
Certified Hyperbaric Technologist®

Resource Manual



National Board of Diving & Hyperbaric Medical Technology

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. Active Duty Military Corpsman
4. EMT/Paramedic
5. Registered Nurse or LPN
6. Nurse Practitioner
7. Physician

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. A felony conviction will disqualify an applicant as indicated below:

1. All those who are convicted of an offense, the degree of which disqualifies any individual from employment within a health care setting that receives government (namely Medicare and Medicaid program payments) funds is permanently ineligible to sit the CHT examination. This applies even if an individual chooses not to work in a facility that receives government funds.
2. If a subsequent background check on a current CHT notes conviction for an offense consistent with No.1 above, that CHT will immediately and permanently forfeit their certification. They will not be considered eligible for re-certification at any subsequent time period.
3. An exception to No.'s 1 and 2 above would be an individual who subsequently had their conviction overturned or otherwise expunged from their criminal record.
4. An individual who, upon application, is found to have a conviction, the degree of which would prevent that individual from employment in a health care facility (as defined in No. 1 above), for a period of five years, is likewise ineligible to sit the CHT examination for a period of five years from completion of their sentence.
5. If a subsequent background check on a current CHT notes conviction of an offense consistent with No. 4 above, they will immediately forfeit their CHT certification. They will become eligible to re-apply for CHT status, as a new applicant, following a period of five years from completion of their sentence.

Training and Competency

1. Be at least 18 years of age with a high school diploma or equivalent.
2. CHT® applicants must have completed a National Board of Diving & Hyperbaric Medical Technology (NBDHMT) approved hyperbaric medicine introductory training course within three years of intended CHT test date.

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3. As part of the clinical internship, the CHT® must complete the Transcutaneous Oxygen Monitoring (TCOM) Module.
 4. Upon completion of an approved course, CHT® applicants must undergo a clinical work experience of 480 hours in undersea, hyperbaric medicine or aviation medical technology. Forty (40) hours of this requirement must be a supervised direct and physically present clinical internship. The Board must be notified in writing of the name of the preceptor prior to commencing the internship. The preceptor should be either a CHT or a CHRN with a minimum of two years experience.
 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 NBDHMT approved facility)
 6. Maintain a minimum 24 continuing education credits every two years with at least 12 of those specific to undersea/hyperbaric operations, technical and safety aspects. See continuing education requirements, page 17.

Competency Standards

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

Minimum General Requirements

Understand:

1. Physical aspects of pressurized exposure
 2. Basic calculations for the conversion of common pressure units used in diving and hyperbaric practice (examples include feet/meters, psi/bar/kPa, Kg/pound etc.)
 3. Basic physical units used in diving and hyperbaric practice
 4. Boyle's Law (calculating air volumes, air consumption and the inverse relationship between pressure and volume)
 5. Dalton's Law (partial pressure of gases at various depths)
 6. Gay Lussac's Law (the relationship between pressure and temperature changes in a fixed volume)
 7. Henry's Law (the effect of gas partial pressures on solubility of various gases in liquids and their corresponding effects on decompression)
 8. The principles of heat transfer by conduction, convection and radiation
 9. Mechanisms of action for Undersea & Hyperbaric Medical Society recommended hyperbaric oxygen therapy indications
 10. Direct effects of pressure change; how and where potential barotrauma occurs
 - a. Ears
 - b. Sinus spaces
 - c. Teeth
 - d. Lungs
 - e. G.I. Tract
 11. Signs and symptoms of decompression illness (DCI)
 12. Relevant aspects of diving and hyperbaric medicine on anatomy and physiology pertaining to the following systems:
 - a. Musculoskeletal
 - b. Neurological
 - c. Integumentary
 - d. Cardiovascular
 - e. Respiratory
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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 (CO₂) retention
3. Carbon monoxide (CO) poisoning
4. Hyperbaric chamber atmosphere contamination
5. Built-in breathing system (BIBS) contamination
6. Oxygen (O₂) toxicity
7. Anoxic and hypoxic events
8. Nitrogen (N₂) narcosis
9. Decompression illness (DCI)
10. Hypothermia and hyperthermia

Gas Systems

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

1. Tests for purity and oxygen content of gases
2. Mathematical calculations of gas usage
3. Principles and use of gas analyzers
4. Importance of oxygen cleanliness within a hyperbaric delivery system
5. Gas line filtration
6. Calibration of gas analyzers
 - a. Delivery of multiple gases during hypo/hyperbaric operations
 - b. Monitor chamber for depth, temperature and humidity, using commonly available equipment
 - c. Calibration and verification of analyzing equipment
7. Basis for gas stratification and its prevention
8. Maintain a legible and accurate record of all aspects of the hyperbaric delivery system
9. 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 system checks and user maintenance needed before and after using a hypo/hyperbaric chamber
4. Pre and post dive checks of a hypo/hyperbaric chamber complex using specific checklists
5. The operation and design of medical locks, including various types of interlocks and safety devices
6. The principles of operation of various items of equipment used in a typical hyperbaric system, such as compressors, fire suppression systems
7. The characteristics of and maintenance requirements for acrylic viewports
8. The monitoring of internal chamber operations
9. The monitoring of internal/external chamber gas quality and gas system quality
10. The operation, function testing and selection of gas supplies for multiplace chamber patient breathing systems, including routine maintenance and repairs
11. Compression and decompression procedures for all clinical indications

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12. The construction and purpose of valves, fittings, gauges, regulators, hoses and pipe work
 13. How to carry out normal operations and maintenance on air and medical gas and fluid systems
 14. The differences between various thread forms and their rationale
 15. The principles of chamber life support systems with priority on pre-operational checklists, monitoring during use and routine maintenance
 16. Proper identification of various gas cylinders
 17. Proper handling and storage of high pressure gas cylinders
 18. Emergency preparedness for fire, loss of oxygen, loss of communications and medical complications
 19. The use of various types of fire suppression systems including routine maintenance and operational checks
 20. The various substances and materials, which are prohibited inside a chamber
 21. Appreciate the unique differences between monoplace and multiplace chambers
 22. 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), 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), Joint Commission (JC), De Norske Veritas (DNV) and the Undersea and Hyperbaric Medical Society (UHMS)

Clinical Skills (supervised)

Possess a basic understanding in the operation of biomedical devices within the hyperbaric medicine department

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

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

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

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2. Describe the signs, symptoms and immediate management of hyper- and hypothermia
 3. Describe the general effects of gases on the body
 4. Describe the effects of pressure on the body and the principles of decompression and therapeutic procedures
 5. Proper body mechanics to protect from self injury
 6. Communication with all levels of hyperbaric team
 7. Reinforce age-specific teaching
 8. Perform transcutaneous oximetry (TCOM) testing, 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
 12. Medical record keeping

Infection control measures

1. Universal precautions
2. Use of approved disinfectants for chamber and equipment; recognizing 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 supervised clinical internship must be preceptor-based. As a minimum requirement, each designated facility preceptor(s) must be a Certified Hyperbaric Technologist® or a Certified Hyperbaric Registered Nurse® with a minimum of two (2) years of undersea/clinical hyperbaric/aviation medicine experience. The Board must be notified in writing (www.CHTPreceptorshipnotificationform.com) of the name of the preceptor prior to commencing the supervised preceptorship.

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 their situation. This approach allows individuals with varied skills and backgrounds to utilize a common program of clinical training.

These 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.

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 and oxygen content.

Additional Objectives: Inspect the entire gas supply pathway. This will vary, depending upon chamber type. High pressure or cryogenic oxygen 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 and oxygen content. Practice proper connection and operation of breathing gas supply.

Additional Objectives: Inspect the entire breathing gas supply pathway(s). This may 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 Systems

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 applicable forms of voice and visual communications. Recognize factors that may influence or complicate 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, Decompression Tables and Treatment Protocols

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

Additional Objectives: Demonstrate a working knowledge of U.S. Navy air decompression table computations.

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 elective and emergent patient referrals. 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 burning rates 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 Undersea and Hyperbaric Medical Society approved 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 physician interpretation. Formulate and rationalize a treatment plan.

Ongoing Assessment

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

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 issues.

Follow-up Assessment

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

Additional Objectives: Attend periodic patient follow-up visits. Determine any 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 barotrauma 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 clinical manifestation of decompression sickness.

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

Pulmonary Barotrauma

Internship Objectives: Know and demonstrate knowledge of the risk factors for pulmonary barotrauma 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 decrease the risk of pulmonary barotrauma. Know and demonstrate knowledge of immediate management of suspected pulmonary barotrauma of ascent.

Additional Objectives: Appreciate the definitive management of the various forms of pulmonary barotrauma 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 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 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 wound healing principles 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.

Transcutaneous Oxygen (TCOM) Monitoring Module

Background

CHT®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
- Guides selection of hyperbaric treatment pressure
- Provides an early indication of therapeutic response
- Helps to identify a therapeutic end point

Purpose

The TCOM Module is designed to ensure that CHT®s are provided with sufficient knowledge and skill to effectively undertake 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®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 (tcpO₂) technology
 - A. Principals of transcutaneous oximetry
 - B. Applications of transcutaneous oximetry
- II. Transcutaneous oxygen monitors and related equipment
 - A. Operating functions of the monitors
 - B. Calibration and calibration verification procedures
 - 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.
2. Niinikoski J. **Hyperbaric Oxygen Therapy of Diabetic Foot Ulcers, Transcutaneous Oximetry in Clinical Decision Making.** *Wound Rep Reg* 2003; 11:458-461.

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3. Smart DR, Bennett MH, Mitchell SJ. **Transcutaneous Oximetry, Problem Wounds and Hyperbaric Oxygen Therapy.** *Diving and Hyperbaric Medicine* 2006; 36(2):72-86.
 4. 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 hyperbaric technologists (CHT®'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® applicants must complete this TCOM Module. 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® application, a letter from the applicant's program manager or medical director that confirms 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 tcpO₂ 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
- 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 monitor is cleaned and the sensor electrode is 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 generalized vascular anatomy of common testing sites
 - i. Vascular supply
 - 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 the provocative challenges

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- i. Baseline air breathing test procedure
 - ii. Provocative challenges
 - a. Normobaric 100% oxygen at ambient pressure
 - b. Extremity elevation; air breathing
 - c. 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 triceps, where the chest is not suitable (large amount of fatty tissue; previous history of therapeutic radiation; CABG surgery with mammary artery diversion)
 - F. List anticipated tcpO₂ 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 tcpO₂ test that is consistent with current practice standards.
 - A. Describe the anatomy of the most common tcpO₂ 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 tcpO₂ study that will identify basic tcpO₂ values and tcpO₂ responses to physiologic challenges
 - i. Baseline with normobaric air
 - ii. Physiologic challenges
 - a. Elevated extremity
 - b. Normobaric oxygen with 100% O₂
 - c. Hyperbaric oxygen
 - 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 tcpO₂ 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
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- F. Trainee should be able to describe how to obtain patient consent for tcpO₂ 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 tcpO₂ 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 tcpO₂ test that is consistent with current clinical practice standards
 - i. Set up the oxygen monitor
 - a. Sensor temperature setting
 - b. pO₂ setting
 - c. pCO₂ setting (if applicable to this monitor)
 - d. Re-membrane electrode
 - e. Calibrate electrode
 - f. Verify calibration
 - 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 tcpO₂ 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
-

SAMPLE TCOM COMPETENCY SKILLS CHECKLIST

Technical Knowledge of Transcutaneous Oxygen Monitor and Sensor Electrode

Name _____ Preceptor Name: _____
as it appears on government issued I.D.

Demonstrate knowledge of the following

<input type="checkbox"/>	Principles of transcutaneous oximetry
<input type="checkbox"/>	Applications for tcpO ₂ testing
<input type="checkbox"/>	Operating functions of the monitor
<input type="checkbox"/>	Settings
<input type="checkbox"/>	Adjustments
<input type="checkbox"/>	Calibration and calibration verification procedures
<input type="checkbox"/>	Procedure for maintaining membrane & electrode
<input type="checkbox"/>	Troubleshooting procedures for alarms and error codes
<input type="checkbox"/>	Anatomy of common tcpO ₂ sites
<input type="checkbox"/>	How to select tcpO ₂ site
<input type="checkbox"/>	How to prepare tcpO ₂ site
<input type="checkbox"/>	How to perform a tcpO ₂ study
<input type="checkbox"/>	Why reference information is obtained
<input type="checkbox"/>	Anticipated normal tcpO ₂ values
<input type="checkbox"/>	How to calculate a regional perfusion index (RPI)
<input type="checkbox"/>	Three common testing errors and their effect on tcpO ₂ measurements
<input type="checkbox"/>	How to obtain the subjects consent for tcpO ₂ 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"/>	pCO ₂ (if applicable to this facility)
<input type="checkbox"/>	O ₂ alarm limits (if applicable to the monitor in question)
<input type="checkbox"/>	CO ₂ alarm limits (if applicable to the monitor in question)
	<i>Electrode</i>
<input type="checkbox"/>	Cable intact and undamaged
<input type="checkbox"/>	Membrane change
<input type="checkbox"/>	Frequency of changes
<input type="checkbox"/>	Technique
	<i>Ancillary Equipment</i>
<input type="checkbox"/>	O ₂ source (portable E or H cylinder, wall O ₂)
<input type="checkbox"/>	O ₂ delivery (mask or hood assembly)
<input type="checkbox"/>	Calibration gas (if applicable)

Demonstrate test procedure

Conduct tcpO₂ Study (3 patients/subjects)	1	2	3
Set up oxygen monitor			
Set up temperature			
Set pO ₂ /pCO ₂ (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 tcpO ₂ air			
Ambient pressure 100% O ₂			
Record data			
Data sheet or computer			
Calculate RPI			
Remove electrode			
Remove adhesive electrode			
Clean sensor electrode cable			
Store electrode			

Preceptor Signature: _____ Date: _____

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 operational application of undersea, hyperbaric or aviation medicine.

A test bank of several hundred questions is accessed to develop each applicant’s examination. The bank is monitored regularly and updated as indicated. A concerted effort has been made to ensure little or no bias regarding each examinee’s background, be it multiplace or monoplace, civilian or military. There will be questions that relate to a specific hyperbaric setting, however, one’s strengths should compensate for any weaknesses. Due to the breadth of this discipline no one is expected to have a complete and comprehensive knowledge of all hyperbaric-hypobaric operating systems. A score of at least 70% correct is required to pass the exam. Scores of 90% or greater are graded “With Distinction”. A “With Distinction” grade is only achievable on the first examination attempt. The examination is taken online, involves 120 questions and has a limit of two hours. Questions are either multiple choice or true-false.

Examinations are scheduled at recognized testing centers in close geographic proximity to each individual examinee. Plan to arrive at the test site at least 15 minutes prior to your scheduled examination time. Government issued photographic identification is required to enter the testing area. A simple (non-memory storing) calculator may be helpful. Mobile phones are not permitted within the testing center. A set of US Navy Air Decompression Tables and scratch paper will be provided.

Certification/Recertification

Examination Registration

Applicants must complete a NBDHMT Certification Examination Registration Form (available at www.ndbhmt.org) and return it to NBDHMT headquarters along 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 completion of a NBDHMT approved hyperbaric training course, CHT® applicants must undergo an internship of a minimum of 480 hours relating to undersea, hyperbaric medicine or aviation medicine technology, operations and safety. Forty (40) of these hours must be directly supervised. The Board must be notified in writing of the name of the supervising preceptor prior to commencing the internship. The preceptor should be a CHT or a CHRN with a minimum of two years’ experience.
4. Payment of US\$175.00.
5. A completed ‘Code of Conduct’ declaration.
6. If special accommodation arrangements are required for documented disabilities or underlying medical condition, this should be noted in the space provided on the examination application form. Failure to indicate a special need may impact your ability to be appropriately accommodated at the time of testing.

Expiration Date

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

Example:

Individuals successfully completing the examination on any day during May of 2022 will have an expiration date of May 31, 2024. Certification is maintained through a system of verified continuing education.

Re-certification

Re-certification is awarded upon completion and verification of required continuing education credits, continued workplace experience, submission of the re-certification form and a \$100.00 fee.

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

1. Proof of a minimum of 24 (minimum of 12 Category “A”) CEU hours during the prior two (2) years.
2. Verify a minimum of 100 clinical work hours via the Certified Hyperbaric Technologist Recertification Verification Letter.

Continuing Education Requirements

A minimum of 24 hours of continuing education credits (hours) are required during each re-certification period. Ideally all, but at least 12 should be Category A, defined as education and training directed related to technical, operations and safety aspects of hyperbaric or hypobaric operations. Examples of other suitable Category A topics include infection control/universal precautions, recognition and immediate management of barotrauma, recognition and immediate management of CNS oxygen toxicity, other chamber related complications, tissue oximetry testing, and inside attendant duties and decompression procedures. Credits may be earned through attendance at meetings and conferences approved by the NBDHMT. They can also be earned through NBDHMT approved employer initiatives directed at maintenance and updating of knowledge and skills. Online Category A approved credit opportunities exist, and details are available from Board headquarters. Retroactive Continuing Educations Applications and a sample continuing education log are available at www.nbdhmt.org/cht.asp.

If access to 24 Category A credits is not possible, the balance beyond 12 can be made up with Category B credits. They are defined as courses, programs and other learning opportunities related to allied health professional knowledge and skills in general and the clinical and compliant practice of undersea, hyperbaric or hypobaric medicine in particular. Examples include clinical assessment and case management of the hyperbaric referral, emerging technologies, potential new uses of the hyperbaric chamber, related compliance expectations and standards, and BLS/ACLS/PALS certification/recertification. CHT’s who formally present at meetings where CEU’s are offered are eligible for credits. For participation in development of a Poster Presentation, the NBDHMT will award two (2) credits (A or B depending upon the topic). Oral presentations, regardless of length, earn six (6) A or B credits. For those who serve as UHMS Facility Accreditation Surveyors, the NBDHMT allows a one-time award of five (5) Category A credits, upon receipt of supporting documentation from the lead surveyor.

Failure to Recertify

CHT’s who fail to recertify upon completion of any two-year certification period have a 12-month grace period. Application for recertification within this grace period will incur a \$100.00 penalty, in addition to the \$100.00 recertification payment. All the application requirements noted above for regular CHT recertification will apply.

Those who fail to recertify within the 12-month grace period are extended one remaining option, providing that they have maintained active certification or licensure in their qualifying pathway. In these cases, the applicant will be required to re-take the CHT examination. This option is only valid for a period of 12 months following expiration of the 12-month grace period.

Those who have not maintained their qualifying pathway do not have the option to recertify following expiration of their grace period. They will be required to apply for certification as an entirely new

applicant, as will all of those whose CHT lapsed beyond the two year period from their initial respective recertification dates. **This process includes successful completion of an NBDHMT approved hyperbaric training course within the previous two years of the re-application date.**

Application for CHT-ADMIN

The CHT-ADMIN designation is possible only at the time of recertification. The requirement to show proof of 12 CEU hours and verification of 100 clinical work hours is waived for this designation. CHT-ADMIN applicants must provide a copy of their resume/C.V.

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

By applying for CHT-ADMIN, individuals can maintain their CHT 'identity' and continue to be recognized as a hyperbaric professional.

For those who desire reinstatement as a practicing CHT several pathways are available.

1. 0-2 years as a CHT-A

\$50.00 reinstatement fee and \$150.00 re-certification fee

\$25.00 background check fee

Proof of 24 hours continuing education (minimum 12 Cat. A)

Letter of support from facility medical/program director

2. 2-4 years as a CHT-A

\$50.00 reinstatement fee and \$150.00 re-certification fee

\$25.00 background check fee

Proof of 24 hours continuing education (minimum 12 Cat. A)

Letter of support from facility medical/program director

40-hour preceptorship

3. > 4 years as a CHT-A

\$50.00 reinstatement fee and \$150.00 re-certification fee

\$25.00 background check fee

Proof of 24 hours continuing education (minimum 12 Cat. A)

Letter of support from medical/program director

480-hour internship (including 40 hours preceptorship)

Re-test

Failing and Retaking the Exam

- If the first attempt is unsuccessful (a score of less than 70%) the applicant must wait at least three (3) months before retaking the exam.
- If the second attempt is also unsuccessful another three (3) month wait is again required, the applicant must also retake a NBDHMT Approved Hyperbaric Medicine Training Course and repeat the internship/preceptorship before a third attempt.

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, 2018 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, 2019; 14th Edition. Undersea and Hyperbaric Medical Society.
4. Hyperbaric Medicine Practice, 4th Edition, 2017. Kindwall EP and Whelan HT, Editors. Best Publishing Company. ISBN: 978-1-947239-005, or Physiology

Medicine of Hyperbaric Oxygen Therapy, 2008: Neuman TS, Thom SR. Saunders Publishing. ISBN 978-1-4160-3406-3

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.

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 agrees that:

1. They will comply with all rules of the NBDHMT, including the requirements of the CHT Code of Conduct.
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 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 certification examination 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 with any Board investigation. The Board reserves the right to cancel any exam score if, in the sole opinion of the Board, there is adequate reason to question its validity. Before 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 act 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.

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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 the section immediately above has occurred by any applicant or certified hyperbaric technologist, 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(s);
2. A statement of facts constituting the alleged violation of the rule(s),
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 30 days of notice of violation), the Board President shall:

1. Schedule a hearing within 30 days of the request for 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. The hearing can be conducted by a telephone conference call.
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 subsequently 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
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-
6. Retest
 7. Educational requirement

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 30 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 knowledge of the facts and circumstances may have concerning the alleged conduct.

Position on Issued Credentials

NBDHMT credentials must be used correctly. Titles and credentials are registered trademarks issued to the NBDHMT by the U.S. Patent and Trademark Office. They can only be used when authorized and for a period specifically designated by the NBDHMT. In addition, guidelines exist for displaying credentials correctly. For display of proper and improper use, the Certified Hyperbaric Technologist® (CHT®) is used below but applies to all certifications issued by the NBDHMT.

Examples of correct CHT use

- John P. Doe, CHT
- John P. Doe, Certified Hyperbaric Technologist
- John P. Doe, CHT-ADMIN
- John P. Doe, Certified Hyperbaric Technologist-ADMIN

The credential may be used only for the period for which use is authorized. Use expires if renewal fees go unpaid and/or recertification requirements are not met. Use of these titles beyond the authorized period constitutes unauthorized use.

Credentials may be used on business cards, a resume, curriculum vitae, social media, and correspondence with a signature block. Credentials are awarded to individuals, not to companies or organizations, and should only be used with an individual's name.

Example of proper company/organization use

- XXX provides advanced wound care and hyperbaric services. Employees holding the Certified Hyperbaric Technologist® (CHT®) certification include John P. Doe, CHT, and Mary P. Jones, CHRN.

Example of improper company use

- XXX provides advanced wound care and hyperbaric services by Certified Hyperbaric Technologists.

Retired Credential Holders

Individuals who retire can hold their certification in retired status should they meet the following requirements:

- Held certification a minimum of 10-years
- Completed two (2) recertification cycles

To maintain certification in retired status

- Accrue no more than 40 hours of annual operational practice
- Payment of a biannual renewal fee of \$10

Individuals holding a certification in retired status must indicate their status using any of the following examples

- John P. Doe, CHT Retired
- John P. Doe, CHT (Retired)
- John P. Doe, CHT Ret.
- John P. Doe, Certified Hyperbaric Technologist (Retired)

Use of NBDHMT credentials without authority

The NBDHMT has established procedures for investigating individuals, companies and organizations who appear to be using a NBDHMT credential without authorization. The identity of anyone reporting potential violations will remain confidential.

Unauthorized use may occur online, on a business card, resume, curriculum vitae, business letterhead, brochure, or similar publication, or within a signature block.

After receiving notification of potential unauthorized use, the NBDHMT will undertake steps to determine any irregularities, which may include legal counsel.

Those who have used NBDHMT credentials without authority may be barred from pursuing NBDHMT certification for up to five (5) years. Their names may be published on the board's website. The NBDHMT reserves the right to use the legal system to protect its trademarks.