



University of Pennsylvania Diving and Hyperbaric Medicine Fellowship Program

The University of Pennsylvania Diving and Hyperbaric Medicine Fellowship is designed to provide licensed physicians the opportunity to be educated and trained in the theory and practice of diving and hyperbaric medicine. Individuals successfully completing the one-year fellowship will obtain sufficient didactic and practical knowledge to work efficiently and competently in a hyperbaric clinical and research environment, to act in a supervisory capacity of a hyperbaric chamber, and meet eligibility requirements to sit for the American Board of Medical Specialists' certification examination for special competency in Undersea and Hyperbaric Medicine.

Program Curriculum Goals:

The subspecialty of Undersea and Hyperbaric Medicine deals with the therapeutic use of high environmental oxygen pressure and the prevention of injury and illness due to exposure to environments with elevated ambient pressure. The scope of the subspecialty emphasizes occupational, environmental, safety, and clinical aspects of diving, hyperbaric chamber operations and hyperbaric oxygen (HBO₂) therapy. At completion of the fellowship, the trainee will:

1. Develop a knowledge base and clinical skills necessary to:
 - Evaluate and prescribe appropriate HBO₂ therapy for all the medical conditions accepted by the Undersea and Hyperbaric Medical Society as amenable to treatment.
 - Manage patients during hyperbaric treatment.
 - Evaluate individuals for scuba diving activities, and treat diving-related illnesses.
2. Discuss investigational indications for the use of HBO₂ and areas for future research.
3. Develop requisite academic skills to be an effective teacher and researcher in diving and hyperbaric oxygen therapy.

Fellowship Requirements and General Characteristics:

Fellowship candidates must be graduates of an approved residency and hold a valid medical license for the state of Pennsylvania. The educational program is designed for two fellows per year. Participation in clinical and research activities of the Institute for Environmental Medicine (IFEM) is the core focus.

Curriculum:

1. Required clinical activities:
 - a. Participate in HBO₂ clinical operations by monitoring daily treatment sessions and emergency on-call treatments at least 4 days/week,
 - b. Provide consultation service to physicians referring patients.
 - c. Participate in weekly wound care clinic and biweekly diving medicine clinic.
2. Didactic curriculum and HBO₂ core lecture series:
 - a. Weekly clinical rounds discussion.
 - b. Weekly IFEM research work-in-progress meetings.
 - c. Weekly IFEM visiting research professor's lecture series.
 - d. Weekly hour-long meetings with IFEM faculty on core content subjects.
3. Development of four HBO₂ lectures for demonstration of knowledge in core curriculum subjects. These will be presented at community hospitals, rotating resident lectures, and/or at IFEM lecture sessions.
4. Required participation in one or more on-going research project. Based on a fellow's prior training and interests, a new project may be developed and funded by IFEM internal resources.
5. Participation in the Delaware Valley Regional Poison Control Center.
6. Elective clinical opportunities (may elect up to two):
 - Surgical Critical Care 1 month rotation
 - Medical Intensive Care 1 month rotation

Core Content Outline:

1. History of pressure therapy in medicine
2. Physiologic effects of hyperbaric oxygen
 - a. Increase in healing of hypoxic wounds
 - b. Inhibition of Clostridial alpha toxin

- c. Lessening carbon monoxide toxicity
 - d. Influence on various blood cells
 - e. Vasoconstriction
 - f. Decrease in edema in burns and post-ischemic tissue
 - g. Preservation of tissue flaps
 - h. Decrease in lipid peroxidation
 - i. Inhibit PMN adherence/role of HBO₂ in ischemia reperfusion injuries
3. Mechanical effects of pressure
 - a. Reduce bubble volume
 - b. Inert gases, supersaturation, re-dissolving nitrogen bubbles
 4. Oxygen toxicity
 5. Multiplace chamber operation
 - a. Equipment considerations
 - b. Patient considerations
 - c. Emergency procedures
 6. Monoplace chamber operation
 - a. Equipment considerations
 - b. Patient considerations
 - c. Emergency procedures
 7. Approved indications for hyperbaric oxygen therapy
 - a. Air or gas embolism
 - b. Carbon monoxide poisoning
 - c. Carbon monoxide poisoning complicated by cyanide poisoning
 - d. Clostridial myonecrosis
 - e. Acute traumatic ischemias
 - f. Decompression sickness
 - g. Enhancement of healing in selected problem wounds
 - h. Exceptional blood loss
 - i. Necrotizing soft tissue infections
 - j. Refractory osteomyelitis
 - k. Radiation tissue damage
 - l. Compromised skin grafts and flaps
 - m. Thermal burns
 8. Contraindications and side effects of HBO
 - a. Absolute
 1. Untreated pneumothorax
 2. Selected medications (e.g. bleomycin)
 - b. Relative
 1. COPD with CO₂ retention, bullous disease
 2. High fever

3. Seizure disorder
 4. Recent thoracic surgery
 5. Ear or sinus surgery
 6. Congenital spherocytosis
 7. Optic neuritis
 8. Claustrophobia
- c. Side effects
1. Barotrauma (otic, sinus, pulmonary)
 2. Visual refractive changes
 3. Oxygen induced seizures and other CNS effects
 4. Claustrophobia
 5. Pulmonary oxygen toxicity
9. Tissue oxygen measurements
- a. Ankle brachial index
 - b. Transcutaneous oximetry
10. Investigational areas (examples)
- a. Ischemia reperfusion injury
 - b. Myocardial infarction
 - c. Cerebrovascular accident
11. Administrative aspects of chamber operation
- a. Guidelines for hyperbaric facilities
 - b. Economic aspects
 - c. Quality assessment
 - d. Peer review
12. Care of the critically ill patient in a hyperbaric chamber
- a. Drugs and critical care equipment under pressure
 - b. Nursing considerations
 - c. Resuscitation management
13. Hyperbaric medicine in pediatric practice
- a. Indications for HBO in children
 - b. Special contraindications
 - c. Psychologic preparation and support
14. Physiologic effect of pressure and immersion
- a. Physics of diving
 - b. Hypothermia and hyperthermia
 - c. High pressure nervous syndrome
 - d. Breath-hold diving

15. Decompression Theory
 - a. Inert gas exchange
 - b. Mechanisms of bubble formation
 - c. Saturation decompression theory
 - d. Repetitive diving
 - e. Surface decompression
 - f. Bubble detection
 - g. Mixed gas diving
 - h. Altitude diving, flying after diving

16. Pathophysiology and treatment of decompression illnesses
 - a. Signs and symptoms of decompression sickness and AGE
 - b. Mechanisms of gas entry and distribution
 - c. Effects of bubbles
 - d. Dysbaric osteonecrosis
 - e. Barotrauma
 - f. Treatment of decompression illnesses

17. Health hazards in divers
 - a. Medical examination and standards for hyperbaric exposure:
Military, commercial, recreational, scientific, hyperbaric personnel
 - b. Recognition and treatment of hazardous marine life injuries

Faculty:

Fellowship Director: Stephen R. Thom, M.D., Ph.D.

Associate Director: Kevin Hardy, M.D.

IFEM core faculty and attending staff: James Clark, M.D., Ph.D.

Aron Fisher, M.D.

Associated faculty: Michael Beers, M.D. (Pulmonary Medicine Diving Clinic)
Ara Chalian, M.D. (ENT care and myringotomy training)
Francis DeRoos, M.D. (EM Residency Director)
Robert Goldman, M.D. (Rehabilitation Medicine Wound Clinic)
Omaida Velazquez, M.D. (Vascular surgeon, Wound Care Clinic)