Certified Hyperbaric Technologist

Approved Training Course Standard

National Board of Diving & Hyperbaric Medical Technology

Last reviewed October 2022

Training and Competency Standards

This document describes content, training and competency requirements for NBDHMT approved introductory courses in hyperbaric medicine. These requirements must be incorporated into a 40-hour time frame. Additional related content may be added at the course director's discretion but must be provided in addition to the 40-hours.

Minimum Content/Topic Time Frames

Recommended minimum time frames serve to allow adequate topic concentration, and are consistent with the make up of the certification question bank. The additional five hours necessary to complete the 40 hour course requirement are allocated at the discretion of the respective course director, with individual sections adjusted upwards accordingly.

Section 1. 2.0 hours **Section 2.** 1.5 hours **Section 3**. 5.0 hours **Section 4**.3.0 hours **Section 5.** 4.0 hours **Section 6.** 4.0 hours **Section 7.** 5.0 hours **Section 8.** 1.0 hour **Section 9.** 0.5 hour **Section 10.** 6.0 hours **Section 11.** 1.0 hour **Section 12.** 2.0 hours

Minimum Content/Topic Requirements

1. Physics of hyperbaric and hypobaric exposures
    a. Applicable gas laws, to include
        i. Boyle's Law, Dalton's Law, Gay-Lussac's Law, Charles' Law, Henry's Law
    b. Common physical units associated with diving and hyperbaric practice
    c. Calculations for the conversion of common units used in diving and hyperbaric operations
2. Air decompression procedures
    a. Decompression theory fundamentals
    b. Decompression procedures, per U.S. Navy Diving Manual
        i. No-Decompression Tables
        ii. Decompression Tables
        iii. Repetitive Diving Tables
    c. Inside attendant decompression procedures
3. Food Drug Administration approved/Undersea and Hyperbaric Medical Society recommended indications for hyperbaric oxygen (HBO) therapy
    a. Mechanisms of action that constitute the basis for approved/recommended indications
    b. Hyperbaric medicine's indications
    c. Fundamentals of clinical management and dosing guidelines
    d. UHMS utilization review
4. Patient assessment and management
    a. Plan of care/treatment considerations
    b. Pre- and post-treatment assessments

c. Patient scheduling
d. Patient charting and related documentation
e. Special issues related to diabetic patients

5. Risk factors, side effects and contraindications
    a. Central nervous system and pulmonary oxygen toxicity
    b. Absolute and relative contraindications
    c. Management of complications
    d. Adverse effects of pressure change (barotrauma)
        i. Ears
        ii. Sinus spaces
        iii. Teeth
        iv. Lungs
        v. Gastrointestinal tract
        vi. Implanted device considerations
6. Hyperbaric chamber and supportive systems
    a. Fundamentals of multiplace and monoplace chambers
    b. Operating policies and procedures
    c. Pressurization gas systems
    d. Breathing gas systems
    e. Safe handling of high pressure gas cylinders
    f. Biomedical support equipment
    g. Environmental systems
    h. Acrylic viewport/window inspection and care
7. Hyperbaric safety
    a. Hyperbaric Safety Director roles and responsibilities
    b. Hyperbaric chamber fires and lessons learnt
    c. Emergency procedures
    d. Applicable codes and standards
    e. Operational checklists
    f. Mechanical and electrical considerations
    g. Approved and prohibited items
8. Administration and management
    a. Hyperbaric chamber staffing
        i. Inside attendant fitness-to-work in pressurized settings
    b. Professional societies and organizations
    c. Hyperbaric personnel certification
    d. Hyperbaric facility accreditation
    e. Operational, technical and safety resources
    f. Familiarity with the role of 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' Committee on Pressure Vessels for Human Occupancy (ASME-PVHO); The Joint Commission (JC); De Norske Veritas (DNV); The Undersea and Hyperbaric Medical Society (UHMS)

9. Infection prevention
    a. Universal precautions
    b. Use of approved disinfectants for chamber and related equipment; risks associated with in-chamber chemical off-gassing
    c. Hand washing
    d. Personal protective equipment (PPE)
10. Practical orientation; may be direct observation, hands-on, or combination
    a. Hyperbaric chamber operations
    b. Compression and breathing gas systems
    c. Ancillary equipment
    d. Emergency drills examples; to include:
        i. In-chamber fire
        ii. In-facility/nearby fire
        iii. Suspected patient pneumothorax
        iv. Emergency decompression (cardiac arrest, etc.)
        v. Timed egress
    e. Patient pre- and post-treatment assessments
    f. Documentation
        i. Patient charting; examples to include:
            a. Patient history
            b. Patient assessment
            c. Education checklist
            d. Prohibited items authorization
            e. Treatment record/progress notes
            f. Treatment consent
            g. Photography consent
        ii. Equipment check lists
        iii. Facility check lists
11. Evaluation
    a. Written examination (paper or online)
    b. Course and faculty critiques (paper or online)
12. Transcutaneous oxygen monitoring (TCOM)

Transcutaneous Oxygen Monitoring (TCOM) Module

Background

During initial screening and case management of wound healing referrals, CHT's may be called

upon to conduct transcutaneous oxygen testing. This procedure represents a non-invasive and quantitative assessment of tissue oxygenation states, commonly involving lower extremity sites. Used in an algorithmic manner, transcutaneous oxygen testing:

- Identifies whether local hypoxia is a factor in healing compromise
- Determines capacity to respond locally (wound) to centrally (lungs) delivered increases in oxygen
- Provides early indication of therapeutic response
- Helps identify a therapeutic endpoint

Purpose
This Module is designed to ensure that CHT's are provided with sufficient knowledge and skill to effectively conduct transcutaneous oxygen testing and data recording. It contains both learning objectives and methods to demonstrate proficiency.

Disclaimer
It is not the intent of this 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. General principals
   B. Common applications
II. The transcutaneous oxygen monitor and related supplies
   A. Operating functions
   B. Calibration procedure and verification
   C. Sensor electrode care and maintenance
   D. Membrane replacement
   E. Monitor care
   F. Trouble-shooting fundamentals
III. The transcutaneous oxygen testing procedure
   A. Patient informed consent
   B. Fundamentals of site selection
   C. Site preparation
   D. Anticipated normal values; chest and lower extremities
   E. Effects of testing at altitude
   F. Control/reference sites
   G. Normobaric air breathing
   H. Normobaric oxygen breathing
   I. Hyperbaric oxygen breathing
   J. Testing documentation and data recording
   K. Regional perfusion index (RPI) computation
   L. Common testing errors

TCOM MODULE TRAINING OUTLINE

I. Trainee will demonstrate a working knowledge of the transcutaneous monitor's technology, specifically:
   A. Principles of testing, to include:
      i. i. Monitor set up
      ii. Function of the sensor electrode
      iii. Physiological effect of the sensor electrode heating
      iv. Potential patient risks
   B. Common indications for testing
      i. Small and large vessel arterial screening
      ii. Wound hypoxia definition
      iii. Values suitable to undergo HBO therapy

iv. Evidence of therapeutic response
v. Determination of therapeutic
vi. Skin flap assessment

C. Describe the operating function of the monitor, including settings and adjustments
D. Describe calibration verification procedures, and on what frequency
E. Describe technique for changing sensor membranes
F. Describe how sensor electrode is cleaned and disinfected

II. Trainee will demonstrate a working knowledge of the testing procedure.
A. Describe related anatomy of common testing sites
i. Arterial vascular supply
ii. Issues related to bones, tendons and pulse sites
B. Describe how the testing sites are commonly selected
i. Anatomic characteristics
ii. Skin characteristics
iii. Indication-specific issues
C. List steps involved in site preparation
i. Removal of any hair
ii. Removal of oils and dirt
iii. Removal of loose outer skin (stratum corneum)
D. Describe testing process
i. Baseline air breathing test procedure
ii. Provocative challenges
a. Normobaric 100% oxygen at ambient pressure
b. 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 chest (left second intracostal space, mid-clavicular), tricep, 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 $tcpO_2$ values or range of normal values for both 1.0 ATA air testing and effect of elevated altitudes
i. Chest reference site 60-95mmHg
ii. Lower extremity; normal > 50mmHg adequate for oxygen-dependent wound healing; > 40mmHg
G. Describe trouble shooting procedure for
i. Alarms
ii. Error Codes

III. Trainee should be able to demonstrate knowledge of a $tcpO_2$ test that is consistent with best practice standards.
B. Calculate Regional Perfusion Index (RPI)
i. Completed during air breathing only
ii. Divide wound value by chest control value
C. Explain the effects of common testing errors on $tcpO_2$ values obtained
i. Positioning of patient
ii. Patient animated
iii. Ambient room temperature variance
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. Inadequate/faulty fixation ring adhesion

D. Trainee should be able to describe informed consent procedure
    i. Explain planned procedure and why it is necessary
    ii. Explain risks involved
    iii. Summarize its potential value
E. Trainee should be able to inspect and verify completeness of equipment required to conduct a $tcpO_2$ study
    i. Monitor
    ii. Electrode(s)
    iii. Ancillary Equipment
        a. Oxygen source
        b. Patient oxygen delivery device (non-rebreather mask or hood)
        c. Calibration gas (if applicable)
F. Trainee should be able to conduct a $tcpO_2$ test consistent with best practice standards
    i. Set up the monitor
        a. Sensor temperature setting
        b. pO_2 calibration
        c. pCO_2 setting (if available)
        d. Re-membrane electrode
    ii. Prepare patient
        a. Brief patient
        b. Obtain patient's consent
        c. Position patient
    iii. Prepare site(s)
        a. Prepare the selected site(s)
        b. Attach fixation ring and connect sensor electrode
    iv. Collect data
        a. Baseline $tcpO_2$ on normobaric air
        b. Physiologic challenge (either of c. or d.)
        c. Normobaric oxygen challenge on 100% oxygen
        d. Hyperbaric oxygen challenge with 100% oxygen
    v. Record data
        a. Complete data sheet or input information to computer
        b. Calculate RPI
    vi. Remove electrode
        a. Remove adhesive device
        b. Clean/decontaminate electrode
        c. Store monitor

SAMPLE TCOM COMPETENCY SKILLS CHECKLIST

Technical Knowledge of Transcutaneous Oxygen Monitoring System

Name_____ Auditor/Instructor _____
as it appears on government issued I.D.

Demonstrate knowledge of the following

☐	Principles of transcutaneous oximetry
☐	Common indications for $tcpO_2$ testing
☐	Operating functions of the monitor
☐	Settings
☐	Adjustments
☐	Calibration procedures
☐	Procedure for maintaining membrane & electrode
☐	Troubleshooting procedures for alarms and error codes
☐	Arterial anatomy related to common $tcpO_2$ testing sites
☐	Fundamentals of site selection
☐	How to prepare $tcpO_2$ testing sites
☐	How to perform a $tcpO_2$ study
☐	Why reference information is obtained
☐	Anticipated normal lower extremity $tcpO_2$ values
☐	How to calculate regional perfusion index (RPI)
☐	Common testing errors and their effect on $tcpO_2$
☐	How to obtain informed consent for $tcpO_2$ testing

Demonstrate procedure for inspection of the equipment

	Monitor
☐	Monitor temperature setting
☐	pO_2 setting
☐	pCO_2 (if applicable)
☐	O2 alarm limits
☐	CO_2 alarm limits (if applicable)
	Sensor electrode
☐	Cable intact/undamaged
☐	Membrane change
☐	Frequency of changes
	Ancillary Equipment
☐	O_2 source (HP cylinder; wall O_2)
☐	O_2 delivery (non-rebreather mask or hood assembly)
☐	Calibration gas (if applicable)

Demonstrate test procedure

Conduct $tcpO_2$ Study (3 patients/subjects)	**1**	**2**	**3**
Set up oxygen monitor			
Set temperature			
Set pO_2 (pCO_2 if applicable)			
Re-membrane electrode (once)			
Calibrate monitor (if applicable)			
Prepare the patient/subject			
Brief the patient/subject			
Obtain consent (where necessary)			
Position patient/subject for test			
Prepare the site(s)			
Sites selected by hyperbaric physician			
Shave any hair and strip off loose skin			
Clean the site			
Attach fixation ring(s)			
Collect data			
Baseline $tcpO_2$ air			
NBO challenge			
HBO challenge (if equipment available)			
Record data			
Data sheet or computer program			
Calculate RPI			
Remove electrode(s)			
Remove fixation ring(s)			
Clean and secure electrode			

Preceptor Signature: _____Date: _____