

# Certified Hyperbaric Technologist<sup>®</sup>

## Resource Manual



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**National Board of Diving & Hyperbaric Medical Technology**

*[www.nbdhmt.org](http://www.nbdhmt.org)*

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## Scope of Practice

### Purpose

The purpose of this document is to describe the training and competencies necessary to become certified as a hyperbaric technologist. CHT® is not an entry-level qualification, rather an additional certification beyond the applicant's qualifying profession (refer to qualifying pathway list).

### Qualifying Pathways

1. Respiratory Therapist
2. Physician Assistant
3. Military Corpsman
4. EMT/Paramedic
5. Registered Nurse or LPN
6. Nurse Practitioner
7. Physician
8. Certified Nurse Aide
9. Certified Medical Assistant
10. Physiologist
11. Others, upon application to the Board (case by case)

### Legal Status

This document has no legal status.

### Criminal Background Check

A criminal background check (paid for by applicant) is required for all applicants for CHT® status.

### Training and Competence

1. Be at least 18 years of age with a high school diploma or equivalent.
2. The CHT® applicant must have completed a National Board of Diving & Hyperbaric Medical Technology (NBDHMT) approved hyperbaric medicine introductory course.
3. As part of the clinical internship, the CHT® must complete the Transcutaneous Oxygen Monitoring (TCOM) Module.
4. Upon completing an approved course, CHT® applicant must undergo a clinical work experience of 480 hours in undersea, hyperbaric medicine or aviation medicine technology. Forty (40) hours of the requirement must be a supervised clinical internship for all approved training courses attended after January 1, 2010. The Board must be notified in writing of the name of the preceptor prior to commencing the internship. The preceptor should be a CHT or a CHRN.
5. Military personnel must complete 1000 clinical hours in addition to required, approved, training received in the military (unless 480 hours of approved clinical internship can be completed at an approved facility)
6. Maintain a minimum 12 continuing education credits every two years with at least six of those specific to undersea, hyperbaric, or aviation medicine.

### Competency Standards

This document describes the minimum general requirements and competency levels required of a CHT®.

### Minimum General Requirements

Understand:

1. Physics related to pressure exposures

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2. Basic calculations for the conversion of common units used in diving and hyperbaric practice (examples include feet/meters, psi/bar/Pa, Kg/pound etc.)
  3. Basic physical units used in diving and hyperbaric practice
  4. Boyle's Law (calculating air volumes and air consumption)
  5. Dalton's Law (partial pressure of gases at various depths)
  6. Charles' Law (the relationship between pressure changes and temperature changes)
  7. Henry's Law (the effect of partial pressures on the solubility of various gases in liquids and their corresponding effects on decompression)
  8. The principles of heat transfer by conduction, convection and radiation
  9. Mechanism of action for all UHMS approved hyperbaric oxygen indications
  10. Direct effects of pressure change; how and where barotrauma occurs
    - a. Ear
    - b. Sinus
    - c. Dental
    - d. Pulmonary
  11. Signs and symptoms of decompression illness (DCI)
  12. Relevant aspects of anatomy and physiology pertaining to these systems:
    - a. Musculoskeletal
    - b. Neurological
    - c. Integumentary
    - d. Cardiovascular
    - e. Respiratory
    - f. Endocrine
    - g. Gastrointestinal
    - h. Hematologic

Possess the capability to provide clinical support and assist in the prevention and/or management of pressure related problems:

1. Ear squeeze and other barotraumas
2. Carbon Dioxide (CO<sub>2</sub>) retention
3. Carbon Monoxide (CO) poisoning
4. Hyperbaric chamber atmosphere contamination
5. Built in breathing system (BIBS) contamination
6. Oxygen (O<sub>2</sub>) toxicity
7. Anoxic and hypoxic events
8. Nitrogen (N<sub>2</sub>) narcosis
9. Decompression illness (DCI)
10. Hypothermia and hyperthermia events

### **Gas Systems**

Understand and/or conduct procedures for chamber operations and life support systems

1. Test for purity of gases
2. Elemental gas schematics and their interactions when mixed
3. Mathematical calculations of gas usage
4. The principles and use of gas analyzers
5. Methods of identifying gas impurities

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6. The importance of oxygen purity in a gas delivery system
  7. Gas line filtration
  8. Calibrate gas analyzers
    - a. Delivery of multiple gases during hypo/hyperbaric operations
    - b. Monitor the chamber for depth, temperature and humidity using available types of equipment
    - c. Calibrate analyzing equipment
  9. Rationale for gas stratification and its prevention
  10. Maintain a legible and accurate record of all aspects of a hyperbaric delivery system
  11. Maintain a gas status board showing gas reserves and mixtures

### **Chamber Operations and Environment**

Understand:

1. Procedures for operating a hypo/hyperbaric chamber
  2. Inside attendants' responsibilities in a hypo/hyperbaric chamber
  3. The conduct of a post-exposure therapeutic recompression
  4. The system checks and user maintenance needed after using a hypo/hyperbaric chamber
  5. Pre and post dive checks of a hypo/hyperbaric chamber complex using specific checklists
  6. The operation and design of medical locks, including various types of interlocks and safety devices
  7. The principles of operation of various items of equipment used in a typical hyperbaric system, such as compressors, fire suppression systems, oxygen scrubbing and gas reclaim equipment
  8. The characteristics of and maintenance requirements for acrylic viewports
  9. The monitoring of internal chamber operations
  10. The monitoring of internal/external chamber gas quality and gas system quality
  11. The operation, function testing and selection of gas supplies for BIBS and overboard dump systems, including routine maintenance and repairs
  12. Compression and decompression procedures for multiple indications
  13. The construction and purpose of valves, fittings, gauges, regulators, hoses and pipe work
  14. How to carry out normal operations, maintenance and basic repairs on gas and fluid systems
  15. The differences between various thread forms and rationale
  16. The principles of chamber life support systems with priority on pre-operational checklists, monitoring during use, routine maintenance and basic repairs
  17. Proper identification of various gas cylinders; mandatory hospital grade gases
  18. Proper handling and storage of gas cylinders
  19. Emergency preparedness for fire, loss of oxygen, medical complications
  20. The use of various types of fire suppression systems including routine maintenance and operational checks
  21. The various substances and materials, which are prohibited inside a chamber, such as medical preparations, combustible materials, etc.
  22. Operate telephone emergency signals and other communications systems
  23. Risks/benefits involved with emergency decompression
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24. Appreciate the unique differences between monoplace and multiplace chambers
  25. Familiarity with the following regulatory agencies and related organizations: Food and Drug Administration (FDA), Centers for Medicare and Medicaid Services (CMS), Occupational, Safety and Health Administration (OSHA), Centers for Disease Control and Prevention (CDC), National Fire Protection Association (NFPA), American Society of Mechanical Engineers (ASME), American Society of Mechanical Engineers' Committee on Pressure Vessels for Human Occupancy (ASME PVHO), Association of Diving Contractors International (ADCI), Joint Commission (JC) and the Undersea and Hyperbaric Medical Society (UHMS)

**Clinical Skills (supervised)**

Have a basic understanding in the operation of biomedical devices within the department

Be able to carry out relevant diagnostic and clinical procedures such as:

1. Ability to report to nurse or physician an accurate medical history
2. Assess patient for pain and document findings
3. Obtain vital signs (pulse, respiratory rate, body temperature, and blood pressure)
4. Observe for changes in neurological status
5. Know when to use appropriate clean or sterile techniques
6. Collection and removal of patient waste products
7. Assist in patient care procedures; dressing changes
8. Basic EKG recognition; set alarm parameters; print and post strip
9. Ability to safely operate all stretchers, gurneys, wheelchairs, beds and other assistive devices
10. Comply with quality control (QC) measures; glucometer
11. Prepare patient for treatment
  - a. Body positioning of patients
  - b. All cotton garments or other approved materials only for in chamber
  - c. EKG placement on patient, as ordered
  - d. Age specific patient education on fundamentals of HBO treatment; equalizing ear pressure
  - e. Provide comfort measures with approved safety constraints.

**Generalized Clinical Knowledge**

Have a basic understanding of the risks, side effects and hazards of certain medications in the hyperbaric chamber.

1. Maintain CPR, ability to establish an airway
2. Describe the signs, symptoms and treatment of hyper- and hypothermia
3. Describe the effects of gases on the body and their limits under pressure
4. Describe the effects of pressure on the body and the principles of decompression and therapeutic procedures
5. Proper body mechanics to protect self from injury
6. Communication with all levels of hyperbaric medical team
7. Reinforce age-specific teaching
8. Perform transcutaneous oximetry (TCOM), as ordered
9. Basic medical terminology
10. Proper use and application of restraints when ordered by physician; assess circulation
11. Patient privacy and confidentiality; observe HIPAA requirements

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12. Medical record keeping; secure

Infection control measures

1. Universal precautions
2. Use of approved disinfectants for chamber and equipment; recognizing the risks associated with off gassing of chemicals in the chamber
3. Hand washing
4. Personal protective equipment (PPE)

## **Clinical Internship in Hyperbaric Technology**

### **Introduction**

In order to facilitate entry for certification in hyperbaric technology, the National Board of Diving & Hyperbaric Medical Technology has established a set of clinical internship guidelines.

Graduates of approved introductory training programs in hyperbaric technology and/or medicine are subsequently required to undergo a minimum clinical internship of 480 hours. Forty (40) hours of this requirement must be supervised for all applicants who undergo NBDHMT approved training courses after January 1, 2010.

The forty (40) hours of supervised clinical internship must be preceptor based. As a minimum requirement, each designated facility preceptor(s) must be a Certified Hyperbaric Technologist<sup>®</sup> or a Certified Hyperbaric Registered Nurse<sup>®</sup> subsequent with a minimum of two (2) years of undersea/clinical hyperbaric/aviation medicine experience. The Board must be notified in writing of the name of the preceptor prior to commencing the supervised preceptorship.

The supervised clinical internship guidelines that follow are general in nature. They are divided into five categories, with specific topics listed for each category. The objectives for each topic are described under the heading "Internship Objectives". Some of the topics have been expanded to include "Additional Objectives". Interns should be encouraged to achieve each of the additional objectives in whichever topics are of particular interest, or most applicable to his/her situation. This approach allows individuals with varied skills and backgrounds to utilize a common program of clinical training.

The supervised clinical internship guidelines are not specific to a particular facility or method of delivery of hyperbaric oxygen therapy. Rather, they provide the broadest possible subject matter so that each center can tailor these guidelines to best fit their respective resources and areas of expertise. It should be kept in mind that the objective of this program is to provide the intern with a broad-based general knowledge. Each center is encouraged to develop specific training material with regard to precise objectives, subject matter and teaching methods.

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## Chamber Equipment

### Chamber Compression Gas

**Internship Objectives:** Know and demonstrate knowledge of the routing of the compression gas supply and the Quality Assurance procedure to ensure gas purity.

**Additional Objectives:** Inspect the entire gas supply pathway. This will vary, depending upon the chamber type. High pressure or cryogenic storage, or low pressure compressor intake, to pressure reducing or compression mechanisms, to accumulators, zone shut-off -valve to chamber control valving and flow lines should be identified, respectively.

### Breathing Gas Supply

**Internship Objectives:** Know and demonstrate knowledge of the source of the breathing gas supply and the Quality Assurance procedure to ensure gas purity. Practice proper connection and operation of breathing gas supply.

**Additional Objectives:** Inspect the entire breathing gas supply pathway(s). This will likely involve multiple gas mixtures and oxygen in multiplace chambers, and both oxygen and compressed air in monoplace chambers. Special attention should be directed to pressure reduction, isolation and emergency shut-off procedures. Conduct troubleshooting and maintenance of the breathing gas system(s): i.e. regulator, flow meter, humidifier, overboard dump and patient delivery system.

### Fire Extinguishing System

**Internship Objectives:** Be familiar with the fire extinguishing system activation procedures for the chamber (where fitted) and the surrounding hyperbaric facility. Operate handheld hose(s), where fitted, and be familiar with the operation of portable handheld devices. Recognize the fire alarm(s).

**Additional objectives:** Inspect the water tanks, water delivery, fire director sensors and alarm panel (where fitted). Review maintenance and troubleshooting procedures.

### Communications

**Internship Objectives:** Be familiar with all applicable forms of voice and visual communications. Recognize factors that may influence operator/inside attendant/patient communications.

## Chamber Operations

### Chamber Standard Operating Procedures

**Internship Objectives:** Know and be able to perform the chamber(s) standard operating procedures.

**Additional Objectives:** Inspect chamber console/panel layout. Locate and operate manual and automatic controls.

### Chamber Emergency Operating Procedures

**Internship Objectives:** Know, and be able to perform, the chamber operating procedures that become necessary under various emergency situations.

**Additional Objectives:** Inspect chamber console/panel layout, as it pertains to emergency and override controls.

### Checklists, Dive Tables and Treatment Protocols

**Internship Objectives:** Be familiar with all chamber checklists (equipment and patient). Have a working knowledge of dive/decompression protocols. Have a working knowledge of all patient treatment protocols.

**Additional Objectives:** Demonstrate a working knowledge of decompression table computations.

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#### Patient Treatment and Staff Dive Records

**Internship Objectives:** Be familiar with all of the procedural and operational aspects necessary to institute hyperbaric oxygen therapy protocols.

**Additional Objectives:** Compile a record of typical patient treatments in accordance with local operating procedures.

#### Support Equipment and Supplies

**Internship Objectives:** Be familiar with all chamber and patient ancillary equipment (ECG and pressure monitor; infusion pump; suction apparatus; transcutaneous oxygen monitor; mechanical ventilator; blood pressure and vital signs monitors; Ambu bag etc.). Know all of the supplies necessary to support the elective and emergent patient referral. Be able to identify the effects of pressure on ancillary equipment and supplies. Recognize any associated safety hazards.

**Additional Objectives:** Practice set-up, operation and troubleshooting of all ancillary equipment.

#### Patient Preparation, Loading and Unloading

**Internship Objectives:** Know and demonstrate knowledge of patient preparation for hyperbaric oxygen therapy. Know the correct procedure for transferring patient into and removing from the chamber.

**Additional Objectives:** Practice patient preparation procedures with particular attention to physical, physiological and equipment risk factors. Practice chamber loading and unloading of patients.

#### Safety

##### Fire Safety

**Internship Objectives:** Know and demonstrate knowledge of how to prevent/minimize electrostatic spark discharge and control/minimize static electricity accumulation and other potential ignition sources. Appreciate the effect of hyperbaric oxygen environments and the burning rate of materials that are allowed, and those not allowed, in the chamber.

Know how to control oxygen levels in multiplace chambers to within operational limits.

##### Pressure Safety

**Internship Objectives:** Know and demonstrate knowledge of the correct procedure for operating/securing all doors, hatches and other pressure boundary accesses. Know the proper set-up and connection of all pass-throughs. Know all of the potential pressure hazards in and around the chamber.

**Additional Objectives:** Practice operation of all pressure boundary doors and hatches. Practice set-up, operation and maintenance of all pass-throughs.

#### Patient Assessment

##### Initial Consultation

**Internship Objectives:** Know and demonstrate knowledge of the appropriate referable conditions for hyperbaric medicine evaluation and the related beneficial mechanism(s). Know the currently accepted hyperbaric treatment protocols. Know the treatment plan and appreciate the duties of each of the hyperbaric staff members involved in the patient's care.

**Additional Objectives:** Observe an initial consultation. Review patient's reason for referral, previous medical management, physical, neurological and vascular examinations. Assist in transcutaneous oxygen testing, review results and interpretation. Formulate and rationalize a treatment plan.

##### Ongoing Assessment

**Internship Objectives:** Appreciate the various clinical and laboratory indicators necessary to evaluate therapeutic response during the treatment course.

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**Additional Objectives:** Undertake patient evaluation during the treatment course. Determine patient compliance and cooperation. Evaluate for side-effects, including, but not limited to, middle ear/tympanic membrane changes and blood glucose control.

#### Follow-up Assessment

**Internship Objectives:** Appreciate periodic patient follow-up parameters. Appreciate clinical and laboratory responses, need for other therapy and prognosis.

**Additional Objectives:** Attend periodic patient follow-up visits. Determine degree of outcome complications and side-effects to hyperbaric oxygen therapy.

#### Patient Care

##### Patient Pre-treatment Briefing

**Internship Objectives:** Know and demonstrate knowledge of the risks and potential side-effects of exposure to hyperbaric doses of oxygen.

**Additional Objectives:** Brief patient concerning the physical effects of changes in environmental pressure. Brief patient on the correct procedures to limit/reduce the likelihood of barotraumas to the lungs, sinus spaces, ear, teeth and gastrointestinal tract. Brief the patient concerning known risk factors for exposure to hyperbaric doses of oxygen.

##### Barotrauma Management

**Internship Objectives:** Know and demonstrate knowledge of the signs and symptoms of barotrauma. Know and demonstrate knowledge of the immediate management of barotrauma.

**Additional Objectives:** Instruct and assist patients during compression and decompression phases.

##### Oxygen Toxicity Management

**Internship Objectives:** Know and demonstrate knowledge of the signs and symptoms of central nervous system intolerance to hyperbaric doses of oxygen. Know and demonstrate knowledge of the signs and symptoms of pulmonary oxygen toxicity. Know and demonstrate knowledge of the various methods that serve to reduce the likelihood of oxygen toxicity. Know and demonstrate knowledge of the immediate management of CNS oxygen toxicity.

**Additional Objectives:** Appreciate the complicating factors associated with the development of pulmonary oxygen toxicity.

##### Hypoglycemia Management

**Internship Objectives:** Know and demonstrate knowledge of the differential diagnosis of hypoglycemia vs. CNS oxygen toxicity. Appreciate the methods of determining blood glucose. Appreciate methods of correcting hypoglycemia.

**Additional Objectives:** Witness blood glucose assessment. Determine prophylaxis or correctional requirements for diabetic patients pre-HBO, where indicated.

##### Decompression Sickness Management

**Internship Objectives:** Know and demonstrate knowledge of the procedures necessary to prevent/reduce the incidence of iatrogenic decompression sickness. Recognize the common manifestation of decompression sickness.

**Additional Objectives:** Appreciate the differential diagnosis of decompression sickness vs. cerebral arterial gas embolism.

##### Pulmonary Barotrauma

**Internship Objectives:** Know and demonstrate the knowledge of the risk factors for pulmonary barotraumas of ascent. Appreciate the differential diagnosis of cerebral arterial gas embolism vs. pneumothorax vs. tension pneumothorax vs. mediastinal emphysema vs. subcutaneous emphysema. Know and demonstrate knowledge of the various risk factors that increase and

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decrease the risk of pulmonary barotraumas. Know and demonstrate knowledge of immediate management of suspected pulmonary barotraumas of ascent.

**Additional Objectives:** Appreciate the definitive management of the various forms of pulmonary barotraumas of ascent.

#### Cardiopulmonary Complications

**Internship Objectives:** Demonstrate proficiency in obtaining vital signs. Know and demonstrate knowledge of the common clinical signs of severe, acute onset, cardiovascular distress. Demonstrate proficiency in basic CPR.

**Additional Objectives:** Appreciate normal vs. abnormal ECG wave forms. Appreciate basic methods of airway control.

#### Infection Control

**Internship Objectives:** Know and demonstrate knowledge of standard universal precautions and supplemental local infection control policies. Practice universal and local specific infection control precautions.

**Additional Objectives:** Recognize patient and equipment risk factors for cross-contamination.

#### Patient Comfort

**Internship Objectives:** Know and demonstrate knowledge of the various procedures necessary to ensure patient comfort and thermal control. Know and demonstrate knowledge of the signs and symptoms of claustrophobia and confinement anxiety.

**Additional Objectives:** Appreciate the various methods helpful in overcoming confinement anxiety.

#### Wound Care

**Internship Objectives:** Appreciate the general principles of wound homeostasis; infection control and treatment and wound healing and non-surgical wound care.

**Additional Objectives:** Assist in the evaluation of wounds. Assist in the limited debridement of wounds and appreciate the different types of wound dressings and their respective applications.

#### Documentation

**Internship Objectives:** Know and demonstrate knowledge of all forms and paperwork used to document patient treatment.

**Additional Objectives:** Complete pre-treatment patient assessment and treatment protocol forms. Complete ancillary patient chart notes and post-treatment documentation.

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## Transcutaneous Oxygen (TCOM) Monitoring Module

### Background

CHT<sup>®</sup>s and CHRN<sup>®</sup>s are occasionally called upon to conduct transcutaneous oximetry testing. Commonly, this involves patients with lower extremity wound healing deficiencies. Tissue oximetry testing is a non-invasive and quantitative assessment of oxygen availability in tissues directly beneath the sensor electrode. Used in an algorithmic manner, transcutaneous oxygen testing:

- Identifies whether or not local hypoxia is a factor in healing compromise
- Determines the physiologic capacity to respond locally (the wound) to centrally (the lungs) delivered increases in oxygen delivery
- Provides an early indication of therapeutic response
- Helps to identify a therapeutic end point

### Purpose

The TCOM Module is designed to ensure that CHT<sup>®</sup>s and CHRN<sup>®</sup>s are provided with sufficient knowledge and skill to effectively conduct transcutaneous oxygen data collection. This module contains both learning objectives and methods to demonstrate competency.

### Disclaimer

It is not the intent of the TCOM Module to provide CHT<sup>®</sup>s and CHRN<sup>®</sup>s with certification in transcutaneous oxygen testing.

### Learning Objectives

The trainee is expected to be able to demonstrate a working knowledge of:

- I. Transcutaneous oxygen (tcpO<sub>2</sub>) technology
  - A. Principals of transcutaneous oximetry
  - B. Applications of transcutaneous oximetry
- II. A transcutaneous oxygen monitor and related equipment
  - A. Operating functions of the monitor
  - B. Calibration procedure
  - C. Sensor electrode care and maintenance
  - D. Membrane care and replacement
  - E. Monitor care
  - F. Operational trouble-shooting
- III. The transcutaneous oxygen testing procedure
  - A. Patient consent
  - B. Site selection
  - C. Site preparation
  - D. Anticipated normal values
  - E. Control/reference sites
  - F. Normobaric air breathing
  - G. Normobaric oxygen breathing
  - H. Hyperbaric oxygen breathing
  - I. Documentation and data recording
  - J. Regional perfusion index (RPI) computation
  - K. Common testing errors

### RECOMMENDED READING

1. Fife CF, Smart DR, Sheffield PJ, et al. **Transcutaneous Oximetry in Clinical Practice. Consensus Statements Based on Evidence.** *UHM* 2009; 36(1):43-53.

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2. Smart DR, Bennett MH, Mitchell SJ. **Transcutaneous Oximetry, Problem Wounds and Hyperbaric Oxygen Therapy.** *Diving and Hyperbaric Medicine* 2006; 36(2):72-86.
  3. Sheffield PJ. **Measuring Tissue Oxygen Tension: A Review.** *Undersea and Hyperbaric Medicine* 1998; 25(3):179-188.
  4. Jorneskog G, Djavani K, Brismar K. **Day-To-Day Variability of Transcutaneous Oxygen Tension in Patients with Diabetes Mellitus and Peripheral Arterial Occlusive Disease.** *J Vasc Surg* 2001; 34(2):277-282.
  5. Niinikoski J. **Hyperbaric Oxygen Therapy of Diabetic Foot Ulcers, Transcutaneous Oximetry in Clinical Decision Making.** *Wound Rep Reg* 2003; 11:458-461.
  6. Transcutaneous Oxygen Monitor Operations Manual.

### **ELIGIBILITY REQUIREMENTS**

Completion of the Transcutaneous Oxygen Monitoring Module is one of several prerequisites necessary for those who wish to certify as either hyperbaric technologists (CHT<sup>®</sup>s) or hyperbaric nurses (CHRN<sup>®</sup>s). Other prerequisites include successful completion of a NBDHMT approved Hyperbaric Medicine Introductory Course and the prescribed clinical internship. As a component of the clinical internship, CHT<sup>®</sup>/CHRN<sup>®</sup> applicants must complete this TCOM Module if it was not included in the approved introductory course. In order to complete the TCOM Module training process, applicants must:

- Review the learning objectives
- Study the Recommended Reading materials, referenced above
- Be formally trained by a competent source in each of the Learning Objectives
- Conduct at least three (3) preceptored lower extremity transcutaneous oxygen studies
- Include with the CHT<sup>®</sup>/CHRN<sup>®</sup> application, a letter from the applicant's manager or medical director that certifies completion of the TCOM Module.

### **TCOM MODULE MINIMUM TRAINING OUTLINE**

- I. Trainee should be able to demonstrate a working knowledge of the transcutaneous monitor technology, specifically:
    - A. Describe the principles of transcutaneous oximetry testing to include:
      - i. Function of the sensor electrode
      - ii. Physiological effect of the heating element
      - iii. Potential patient risks
    - B. Summarize the various applications of tcpO<sub>2</sub> monitoring, as they relate to the wound healing deficient patient
      - i. Small and large vessel abnormality screening
      - ii. Wound hypoxia determination
      - iii. Suitability to undergo HBO therapy
      - iv. Evidence of therapeutic response
      - v. Determination of potential therapeutic endpoint
      - vi. Skin flap assessment
  - II. Trainee should be able to demonstrate a working knowledge of the transcutaneous oxygen monitor and its supportive equipment.
    - A. Describe the operating functions of the monitor, including settings and adjustments
    - B. Explain how the monitor is calibrated, and on what frequency
    - C. Summarize the correct procedures for maintaining the sensor electrode and changing sensor membranes
    - D. Describe how the sensor electrode is cleaned and disinfected
    - E. Describe the necessary trouble-shooting procedures for alarms and error codes
  - III. Trainee should be able to demonstrate a working knowledge of the transcutaneous oxygen testing procedure.
    - A. Describe the related anatomy of common testing sites
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- i. Vascular supply
      - ii. Bones and tendons
    - B. Describe how the various testing sites are selected
      - i. Anatomic characteristics
      - ii. Skin characteristics
      - iii. Peri-wound issues
    - C. List the steps involved in site preparation
      - i. Removal of hair
      - ii. Removal of oils and dirt
      - iii. Removal of loose dry skin/stratum corneum
    - D. Describe the testing process, and at least two types of provocative challenges
      - i. Baseline air breathing test procedure
      - ii. Provocative challenges
        - a. Normobaric 100% oxygen at ambient pressure
        - b. Extremity elevation; air breathing
        - c. Extremity dependency; air breathing
        - d. Limb occlusion
        - e. Hyperbaric oxygen challenge
    - E. Explain why patient-specific control/reference sites are employed and provide examples
      - i. To allow each patient to serve as their own control
      - ii. To determine differences in degree of 'central' (chest) vs. 'local' (extremity or wound) tissue oxygenation
      - iii. Example sites include the chest (left second intracostal space, mid-clavicular), the tricep, where the chest is not suitable (large amount of fatty tissue; previous history of therapeutic radiation; CABG surgery and mammary artery diversion; contralateral extremity).
    - F. List anticipated tcpO<sub>2</sub> values or range of normal values for both 1.0 ATA air testing and at elevated altitudes
      - i. Chest reference site 60-95mmHg
      - ii. Lower extremity; normal > 50mmHg adequate for oxygen-dependent wound healing; > 40mmHg
      - iii. Foot; as per ii above.
    - G. Describe trouble shooting procedure for
      - i. Alarms
      - ii. Error Codes
  - IV. Trainee should be able to demonstrate knowledge of a tcpO<sub>2</sub> test that is consistent with current industry standards.
    - A. Describe the anatomy of the most common tcpO<sub>2</sub> sites
      - i. Vascular supply
      - ii. Bones and Tendons
    - B. Describe how to determine site selection
      - i. Anatomical characteristics
      - ii. Skin characteristics
      - iii. Peri-wound characteristics
    - B. List 3 steps of site preparation
      - i. Remove hair
      - ii. Remove loose dry skin
      - iii. Cleanse skin to remove oils and dirt
    - C. Explain how to perform a comprehensive tcpO<sub>2</sub> study that will identify basic tcpO<sub>2</sub> values and tcpO<sub>2</sub> responses to 3 physiologic challenges
      - i. Baseline with normobaric air
      - ii. Physiologic challenges
        - a. Elevated and dependent extremity challenge
        - b. Normobaric oxygen challenge with 100% O<sub>2</sub>
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- c. Hyperbaric oxygen challenge
  - D. Explain how one calculates Regional Perfusion Index (RPI)
    - i. Completed for air breathing only
    - ii. Divide wound site value by chest reference site value
  - E. Explain the effects of common testing errors on tcpO<sub>2</sub> value obtained
    - i. Positioning of patient
    - ii. Patient talking or moving
    - iii. Ambient room temperature variances
    - iv. Inconsistent electrode temperature with serial readings
    - v. Inconsistent electrode placement with serial readings
    - vi. Inadequate time for electrode equilibration
    - vii. Inadequate oxygen flow during oxygen challenge
    - viii. Improper adhesion of electrode fixation ring
  - F. Trainee should be able to describe how to obtain the subject's consent for tcpO<sub>2</sub> procedure
    - i. Explain the planned procedure
    - ii. Explain the risks involved
    - iii. Explain the potential value of the test
  - G. Trainee should be able to inspect the equipment needed to conduct a tcpO<sub>2</sub> study
    - i. Monitor
    - ii. Electrode
    - iii. Ancillary Equipment
      - a. Oxygen source
      - b. Oxygen delivery device
      - c. Calibration gas (if applicable)
  - H. Trainee should be able to conduct a tcpO<sub>2</sub> test that is consistent with current clinical practice standards
    - i. Set up the oxygen monitor
      - a. Sensor temperature setting
      - b. pO<sub>2</sub> setting
      - c. pCO<sub>2</sub> setting (if applicable to this monitor)
      - d. Re-membrane electrode
      - e. Calibrate electrode
    - ii. Prepare the patient
      - a. Brief the patient
      - b. Position patient for test
    - iii. Prepare the site
      - a. Prepare the selected sites electrode placement
      - b. Attach adhesive electrode to the skin surface
      - c. Add contact solution
    - iv. Collect and record data
      - a. Baseline tcpO<sub>2</sub> on normobaric air
      - b. Normobaric oxygen challenge on 100% oxygen
      - c. Hyperbaric oxygen challenge
      - d. Record the data
      - a. Complete data sheet or input information to computer
      - b. Calculate RPI
    - v. Remove Electrode
      - a. Remove face mask
      - b. Turn off oxygen
      - c. Remove sensor electrode and secure
      - d. Remove fixation rings
      - e. Disinfect sensor electrode cable
      - f. Re-membrane as necessary
      - g. Replace wound dressings as appropriate
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# SAMPLE TCOM COMPETENCY SKILLS CHECKLIST

## Technical Knowledge of Transcutaneous Oxygen Monitor and Sensor Electrode

Name \_\_\_\_\_ Instructor \_\_\_\_\_  
as it appears on government issued I.D.

### Demonstrate knowledge of the following

<input type="checkbox"/>	Principles of transcutaneous oximetry
<input type="checkbox"/>	Application for tcpO2
<input type="checkbox"/>	Operating functions of the monitor
<input type="checkbox"/>	Settings
<input type="checkbox"/>	Adjustments
<input type="checkbox"/>	Calibration procedure
<input type="checkbox"/>	Procedure for maintaining membrane & electrode
<input type="checkbox"/>	Troubleshooting procedures for alarms and error codes
<input type="checkbox"/>	Anatomy of common tcpO2 sites
<input type="checkbox"/>	How to select tcpO2 site
<input type="checkbox"/>	How to prepare tcpO2 site
<input type="checkbox"/>	How to perform a tcpO2 study
<input type="checkbox"/>	Why reference information is obtained
<input type="checkbox"/>	Anticipated normal tcpO2 values
<input type="checkbox"/>	How to calculate a regional perfusion index (RPI)
<input type="checkbox"/>	Three common testing errors and their effect on tcpO2
<input type="checkbox"/>	How to obtain the subjects consent for tcpO2 procedure

### Demonstrate procedure for inspection of the equipment

	<i>Monitor</i>
<input type="checkbox"/>	Electrode temperature setting
<input type="checkbox"/>	Oxygen calibration- barometric pressure determination
<input type="checkbox"/>	pCO2 (if applicable to this facility)
<input type="checkbox"/>	O2 alarm limits (if applicable to the monitor in question)
<input type="checkbox"/>	CO2 alarm limits (if applicable to the monitor in question)
	<i>Electrode</i>
<input type="checkbox"/>	Cable in intact
<input type="checkbox"/>	Membrane change
<input type="checkbox"/>	Frequency of changes
<input type="checkbox"/>	Technique
	<i>Ancillary Equipment</i>
<input type="checkbox"/>	O2 source (portable E or H cylinder, wall O2)
<input type="checkbox"/>	O2 delivery (mask or hood assembly)
<input type="checkbox"/>	Calibration gas (if applicable)

## Demonstrate test procedure

<b>Conduct tcpO2 Study (3 patients/subjects)</b>	<b>1</b>	<b>2</b>	<b>3</b>
Set up oxygen monitor			
Set up temperature			
Set pO2/pCO2 (if applicable)			
Re-membrane electrode (1 time)			
Calibrate electrode (if applicable)			
Prepare the patient/subject			
Brief the patient/subject			
Obtain consent			
Position patient/subject for test			
Prepare the site			
Select the site			
Remove hair and loose skin			
Clean the site			
Attach electrode to skin			
Collect data			
Baseline tcpO2 air			
Physiologic challenge (any 2 of the following)			
Elevated or dependent limb			
Ambient pressure 100% O2			
Hyperbaric pressure with 100% O2			
Record data			
Data sheet or computer			
Calculate RPI			
Remove electrode			
Remove adhesive electrode			
Clean sensor electrode cable			
Store electrode			
<b>Perform tcpO2 mapping (3 patients/subjects)</b>			
Troubleshoot equipment			
Alarms			
Error codes			

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## **Examination Background**

It is not the intention of the Board to provide an “entry level” pathway for certification in hyperbaric technology. Certification is made available as an “added qualification” for licensed or certified health care, and related, professionals whose professional duties include the medical and/or technical application of undersea, hyperbaric or aviation medicine.

A test bank of several hundred questions is used to develop each applicant’s examination. The test bank is monitored regularly and updated as indicated.

A concerted effort has been made to ensure little or no bias regarding each examinee’s orientation – multiplace or monoplace, civilian or military. There may be questions that relate to a specific hyperbaric setting, however, one’s strengths should compensate for one’s weaknesses. Due to the breadth of this discipline no one is expected to have a complete and comprehensive knowledge of all operating systems and related technologies.

A score of at least 70% correct is required to pass the exam. Scores of 90% or greater are graded “With Distinction”.

Examination opportunities are offered at various venues throughout the year. They are scheduled on a regular basis in conjunction with the Annual Scientific Meeting of the Undersea and Hyperbaric Medical Society and the Society’s regional annual chapter meetings. Special arrangements can be made to have the examination proctored at regional community colleges and other educational institutions approved by the Board. It has been deemed inappropriate for hyperbaric programs to provide “in house” examination proctorship. Stringent controls are in place to insure the examination impeccability.

The examination period lasts for two hours. Plan to be at the test site slightly longer, for an explanation of the testing process and distribution of the examination. The questions are either multiple choice or true-false. Each set of questions at a testing location will be unique and identified with the examinee’s name. It is absolutely necessary, therefore, for each prospective examinee to pre-register with the NBDHMT well in advance of the scheduled test date. Applicants will not be permitted to register at the testing site on the day of the exam.

Bring several #2 pencils and positive identification. A passport, or other photographic identification, will be required of each examinee in order to enter the testing area and receive their examination. A pocket calculator may be helpful. However, it is not absolutely necessary. Decompression tables and scratch paper will be provided.

## **Certification/Recertification**

### Registration for Examination

Applicant must complete a NBDHMT Certification Examination Registration Form (available at [www.ndbhmt.org](http://www.ndbhmt.org)) and return to NBDHMT headquarters with the following:

1. A copy of an NBDHMT approved Introductory Hyperbaric Medicine Training Course certificate of completion.
2. A copy of qualifying vocation license or certificate.
3. Upon completing an approved course, CHT<sup>®</sup> applicant must undergo a clinical work experience of 480 hours in undersea, hyperbaric medicine or aviation medicine technology. Forty (40) hours of the requirement must be a supervised clinical internship for all approved training courses attended after January 1, 2010. The Board must be notified in writing of the name of the preceptor prior to commencing the internship. The preceptor should be a CHT or a CHRN.
4. Payment in the amount of \$175.00 (US Funds).

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5. A completed 'Code of Conduct' declaration.

#### Expiration Date

Certification is awarded for a period of two years. Expiration of certification will occur on the last day of the month you passed the exam, two years hence.

#### *Example:*

Individuals successfully completing the examination during May of 2011 will have an expiration date of May 31, 2013. Certification is maintained through a system of verified continuing education.

#### Re-certification Requirements

Re-certification is awarded upon completion and verification of required continuing education credits, continued experience, submission of the re-registration form and the necessary fee.

Applicants must complete a NBDHMT Certified Hyperbaric Technologist® Re-certification Form ([www.nbdhmt.org](http://www.nbdhmt.org)) and return to NBDHMT headquarters, along with the following:

1. Proof of a minimum of 12 (minimum of 6 Category "A") CEU hours during the prior two (2) years.
2. Letter from place of employment confirming accumulation of at least 100 clinical experience hours during the prior two (2) years.
3. Check or money order in the amount of \$100.00 (US Funds) made payable to NBDHMT.

#### **Continuing Education Requirements**

Twelve continuing education credits (hours) are required during each registration period of which at least six (Category A) credits must be directly related to undersea, hyperbaric or aviation medicine. Continuing education credits can be supplied by the employer, through in-service and respective allied health education, and through a variety of educational opportunities approved by the NBDHMT. Retroactive Continuing Education Applications and a sample Continuing Education Log are available at [www.nbdhmt.org](http://www.nbdhmt.org).

#### **Application for CHT-ADMIN**

The CHT-ADMIN designation is possible only at the time of recertification. The option for CHT-ADMIN on the CHT® Recertification Form explains that the requirement to show proof of 12 CEU hours, and verify 100 clinical work hours are waived for this designation. CHT-ADMINS must include resume or C.V. with their recertification application

The purpose of the CHT-ADMIN designation is to allow past CHT's to continue to use a CHT designation once they have moved from CHT (operational and clinical duties). Commonly, these individuals have moved into management and administrative duties. The CHT ADMIN designation carries with it no clinical or operational intent.

These individuals have frequently been unable to complete the necessary technical and clinical hours to meet CHT® recertification requirements. By applying for CHT-ADMIN, individuals are able to maintain their CHT 'identity' and continue to be recognized as a hyperbaric professional.

#### **Inactive Status**

Should a certified hyperbaric technologist fail to recertify upon the completion of their current registration period then that individual will be considered as inactive.

#### **Reinstatement to Active Status**

Certification reinstatement can be accomplished within 12 months of inactive status. To become reinstated as an active certified hyperbaric technologist, applicants must submit all of those requirements listed under re-certification requirements, as well as an additional \$50.00 reinstatement penalty.

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Certification reinstatement after 12 months of inactive status requires that applicants must retake the certification examination and provide a copy of a current qualifying vocational license or certificate.

### **Failing and Retaking the Exam**

- If on the first attempt the examination is failed, the CHT® applicant must wait six (6) months before retaking the exam.
- If on the second attempt the examination is failed, the CHT® applicant is required to retake a NBDHMT Approved Hyperbaric Medicine training course in addition to waiting six (6) months before retaking the exam.
- If on the third attempt the examination is failed, the CHT® applicant is not allowed to sit again for the exam.

### **Testing Resource Materials**

Much of the material used to generate the examination question bank has been taken from the following resources:

1. National Fire Protection Association 99, Chapter 14, 2012 edition.
2. Hyperbaric Facility Safety: A Practical Guide. Workman WT, Editor, 1999. Best Publishing Company. ISBN: 0-941332-76-4
3. Hyperbaric Oxygen Therapy Indications, 2008. Undersea and Hyperbaric Medical Society. ISBN: 0-930406-23-0
4. Hyperbaric Medicine Practice, 3<sup>rd</sup> Edition, 2008. Kindwall EP and Whelan HT, Editors. Best Publishing Company. ISBN: 9-780941332-78-1

In addition to the above materials a study guide is available. It can be obtained as follows:  
CHT and CHRN Certification Exam Practice Book, available for purchase at:  
[www.hyperbaricmedicine.com](http://www.hyperbaricmedicine.com).

## **Disciplinary Procedures**

### **NBDHMT Standards and Review of Certificate**

The NBDHMT conducts a certification program for applicants and registrants. It does not, however, warrant job performance of applicants and registrants.

In applying for certification, an applicant or registrant agrees that:

1. They will comply with all rules of the NBDHMT.
2. The NBDHMT certificates, cards, logos, emblems, the name “National Board of Diving & Hyperbaric Medical Technology,” and abbreviations relating thereto are all the exclusive property of the Board and may not be used without the Board’s express written consent.
3. They will immediately relinquish using their certificate of certification, wallet card, logo, emblem and the Board’s name and related abbreviations in case of their suspension, limitation, or revocation of hyperbaric certification status.
4. If they refuse to immediately relinquish, refrain from using, and correct at their expense, any misuse or misleading use, of any of the above items when requested, the individual agrees that the Board shall be entitled to obtain injunctive relief, damages, costs and attorney’s fees incurred in obtaining any such or other relief.

### **Score Reports**

The Board is concerned with reporting only valid scores. On rare occasions, misconduct or circumstances beyond the individual’s control may render scores invalid. If doubts are raised about a score because of these or other circumstances, the Board expects all individuals to cooperate fully in any Board investigation. The Board reserves the rights to cancel any exam score if, in the sole opinion of the Board, there is adequate reason to question its validity. Before

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exercising this right the Board will offer the individual an opportunity to take the exam again at no additional fee.

## **Review of Certificates**

### **Violations**

The Board may revoke or otherwise take action with regard to the application or certificate of an applicant or registrant in the case of:

1. Failure to comply with any rule of the Board;
2. Dishonesty in connection with any Board examination;
3. Any misrepresentation, misleading statement or fraud, by commission or omission, to the Board or otherwise;
4. Sexual abuse, molestation or harassment of a present or former patient or other person;
5. Use of any drug or intoxicant to a degree which impairs objective professional performance;
6. Prescribing, selling or administering any substance except as permitted by law;
7. Unauthorized disclosure of confidential patient information;
8. Gross or repeated negligence of malpractice in professional work;
9. Incapacity, impairment or incompetence to perform professional work;
10. The conviction of a felony; or
11. Dishonorable, unethical or unprofessional conduct.

### **Violation of Board standards**

When the Board has reason to believe that a violation set forth in Section 1 above has occurred by any applicant or registrant, the Board President shall send to that person, by certified mail, a statement of the alleged violations of the Board's standard. Such statement shall set forth:

1. The applicable rule;
2. A statement of facts constituting the alleged violation of the rule;
3. That the individual may request a hearing for the disposition of the allegations, with the individual bearing their own expenses for such matter;
4. That the individual shall have 30 days after receipt of the statement to respond to the allegations in writing and notify the Board as to a request for a hearing on the record;
5. A statement that the individual may appear in person with the assistance of counsel, may examine and cross-examine any witness under oath, and produce evidence on his/her behalf;
6. That the truth of allegations or failure to respond may result in sanctions including certification revocation; and
7. That if the individual does not request a hearing, the individual consents that the Board may render a decision and apply available sanctions.

### **Hearing**

If an individual disputes the allegations or available sanctions or requests a hearing (request to be filed within 90 days of notice of violation), the Board President shall:

1. Schedule a hearing and send by certified mail, return receipt requested, Notice of Hearing to the individual.
2. The Notice of Hearing shall include a statement of the time and place of the hearing.

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3. The Hearing Panel shall consist of three members of the Board of Directors of NBDHMT.
  4. The Hearing Panel shall determine all matters relating to the hearing. The hearing and related matters shall be determined on the record by majority vote.

#### Evidence

Formal rules of evidence shall not apply. Relevant evidence may be admitted. Disputed questions shall be determined by majority vote.

#### Sanctions

Sanctions for violation of a Board standard may include, but are not limited to, one or more of the following:

1. Revocation;
2. Non-renewal;
3. Suspension;
4. Censure;
5. Reprimand;
6. Retest;
7. Educational requirement;
8. Reports to the Board.

#### Appeal

1. If the decision rendered by the Hearing Panel finds the allegations are not established, no further action on the appeal shall occur.
2. If the decision rendered by the Hearing Panel is not favorable to the individual, that person may appeal the decision to the Board of Directors. Any appeal must be made in writing to the NBDHMT within 90 days of the notice of the Hearing Panel's decision. A panel of three members of the Board of Directors shall determine the appeal by a majority vote.
3. The Board President shall select the members of the Appeals Panel.
4. The Appeals Panel shall consist of members of the full Board of Directors who did not take part in the decision of the Hearing Panel.
5. The Appeals Panel shall render a decision on the record without oral hearing.

#### Decision

The decision of the Hearing Panel or the Appeals Panel shall be rendered in writing, following the hearing or any briefing. The decision shall contain factual findings, conclusions of law and any sanctions applied. It shall be transmitted to the individual by certified mail.

#### Submission of Information to the Board Concerning Possible Violation of Board Standards

Persons concerned with possible violation of Board standards should submit such information in writing. This information should identify the person's alleged to be involved and the facts concerning the alleged conduct, in as much detail and specificity as possible, with available documentation. The statement should identify by name, address and telephone number the person making the information known to the Board and others who may have knowledge of the facts and circumstances concerning the alleged conduct.