherrman@pennmedicine.upenn.edu
Phone: (215) 898-9095
Home Page: http://www.uphs.upenn.edu/ifem/hbofellowshipoutline.pdf

Fellowship in Undersea and Hyperbaric Medicine

The ACGME accredited fellowship program at The University of Pennsylvania offers comprehensive training for two physicians who are board-eligible in any ABMS specialty. Our program provides intensive training in diving and hyperbaric medicine, including all aspects of wound care and elective opportunities in critical care. A series of didactic lectures occurs weekly, and there are opportunities for research and clinical activity to maintain skills in trainees' primary specialty.

On-line information is found at http://www.uphs.upenn.edu/emergency-medicine/education/fellowships/hyperbaric-medicine/
Interested candidates should contact:
Wendy Kelly at 215-898-9095
or
e-mail: wherrman@mail.med.upenn.edu

TWO POSTDOCTORAL POSITIONS:

Two Postdoctoral Positions are offered to study fundamental mechanisms of oxygen in angiogenesis, cell-to-cell adhesion, or free radical production/pathogenesis as well as the clinical

effects of hyperbaric oxygen. Individuals with clinical experience who are interested in obtaining research training will receive special consideration. An exceptional opportunity exists for collaborative basic and clinical research as part of a NIH-funded Specialized Center of Research in Hyperbaric Oxygen Therapy.

CLINICAL HYPERBARIC MEDICINE FELLOWSHIP:

One position is offered to a board-eligible, licensed physician for intensive training in undersea and hyperbaric medicine. Fellows are actively involved with the clinical program of Penn's Institute for Environmental Medicine and are provided opportunities for involvement in basic and clinical research as a part of the training.

University of Texas Southwestern Medical Center Texas Health Presbyterian Hospital Dallas/ Institute for Exercise and Environmental Medicine, Hyperbaric Unit

DALLAS, TX

Program Director: James Berry, MD
Contact: Rebecca Davis, C-TAGME
Email: Rebecca.Davis@UTSouthwestern.edu
Phone: (214) 648-7837
Home Page: https://www.utswanesthesia.org/fellowships

Undersea and Hyperbaric Medicine (USHM) is a 12-month ACGME-accredited fellowship designed to prepare physicians with another primary Board certification for certification by the American Board of Preventive Medicine in Undersea and Hyperbaric Medicine. The curriculum encompasses: physics and physiology of altered ambient pressure, dive safety, clinical applications of hyperbaric oxygen, and the evaluation and treatment of diving and marine injuries. Our faculty have over 50 years of combined experience in aviation and dive medicine as well as anesthesia and critical care. The multi-place triple-lock hypo/hyperbaric chamber at the Institute for Exercise and Environmental Medicine is the largest in North Texas. We are active in both the clinical practice of and research into hyperbaric medicine.

Publications Considered to Represent the Best Evidence of Hyperbaric Medicine

Updated November 2022

- **a.** Basic science
- **b.** Clinical Science
- **c.** Review

1. Air or Gas Embolism

a. Cerebral Air Embolism Treated by Pressure and Hyperbaric Oxygen
Catron PW, Dutka AJ, Biondi DA, *et al.*
Neurology 1991;41:314-315 **(010-063)**

b. Pulmonary Barotrauma in Submarine Escape Trainees and the Treatment of Cerebral Arterial Air Embolism
Brooks GJ, Green RD, Leitch Dr.
Aviation, Space, and Environmental Medicine 1986;57:1201-1207 **(010-256)**

c. Hyperbaric Treatment of Air or Gas Embolism: Current Recommendations
Moon RE
UHM 2019;46(5):673-683 **(010-797)**

2. Carbon Monoxide

a. Functional Inhibition of Leukocyte B_2 Integrins by Hyperbaric Oxygen in Carbon Monoxide-Mediated Brain Injury in Rats Thom SR
Toxicology and Applied Pharmacology1993;123:248-256 **(020-372)**

b. Hyperbaric Oxygen for Acute Carbon Monoxide Poisoning
Weaver LK, Hopkins RO, Chan KJ, *et al.*
N Engl J Med 2002;347(14):1057-106 **(020-575)**

c. Carbon Monoxide Poisoning
Weaver LK
UHM 2020;47(1):151-169 **(020-867)**

3. Gas Gangrene

a. Effect of Hyperbaric Oxygen and Surgery on Experimental Multimicrobial Gas Gangrene
Hirn M, Niinikoski J, Lehtonen OP, *et al.*
Eur Surg Res 1993;25:265-269 **(120-118)**

b. Management of Clostridial Gas Gangrene and the Role of Hyperbaric Oxygen
Korhonen K, Klossner J, Hirn M, *et al.*
Annales Chirurgiae ET Gynaecologiae 1999;88:139-142 **(120-143)**

c. Clostridial Myonecrosis (Gas Gangrene)
Bakker DJ
Undersea and Hyperbaric Medical Society 2012;39(4):857-865 **(120-148)**

4. Crush Injury; Compartment Ischemia; Other Acute Ischemias

a. Delayed Use of Hyperbaric Oxygen for Treatment of a Model Anterior Compartment Syndrome
Strauss MB, Hargens AR, Gershuni DH, *et al.*
Journal of Orthopaedic Research 1986;4:108-111 **(030-010)**
Lipid Peroxidation Products in Postischemic Skeletal Muscle and After Treatment with Hyperbaric Oxygen
Nylander G, Otamiri T, Lewis DH, *et al.*
Scandinavian Journal of Plastic Reconstructive Surgery 1989;23:97-103 **(030-017)**

b. Hyperbaric Oxygen Therapy in the Management of Crush Injuries: A Randomized Double-Blind Placebo-Controlled Clinical Trial Bouachour G, Cronier P, Gouello JP, *et al.*
The Journal of Trauma: Injury, Infection, and Critical Care 1996;41(2):333-339 **(030-055)**

c. **Adjuvant Hyperbaric Oxygen Therapy in the Management of Crush Injury and Traumatic Ischemia: An Evidence-Based Approach**
Garcia-Covarrubias L, McSwain N, Van Meter K, *et al.*
The American Surgeon 2005;71(2):144-151 **(030-096)**
The Effect of Hyperbaric Oxygen in Crush Injuries and Skeletal Muscle-Compartment Syndromes
Strauss M
Undersea and Hyperbaric Medical Society 2012;39(4):847-855 **(030-114)**

5. Decompression Sickness

a. **Acute Neurologic Decompression Illness in Pigs: Lesions of the Spinal Cord and Brain**
Dick EJ, Broome JU, Hayward IJ, *et al.*
Laboratory Animal Science 1997;47(1):50-57 **(050-335)**
Oxygen in the Treatment of Spinal Cord Decompression Sickness
Leitch DR, Hallenbeck JM
Undersea Biomedical Research 1985;12(3):269-289 **(050-214)**

b. **Twenty Years of Treating Decompression Sickness**
Green RD, Leitch DR
Aviation, Space, and Environmental Medicine 1987:362-366 **(050-161)**
Spinal Cord Decompression Sickness in Sport Diving
Aharon-Peretz J, Adir Y, Gordon CR, *et al.*
Arch Neurol 1993;50:753-756 **(050-252)**

c. **Hyperbaric Treatment for Decompression Sickness: 2021 Update**
Moon RD, Mitchell S.
UHM 2021;48(2):195-203 **(050-852)**

6. Wound Healing

a. **Diabetic Impairments in No-Mediated Endothelial Progenitor Cell Mobilization and Homing are reversed by Hyperoxia and SDF-1a**
Gallagher KA, Zhao-Jun L, *et al.*
J. Clin. Invest. 2007; 117:1249-1259 **(070-205)**
Stem Cell Mobilization by Hyperbaric Oxygen
Thom SR, Bhopale VM, *et al.*
AM J Physiol Heart Circ Physiol 2006; 290:H1378-H1386 **(640-149)**
Hyperbaric Oxygen Induces VEGF Expression Through ERK, JNK and C-JUN/AP-1 Activation in Human Umbilical Vein Endothelial Cells
Lee CC, Chen SC, TSAI SC, *et al.* **(060-216)**
J Biomed SCI 2006;13(1):143-56
Hyperbaric Oxygen Selectively Induces Angiopoietin-2 in Human Umbilical Vein Endothelial Cells
Lin S, Shyu KG, Lee CC, *et al.*
Biochem and Biophys Research Communications 2002;296:710-715 **(640-134)**

b. **Hyperbaric Oxygen Therapy Facilitates Healing of Chronic Foot Ulcers in Patients with Diabetes**
Londahl M, Katzman P, Nilsson A, *et al.*
Diabetes Care 2010;33(5):998-1003 **(070-238)**
A Prospective, Randomized, Controlled Study of Hyperbaric Oxygen Therapy: Effects on Healing and Oxidative Stress of Ulcer Tissue in Patients with a Diabetic Foot Ulcer
Ma L, Shi Z, Hou T, *et al*.
Ostomy Wound Management 2013;59(3):18-24 **(070-267)**

c. **A Clinical Practice Guideline for the use of Hyperbaric Oxygen Therapy fin the Treatment of Diabetic Foot UlcersHuang E, Mansouri J, Murad MH, *et al.***
Undersea Hyperbaric Medicine 2015;42(5):205-247 **(070-296)**

7. Exceptional Anemia

a. **Hyperbaric Oxygen Treatment Attenuates Cytokine Induction after Massive Hemorrhage**
Yamashita M
Am J Physiol Endocrinol Metab 2000;278(5):E811-E816 **(110-034)**

b. **Hyperbaric Oxygen Reverses Organ Dysfunction in Severe Anemia**
Greensmith JE
Anesthesiology 2000;93(4):1149-1152 **(110-038)**

c. **The Effect of Hyperbaric Oxygen on Severe Anemia**
Van Meter KW
Undersea and Hyperbaric Medical Society 2012;39(5):937-942 **(110-045)**

8. Intracranial Abscess

a. **None**

b. **Hyperbaric Oxygen in Intracranial Abscesses** Lampl LA, Frey G, Dietze T, *et al.*
Journal of Hyperbaric Medicine 1989;4(4):111-125 **(350-004)**
Stereotactic Aspiration and Antibiotic Treatment Combined with Hyperbaric Oxygen Therapy in the Management of Bacterial Brain Abscesses
Kutlay M, Colak A, Yildiz S, *et al.*
Neurosurgery 2005; 57(6):1140-1146 **(350-011)**
Hyperbaric Oxygen Therapy for the Treatment of Brain Abscess in Children
Kurschel S, Mohia A, Weigl V, *et al.*
Childs Nerv Syst 2006; 22:38-42 **(350-013)**

c. **Intracranial Abscess**
Barnes RC
Undersea and Hyperbaric Medical Society 2012;39(3):727-730 **(350-017)**

9. Necrotizing Soft Tissue Infections

a. **Hyperbaric Oxygen in the Treatment of Gas Gangrene and Perineal Necrotizing Fasciitis**
Hirn M
European Journal of Surgery Supplement 1993;570:1-36 **(120-117)**

b. **Fournier's Gangrene: Therapeutic Impact of Hyperbaric Oxygen**
Hollabaugh RS, Dmochowski RR, Hickerson WL, *et al.*
Plastic and Reconstructive Surgery 1998;101:94-100 **(140-019)**

c. **Hyperbaric Oxygenation in the Treatment of Fournier's Gangrene: A Systematic Review**
Schneidewind L, Anheuser P, Schonburg S, *et al.*
Urol Int 2021;105:247-256

10. Refractory Osteomyelitis

a. **Synergy of HBO_2 and a Local Antibiotic Carrier for Experimental Osteomyelitis Due to Staphylococcus Aureus in Rats**
Mendel V, Simanowski J, Scholz CH
UHM 2004; 31(4):407-416 **(200-094)**

b. **Results of Chronic Osteomyelitis of the Femur Treated with Hyperbaric Oxygen: A Preliminary Report**
Chen CE, Ko JY, Fu TH, *et al.*
Chang Gung Med J 2004;27(2):91-97 **(200-093)**

c. **Hyperbaric Oxygen for Refractory Osteomyelitis** *from Hyperbaric Oxygen Therapy Indications, 14th ed.*
Hart B.
Undersea and Hyperbaric Medical Society 2021;48(3):297-321 **(200-119)**

11. Late Radiation Injury

a. **Relationship of Oxygen Dose to Angiogenesis Induction in Irradiated Tissue**
Marx RE, Ehler WJ, Tayapongsak P, *et al.*
The American Journal of Surgery 1990;160:519-524 **(210-011)**

b. **Hyperbaric Oxygen Treatment of Chronic Refractory Radiation Proctitis: A Randomized and Controlled Double-Blind Crossover Trial with Long-Term Follow-Up**
Clarke RE, Tenorio LMC, Hussey JR, *et al.*
International Journal of Radiation Oncology, Biology, Physics 2008;72(1):134-143 **(216-063)**
Radiation-Induced Cystitis Treated with Hyperbaric Oxygen Therapy (RICH-ART): A Randomized, Controlled, Phase 2-3 Trial
Oscarsson N, Muller B, Rosen A, *et al.*
Lancet Oncol 2019: Published Online http://dx.doi.org/10.1016/s1470-2045(19)30494-2 **(213-115)**

c. **Challenges Threaten, Opportunity Awaits Hyperbaric Medicine and the Head and Neck Cancer Patient.**
Clarke RE
Undersea and Hyperbaric Medical Society 2019;46(4):385-397 **(211-432)**
Hyperbaric Oxygen Therapy and Delayed Radiation Injuries (Soft Tissue and Bony Necrosis)
Feldmeier J
Undersea and Hyperbaric Medical Society 2012;39(6):1121-1139 **(210-184)**

12. Skin Grafts and Flaps

a. **Survival of Normothermic Microvascular Flaps After Prolonged Secondary Ischemia: Effects of Hyperbaric Oxygen**
Stevens DM, Weiss DW, Koller WA, *et al.*
Otolaryngology-Head and Neck 1996;115(4):360-364 **(160-073)**

b. **Clinical Experience with Hyperbaric Oxygen Therapy in the Salvage of Ischemic Skin Flaps and Grafts**
Bowersox JC, Strauss MB, Hart GB, *et al.*
Journal of Hyperbaric Medicine 1986;1(3):141-149 **(160-070)**

c. **The Effect of Hyperbaric Oxygen on Compromised Grafts and Flaps**
Baynosa R, Zamboni W
Undersea and Hyperbaric Medical Society 2012;39(4):857-865 **(160-114)**

13. Thermal Burns

a. **Hyperbaric Oxygen Therapy and Piracetam Decrease the Early Extension of Deep Partial-Thickness Burns**
Germonpre P, Reper P, Vanderkelen A, *et al.*
Burns 1996; 22(6):468-473 **(180-055)**

b. **A Randomized Prospective Trial of Hyperbaric Oxygen in a Referral Burn Center Population**
Brannen AL, Still J, Haynes M, *et al.*
The American Surgeon 1997;63:205-208 **(180-061)**

c. **Adjunctive Hyperbaric Oxygen Therapy in the Treatment of Thermal Burns**
Cianci P, Sato R, Faulkner J.
Undersea and Hyperbaric Medical Society 2021;48(4):449-468 **(180-093)**

14. Sudden Sensorineural Hearing Loss

a. **None**

b. **Prostaglandin E1 In Combination with Hyperbaric Oxygen Therapy for Idiopathic Sudden Sensorineural Hearing Loss** Suzuki H, Fujimura T, Ikeda K, *et al.*
Acta Oto-Laryngologica 2008;128:61-65 **(556-044)**
Factors Influencing the Outcome of Idiopathic Sudden Sensorineural Hearing Loss Treated with Hyperbaric Oxygen
Korpinar S, Alkan Z, Yigit O, *et al.*
Eur Arch Otorhinolaryngol 2011;268(1):41-7 **(556-054)**
Comparison of Therapeutic Results in Sudden Sensorineural Hearing Loss With/Without Additional Hyperbaric Oxygen Therapy: A Retrospective Review of 465 Audiologically Controlled Cases
Liu SC, Kang BH, Lee JC, *et al.*
Clin Otolaryngol 2011;26(2):121-8 **(556-056)**

c. **Addition of Hyperbaric Oxygen Therapy vs Medical Therapy Alone for Idiopathic Sudden Sensorineural Hearing Loss A Systematic Review and Meta-analysis**
Rhee TM, Hwant D, Lee JS, *et al*.
AMA Otolaryngol Head Neck Surg. 2018;144(12):1153-1161 (**556-096)**
Hyperbaric Oxygen Therapy for Patients with Sudden Sensorineural Hearing Loss A Systematic Review and Meta-analysis
Joshua TG, Ayub A, Wijesinghe P, *et al*.
JAMA Otolaryn Head Neck Surg. doi:10.1001/jamaoto.2021.2685 Published Online October 28, 2021 **(556-111)**

15. Retinal Artery Insufficiency

a. **None**

b. **Early Hyperbaric Oxygen Therapy for Retinal Artery Occlusion**
Beiran I, Goldenberg I, Adir Y, *et al.*
Eur J Ophthalmol 2001;11:345-350 **(480-021)**

c. **Arterial Insufficiencies: Central Retinal Artery Occlusion**
Murphy-Lavoie H, Butler FK, Hagan C, *et al.*
UHM 2022;49(4):533-547 **(480-057)**

National Board of Diving & Hyperbaric Medical Technology

Position Statements

Certification in Hyperbaric Technology and Hyperbaric Nursing (2022-01) June 2022
It is the position of the National Board of Diving & Hyperbaric Technology that all those who operate hyperbaric chambers and related delivery systems, or are required to work within hyperbaric chambers, be certified in hyperbaric technology or hyperbaric nursing. Such certification shall be provided by an authoritative certification organization, one that requires periodic recertification based upon maintenance of requisite knowledge and skills.

Diver Medic Invasive Skills Requirement (2018-01) April 2018
It is the position of the National Board of Diving & Hyperbaric Medical Technology that the diver medic must receive training and skills necessary to undertake medical control physician ordered invasive procedures. Required skills are identified in Appendix II of the Certified Diver Medic "Approved Training Course Outline". The Board expects that once acquired, such skills will be maintained through periodic updating, consistent with both the National Board of Diving & Hyperbaric Medical Technology recertification requirements and those of the medic's employer/medical control physician.
Last reviewed 09/2022

Fitness to Work in Pressurized Settings: (2012-01) July 2012
It is the position of the National Board of Diving & Hyperbaric Medical Technology that every individual employed as a multiplace chamber inside tender, and all those who might otherwise be required to enter the pressurized chamber, be medically cleared as fit to work in this unique environment. The precise scope and extent of such screening examinations will be consistent with both prevailing standards and any recommendations from authoritative bodies. Interval repeat screening assessments should be conducted consistent with prevailing standards and following injury or illness that might influence subsequent medical fitness. Records documenting screening assessments should be maintained within each facility's Human Resources/Personnel files as appropriate, and for a period of time consistent with prevailing regulations.

Failure to undertake such medical fitness screening is considered by the National Board of Diving & Hyperbaric Medical Technology to represent a fundamental breach of hyperbaric operational safety.
Last reviewed 09/2022

Safety During Multiple Occupancy Monoplace Chamber Operations: (2011-02) July 2011

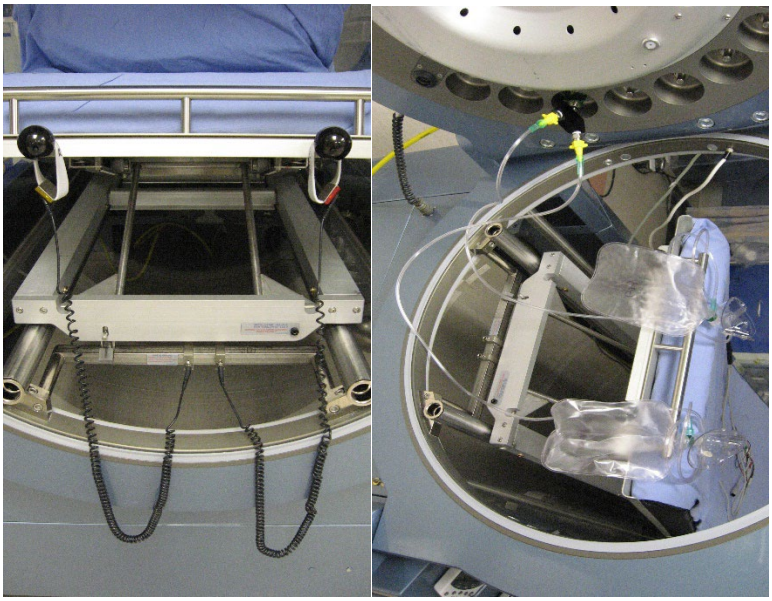
It is the position of the National Board of Diving & Hyperbaric Medical Technology that whenever two persons occupy a Class B 'monoplace' hyperbaric chamber, individual grounding and air breathing capabilities should be provided to both occupants.

Class B chambers are designed for single occupancy in accordance with the National Fire Protection Association – NFPA 99. From time to time, however, a hyperbaric physician may require that a particular patient be accompanied during their monoplace chamber-based treatment(s). A common example is the pediatric patient who is not being mechanically ventilated. These patients may be accompanied by either a staff member or a family member, depending upon several variables. Hyperbaric textbooks and other publications feature numerous photographic examples of this practice pattern.

It is not the intent of the National Board of Diving & Hyperbaric Medical Technology to condone this practice, or otherwise. Rather, the Board recognizes that this practice does occur and wishes to ensure that appropriate safety measures are employed.

Both occupants should be directly grounded, the manner of which should be in accordance with NFPA 99 Chapter 14. An example photographic illustration is attached as Appendix 1. Consistent with the Board's position on intermittent air breathing (Position Statement 2009-04, August 2009), both occupants should be provided with an individualized air breathing capability. An example photographic illustration is attached as Appendix 2.

Last reviewed 09/2022



Portable, Fabric, Low-pressure Hyperbaric Chambers: (2011-01) April 2011 (Rev. November 2016)

It is the position of the National Board of Diving & Hyperbaric Medical Technology that the design, fabrication and common use of portable, fabric, low-pressure (operating at pressures of no greater than 1.4 ATA) hyperbaric chambers is inconsistent with recognized and prevailing safety codes and standards.

The operational design pressure of a hyperbaric chamber that encloses a human within its pressure boundary falls within the scope of the American Society of Mechanical Engineers Pressure Vessels Human Occupancy 1 (ASME PVHO 1-2012). Portable, fabric, low-pressure chambers do not comply with this important safety code.

These chamber types are cleared by the Federal Drug Administration (FDA) only for the treatment of acute altitude (mountain) sickness and only when compressed with air. However, they are widely promoted for a large number of 'off-label' conditions and are at further variance with the FDA's clearance in that some are used with oxygen concentrators and other sources of oxygen ('enriched air'). It is also apparent that these chambers are not always operated in a manner consistent with the standards of the National Fire Protection Association (NFPA) 99 chapter on hyperbaric facilities.

It is the position of the National Board of Diving & Hyperbaric Medical Technology that portable, fabric, low-pressure hyperbaric chambers be limited in their use to the treatment of acute altitude sickness and that they be compressed only with air. Further, these chamber types should be designed, fabricated and operated in a manner consistent with prevailing codes and standards.

Last reviewed 09/2022

On-Line Introductory Training in Hyperbaric Medicine: (2010-02) October 2010 (Rev. September 2022)

It has been the long-held position of the National Board of Diving & Hyperbaric Medical Technology that introductory training in hyperbaric medicine must be undertaken in face-to-face classroom or seminar type settings. The NBDHMT recognizes the value of on-line education as a means of maintaining and advancing knowledge and skills. Such recognition does not extend to the learning of an entirely new field of medicine, technology, and related safety.

Given the current pandemic, the Board now allows introductory training to be delivered virtually. All currently approved courses intending to offer the virtual training option are required to undergo a real time audit to confirm that the delivery process and ongoing confirmation of student attendance meets the Board's expectations. It is currently the intent of the NBDHMT to allow live virtual introductory training courses to continue indefinitely.

Physician Attendance and Supervision of Hyperbaric Oxygen Therapy: (2010-01) April 2010 (Rev. July 2013)

It is the position of the National Board of Diving & Hyperbaric Medical Technology that provision of hyperbaric oxygen therapy must be directly supervised by a physician (which includes a nurse practitioner/physician assistant where permitted by prevailing credentialing and regulatory standards) who is formally (UHMS or other authoritative body) trained in hyperbaric medicine, involving a face to face classroom vs. online setting. Such supervision should extend to:

- Assessment of suitability for HBO therapy
- Determination of risk-benefit profile
- Interpretation of any related diagnostic testing
- Generation of a therapeutic dosing profile
- Evaluation of subsequent clinical course, and
- Management of any related side effects and complications

Further, the hyperbaric physician must be on the premises and immediately available to the chamber facility at all times that the chamber(s) is occupied. Immediately available would meet the intent of this Position Statement if the physician could arrive at the chamber facility within five minutes of being summoned and in doing so, would not place in jeopardy any other patient presently under their care.

It is the duty of hyperbaric nursing and technical personnel to safely implement ordered therapy and closely monitor patients during their treatments. Should a patient voice complaints or manifest signs suggesting an unanticipated change in status, considered to be hyperbaric related or otherwise, the hyperbaric physician should be immediately notified. Importantly, hyperbaric nursing and technical personnel do not assume any of the physician responsibilities noted above and cannot initiate hyperbaric treatment without patient-specific hyperbaric physician signed medical orders.

Last reviewed 09/2022

In-home Delivery of Hyperbaric Oxygen Therapy: (2009-05) October 2009

It is the position of the National Board of Diving & Hyperbaric Medical Technology that the installation and provision of in-home hyperbaric oxygen therapy is inherently unsafe and cannot be condoned. The basis for the position is concern for the well-being of all such patients involved and the safety of those in proximity to the hyperbaric oxygen therapy delivery system.

In-home provision of hyperbaric oxygen therapy is likely to result in a bypassing of otherwise mandatory federal, state, and local codes as they relate to design, construction, installation, and operations.

In-home provision of hyperbaric oxygen therapy is likely to occur without adequate physician oversight and the operational support of appropriately trained and certified hyperbaric technologists and nurses. These shortcomings serve to further erode important safety standards.
Last reviewed 09/2022

Intermittent Air Breathing: (2009-04) August 2009
It is the position of the National Board of Diving & Hyperbaric Medical Technology that every recompression treatment facility and every clinical hyperbaric chamber, regardless of type or class, be equipped to provide intermittent air breathing. Intermittent air breathing, commonly referred to as an 'air break', serves to prophylax against and lower the incidence of, central nervous system oxygen toxicity. Intermittent air breathing also serves to treat pre-monitory signs and symptoms of oxygen toxicity, thereby reducing the potential for symptom progression to overt seizure.

The application and sequencing of intermittent air breathing will be at the discretion of the hyperbaric physician. However, intermittent air breathing should be immediately instituted (by either the multiplace chamber tender or monoplace chamber operator) whenever an acute change in patient status occurs and is consistent with, or suggestive of, CNS oxygen toxicity.
Last reviewed 09/2022

Hyperbaric Safety Director: (2009-03) July 2009
It is the position of the National Board of Diving & Hyperbaric Medical Technology that every recompression treatment facility and every clinical hyperbaric medicine service appoint a Hyperbaric Safety Director. This position is consistent with a previous NBDHMT Position Statement regarding adherence to recognized codes and standards. It serves to emphasize what the NBDHMT considers to be a key safety aspect. The Hyperbaric Safety Director should undergo formal and comprehensive training in the safety aspects of hyperbaric medicine and related technology. They should develop, maintain and manage a safety program based upon compliance with recognized standards. The resulting program should demonstrate effective elements of hazard mitigation, while employing recognized risk management concepts.

It is recognized that some hospitals and management companies with more than one hyperbaric facility appoint corporate safety directors. In these situations, an on-site safety director should also be designated. The intent is to have this individual be a full time member of each hyperbaric facility's staff.

The term Hyperbaric Safety Director can be replaced with other titles of similar meaning and identical intent. Examples include Hyperbaric Safety Supervisor, Hyperbaric Safety Technologist, Lead Hyperbaric Safety Technologist, Hyperbaric Safety Manager, and Duty Hyperbaric Safety Technologist, and like terms. It is not the intent of the NBDHMT to assign

a title. Rather, the intent of this Position Statement is to identify and emphasize the need for a trained and designated hyperbaric safety individual at each facility.
Last reviewed 09/2022

Recognized Hyperbaric Safety Codes and Standards: (2009-02) March 2009
It is the position of the National Board of Diving & Hyperbaric Medical Technology that the codes and standards expressed in the American Society of Mechanical Engineers' safety Standard for Pressure Vessels for Human Occupancy (ASME PVHO-1)* and the National Fire Protection Association 99, Health Care Facilities Code, Chapter 14, (Hyperbaric Facilities)** be rigorously adhered to.

Using only hyperbaric chambers that have been designed, fabricated, tested and stamped in accordance with ASME PVHO-1 gives the user a high level of confidence in the quality and safety of the equipment in use and is an effective risk management tool. The use of hyperbaric chambers that do not meet these codes is strongly discouraged.

The installation and operational requirements found in NFPA 99, Chapter 14 have proven themselves since they were first issued in 1968. Not only does this standard provide guidance with regard to proper installation of hyperbaric chambers, it clearly prescribes safe day-to-day safety procedures that all should adhere to.

One standard that is particularly important from a day-to-day perspective is the issue of acceptable clothing. NFPA 99 Chapter 14 mandates that only clothing, and linens, made of 100% cotton or a blend of cotton and polyester fabric is permitted inside the hyperbaric chamber. These items shall be provided by the treating facility or specifically approved for hyperbaric use by the safety director in accordance with NFPA 99, Chapter 14.

The NBDHMT adds that acceptable patient clothing worn inside the hyperbaric chamber must not contain pockets. The majority of hyperbaric fires over the past two decades have been the result of prohibited items (pocket warmers, cigarette lighters and cellular telephones, are examples) being taken into the chamber. Eliminating pockets will do much to eliminate the introduction of prohibited items.
Last reviewed 09/2022

* American Society of Mechanical Engineers Safety Standard for Pressure Vessels for Human Occupancy, 2002. www.asme.org
**National Fire Protection Association 99, Health Care Facilities; 2021. www.nfpacatalog.org

UHMS Facility Accreditation: (2009-01) January 2009
It is the position of the National Board of Diving & Hyperbaric Medical Technology that every clinical hyperbaric medicine program (defined here as a facility not solely available for the treatment of diving/decompression accidents) undergo the Undersea and Hyperbaric Medical Society Hyperbaric Facility Accreditation Survey.

It is the position of the NBDHMT that UHMS accreditation represents the most effective standard by which safety and effectiveness of hyperbaric medicine delivery systems can best be determined. The survey process allows each hyperbaric medicine program to be recognized for its strengths and to employ strategies to overcome its identified weaknesses.

The NBDHMT believes that a UHMS accredited hyperbaric medicine facility offers its patients, staff, and parent institution the highest assurance of safety, compliance, and therapeutic effectiveness.

Last reviewed 09/2022

Hyperbaric Medicine's Authoritative Codes, Standards, and Guidelines

Federal Guidelines Institute (aka American Institute of Architects (AIA))

The FGI is now the publishing 'home' for the long-standing AIA facility design standards. The FGI is a national not for profit professional association. Their standards extend to the design and layout of hyperbaric chamber facilities and address both multiplace (Class A) and monoplace (Class B) chamber types.

www.fgiguidelines.org

American Society of Mechanical Engineers (ASME)-Pressure Vessel Human Occupancy (PVHO)

This organization generates standards for the design, fabrication, inspection, testing, marketing, and stamping of pressure vessels for human occupancy. These standards extend to requirements for the design, fabrication, inspection, testing, cleaning and certification of related piping systems. By their definition, a PVHO is a pressure vessel than encloses a human being within its pressure boundary while it is under internal or external pressure that exceeds a 2 psi differential. PVHO's include submersibles, diving bells, hyperbaric, recompression, decompression, and altitude chambers. They do not include pressurized airplane of aerospace vehicle cabins, and caissons.

PVHO 1 is the above standard

PVHO 2 is the standard for acrylic windows (multiplace view ports and monoplace tubes)

www.asme.org

Center for Medicare & Medicaid Services (CMS)

This is the US federal agency that administers Medicare, Medicaid and the State Children's Health Insurance Program. Among other things, CMS develops coverage determinations for their reimbursable diagnostic and therapeutic services. They are called 'National Coverage Determinations' (NCD's) and extend to hyperbaric medicine. The hyperbaric NCD (20.29) lists those conditions which they will pay for and those they will not. This NCD is expanded upon as Local Coverage Determination's (LCD's) by Medicare's regional Fiscal Intermediaries, Contractors, and Carriers, see below.

www.cms.gov

Compressed Gas Association (CGA)

The CGA develops and promotes safety standards and safe practices in the industrial gas industry. These standards extend to medical gases that support the hyperbaric medicine facility, with specific reference to purity.

www.cganet.com

Det Norske Veritas Healthcare (DNV)

DNV is a provider of hospital accreditation, infection risk management and standards development. In 2008 DNV was approved by CMS to accredit acute care hospitals in the US, and subsequently approved to accredit critical access hospitals (small rural hospitals with limited inpatient and outpatient services). DNV is the first competitor to the Joint Commission (see below).

www.dnvaccreditation.com

Federal Drug Administration (FDA)

The FDA is responsible for protecting and promoting public health through regulation and supervision of many items and products including medical devices. The FDA lists those conditions for which a hyperbaric medicine chamber is approved to treat. While the treatment of non-FDA approved (off-label) conditions is not a violation of their standards, the marketing and promotion of non-approved conditions is. Such violations carry significant penalties.

www.fda.gov

Joint Commission (JC)

Formerly the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), the JC is a US-based health care accrediting organization. Since 1965 is has been mandatory that a hospital receive JC accreditation in order to qualify for Medicare's 'Conditions of Participation'. Until 2008 JC was the only organization approved by the federal government to award such certification. In 2008, DNV gained CMS authorization to also undertake this accreditation process.

www.jointcommission.org

Local Fire Marshal

The local Fire Marshal (or state Fire Marshal if there is no one designated locally) is charged with fire code enforcement (particularly relating to flammable materials) and/or investigating fires for origin and cause.

With regard to hyperbaric medicine facilities, the Fire Marshal will inspect on the basis of NFPA 99. However, they will not always use its most current version. States will adopt a particular version and many continue to use it even though there has been one and in some cases two subsequent revisions. Commonly, the Fire Marshal will be expected to inspect and approve a hyperbaric facility prior to its opening for clinical operations.

Medicare FI/Contractor/Carrier Local Coverage Determinations (LCD's)

While a federal program, CMS /Medicare contracts with various organizations to administer its program across the country. These companies are either Fiscal Intermediaries (FI's), who review Part A (hospital) claims, Contractors, who review and pay Part A and Part B (physician) claims, or Carriers, who process and pay Part B claims.

These regional organizations generate Local Coverage Determinations (LCD's). LCD's represent defining coverage positions for each diagnostic or therapeutic service covered by Medicare. The LCD is an essential 'clarification' of the CMS/Medicare NCD, while providing much greater detail of Medicare's intent. It is particularly expansive in terms of which ICD-9 codes to use, and how physicians are expected to meet reimbursement compliance standards. Each practitioner should be guided by their respective LCD. If there is no LCD for a given region it means that the FI/Contractor/Carrier is deferring to the NCD.

Occupational Safety and Health Administration (OSHA)

OSHA is an agency of the Department of Labor. Its mission is 'to ensure safe and effective working conditions by setting and enforcing standards and by providing training, outreach, education and assistance'. Like essentially every other workplace (there are exceptions), the hospital setting falls under the purview of OSHA, and its standards. Their inspectors will visit hospitals on a largely irregular basis unless they are advised of harmful or potentially harmful working environments. Typically, these visits will either be a full general survey or a concentrated inspection related to a specific issue. Full general surveys are uncommon. Palmetto Heath Richland Hospital underwent such a survey in July, 2012. The last one was in 1988. Concentration areas tend to be blood borne pathogens, how hazardous waste is handled and general safety issues, including adequate egress. Employees are asked how they manage these issues, what resources guide them (MSDS, etc).

www.osha.gov

National Fire Prevention Association (NFPA)

NFPA 99 establishes criteria for health care services or systems based on risk to patients, staff, or visitors in health care facilities in order to minimize hazards of fire, explosion and electricity. Chapter 14 (2012) is specific to hyperbaric medicine. It classifies chambers as either Class A (multiple occupancy), Class B (single patient occupancy) or Class C (animal only, no human access capability). Chapter 14 addresses, wide-ranging topics, including the requirement for each hyperbaric facility to designate a safety director.

www.nfpa.org

Undersea & Hyperbaric Medical Society (UHMS)

The UHMS is the peer scientific representation of undersea and hyperbaric oxygen therapy. This organization developed the first listing of what they considered to be the appropriate indications for hyperbaric oxygen therapy. This list was adopted by the Federal Drug Administration. It further provided the framework for CMS/Medicare's national coverage policy and that of essentially all of those others who purchase care.

The UHMS updates their list of recommended uses from time to time. Additions to this list receive much greater (evidence-based) scrutiny from the health insurance industry than in past years.

www.uhms.org

Uniform Boiler & Pressure Vessel Society

Under the 'Uniform Boiler and Pressure Vessel Act', organizations, including hospitals, are required to have all equipment that falls under this act inspected to meet required safety standards. The extent to which this inspection program is implemented varies considerably on a state-by-state basis. North Carolina, for example, is particularly rigid in this regard.

Commonly, inspectors will expect to see evidence that hyperbaric chamber has been manufactured consistent with prevailing codes and standards (ASME-PVHO 1 and 2).

www.nationalboard.org/SiteDocuments/E-Publications/nb_132.pdf