

Certified Hyperbaric Registered Nurse®

Resource Manual

&

Study Guide



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

Baromedical Nurses Association

Baromedical Nurses Association Certification Board

(June, 2024)

www.NBDHMT.org or www.hyperbaricnurses.org

Introduction

- The Baromedical Nurses Association (BNA) was created in 1985. The Baromedical Nurses Association Certification Board (BNACB) was established in 1995.
- The BNACB mission is to provide nurses with a professional organization and certification to define, develop, maintain, and promote status and standards of hyperbaric nursing.
- For nurses to be certified in their specialty is similar to physicians becoming boarded. It signifies a degree of competence and education in the field, and a standard knowledge base.
- The hyperbaric nursing certification examination was developed over a period of several years for the National Board of Diving & Hyperbaric Medical Technology (NBDHMT) by the BNA board in conjunction with Dick Clarke, the American Nursing Association (ANA), and others.
- A bank of several hundred test questions was submitted by the Baromedical Nurses Association Executive Board to the National Board of Diving & Hyperbaric Medical Technology.
- A contract was signed with the National Board of Diving & Hyperbaric Medical Technology to validate and administer the exam which would confer the designation of Certified Hyperbaric Registered® (CHRN®).
- CHRN® is an internationally recognized certification.
- Certification is valid for four years.
- The test bank is regularly monitored and updated.

Candidacy

Certification is an added qualification for the registered nurse. It is not an entry level pathway for hyperbaric nursing. The candidate must have met the following requirements when applying for basic CHRN level certification.

1. Current unrestricted Registered Nurse license in the state where you practice hyperbaric nursing.
2. A minimum of two years clinical experience in an in-hospital or hospital-based clinic setting, or one-year critical care experience.
3. Minimum of one-year active hyperbaric medicine experience within the last two years.
4. Successful completion of an entry level 40-hour BNACB approved Hyperbaric Medicine training course within five years of this application. If course attendance is greater than five years, applicant must show proof of 40 Category "A" (hyperbaric related) CE. (Nursing school transcripts do not qualify for initial certification).
5. RN applicant log which includes 480 hours of direct hyperbaric patient care performed **after the initial entry level course**, recorded and signed by RN applicant and your CHRN preceptor to include dates, hours spent, and activities performed. https://nbdhmt.org/wp-content/uploads/2022/06/CHRN_Experience_Log.pdf
 - a) The experience log for new applicants is for you to log your hours per month, until you're required 480 hours is completed. Submit the experience log with your application. Your experience log must be signed by a CHRN or CHT/RN.
 - b) This log is only used for your initial certification ONLY, **you do not need to keep a log of hours after your initial certification**, but you must submit other requirements.

6. If no onsite CHRN or CHT/RN you must follow the following preceptor guidelines.
 - Preceptor CHRN or CHT/RN guidelines: for those not working directly with the CHRN applicant
 - <https://nbdhmt.org/wp-content/uploads/2022/07/BNACB-Preceptorship-Objectives-2022.pdf>
 - Document applicant has notified them of need for preceptorship.
 - Document how you have mentored this applicant through their 480 hours of required experience either direct or indirect preceptorship.
 - Document your recommendation for this applicant to sit for the CHRN exam.
 - Submit signed CHRN preceptor guide to applicant.
7. Letter of recommendation from your employer and/or program manager, including validation of hyperbaric experience, CHRN name that proctored the applicant, validation of nursing experience and recommendation to sit for the CHRN exam.
8. Active CHT (minimum of one year) that has only been an RN for one year may sit for the CHRN exam; must meet all other requirements.

Certification Levels

A passing grade on the certification exam entitles the registered nurse to display the applicable initials:

CHRN®, to signify *Certified Hyperbaric Registered Nurse*®.

ACHRN® - *Advanced Certified Hyperbaric Registered Nurse*®

An applicant may request an application for advanced certification after **three years** of receiving the basic CHRN® certification.

Qualifications in addition to the basic standards of certification:

1. Minimum of three years' experience in the field of hyperbaric oxygen therapy, currently working (10 hour/week or 40 hours/month) for a minimum of 480 hours/year in the clinical and/or administrative areas of hyperbaric nursing.
2. **Written documentation of two of the following:**
 - a. Contributes to the administrative activities of the Hyperbaric Unit Department.
 - b. Taught BNA/BNACB or NBDHMT & UHMS approved entry level hyperbaric oxygen therapy courses and/or classes or lectures on hyperbaric oxygen therapy.
 - c. Have primary responsibility for planning/coordinating nursing care for patients receiving hyperbaric oxygen therapy.
 - d. Active participation in the Baromedical Nurses Association (BNA), Baromedical Nurses Association Certification Board (BNACB), Undersea and Hyperbaric Medical Society (UHMS), UHMS Chapters, and/or UHMS Associates as an officer or committee member.
 - e. Contributes to hyperbaric materials for regional/national distribution, i.e., journal articles, manuals, videos, books, etc.

CHRNC® - *Certified Hyperbaric Registered Nurse Clinician®*

1. Master's Degree from an accredited academic program in Nursing or health related area.
2. Minimum of 5 years' experience in the field of hyperbaric oxygen therapy, currently working (10 hour/week or 40 hour/month) for a minimum of 480 hours/year in the clinical and/or administrative areas of hyperbaric nursing.
3. **Written documentation of three of the following:**
 - a) Responsible for administrative and nursing care activities of the Hyperbaric Department.
 - b) Speaker at regional/national hyperbaric conferences and workshops.
 - c) Contributes to hyperbaric materials for regional/national distribution, i.e., journal articles, manuals, videos, books, etc.
 - d) Active participation in the Baromedical Nurses Association (BNA), Baromedical Nurses Association Certification Board (BNACB), Undersea and Hyperbaric Medical Society (UHMS), UHMS Chapters, and/or UHMS Associates as an officer or committee member.
 - e) Principal investigator or co-investigator in a published hyperbaric or related study.

CHRN- ADM® - *Certified Hyperbaric Registered Nurse - Administrative*

CHRN – ADM–

Certified hyperbaric nurses who contribute or are directly involved in the field of hyperbaric medicine or wound care who have little or no direct patient care. Nurses whose non-direct care influences the care and practice of hyperbaric medicine.

ACHRN ADM–

Advanced certified hyperbaric nurses who contribute or are directly involved in the field of hyperbaric medicine or wound care who have little or no direct patient care. Nurses whose non-direct care influences the care and practice of hyperbaric medicine.

CHRNC ADM–

Certified hyperbaric nurse clinicians who contribute or are directly involved in the field of hyperbaric medicine or wound care who have little to no direct patient care. Nurses whose non direct care influences the care and practice of hyperbaric medicine.

Recertification Levels for ADM (Administrative Hyperbaric Nurse): Administrative levels can only be obtained after your initial certification; you must meet all other requirements.

Examination Process

1. Tests at each location are unique and identified with the RN's name. The RN must pre-register with the NBDHMT and allow 30-45 days before the test date. The RN cannot register at the testing site.
2. The exam is composed of 120 multiple choice and true/false questions. Supplemental materials including dive tables will be included. There are no essays or short answer

questions.

3. The exam is limited to two hours. Plan to be at the test site slightly longer for an explanation of the testing process and distribution of testing material.
4. Test results are based on a Pass Fail. Pass score is 70%.
5. A certificate package is sent to each successful CHRN including a formal wall certificate, wallet card, and complimentary CHRN designator items.
6. Applicants who do not meet a passing percentage (70%) will be notified in writing and be provided with a summary of subject areas that were inadequately met to better prepare the candidate for re-examination.

What to bring:

1. Several #2 pencils.
2. Passport or other government issued photo ID.
3. A pocket calculator is helpful, but not required.

Test Locations:

1. Testing is completed online at a designated college or testing site... Contact NBDHMT for arrangements and requirements for on-line testing.
2. "In house" examination proctorship must be pre-approved by the NBDHMT.

Recertification Requirements

All nurses applying for the Administrative Hyperbaric nursing certification must have first met the initial requirements for CHRN and must be **current with their HBO nursing certification**. Those not current with their nursing certification will be required to retest.

Nurses with current CHRN, ACHRN or CHRNC applying for recertification may continue with their current certification level as long as they meet the education CE requirements. No requirements of logging hours are needed. Please follow all other requirements.

Certified Hyperbaric Registered Nurse® (CHRN®)

1. Complete an application for recertification.
2. Have a current unrestricted Registered Nurse license in the state where practicing hyperbaric nursing.
3. Complete forty hours (40) of continuing education credits (hours) per previous four years, with at least twenty (20) Category A credits in the field of hyperbaric oxygen therapy
4. All continuing education hours must be submitted in an organized Cat A and Cat B format using the following log. https://nbdhmt.org/wp-content/uploads/2022/06/CHRN_CE_Log.pdf

Certified Hyperbaric Registered Nurse Administrative (CHRN-ADM)

Nurses who contribute or are directly involved in the field of hyperbaric medicine. Nurses whose non-direct care influences the care and practice of hyperbaric medicine. Must show proof that they are contributing to the field of hyperbaric nursing or wound care i.e., committee member, articles, surveys, etc.

Nurses must still meet the requirements for recertification at this level except the direct patient care.

Advanced Certified Hyperbaric Registered Nurse® (ACHRN®)

1. Complete an application for recertification.
2. Have a current Registered Nurse license in the state where practicing hyperbaric nursing.
3. Document a minimum of three years' experience in the field of hyperbaric oxygen therapy.
4. Complete sixty hours (60) of continuing education credits (hours) per previous four years, with at least thirty (30) Category A credits in the field of hyperbaric oxygen therapy. All continuing education hours must be submitted in an organized Cat A and Cat B format using the following log: https://nbdhmt.org/wp-content/uploads/2022/06/CHRN_CE_Log.pdf
5. Provide written documentation of at least two of the following:
 - a) Contributes to the administrative activities of the Hyperbaric Unit/Department.
 - b) Taught BNACB approved entry level hyperbaric oxygen therapy courses and/or classes or lectures on hyperbaric oxygen therapy.
 - c) Have primary responsibility for planning/coordinating nursing care for patients undergoing hyperbaric oxygen therapy.
 - d) Active participation in the Baromedical Nurses Association (BNA), Baromedical Nurses Association Certification Board (BNACB), Undersea and Hyperbaric Medical Society (UHMS), UHMS Chapters, and/or UHMS Associates as an officer or committee member.
 - e) Contributes to hyperbaric materials for regional/national distribution, i.e., journal articles, manuals, videos, books, etc.

Advanced Certified Hyperbaric Registered Nurse Administrative (ACHRN-ADM)

Nurses who contribute or are directly involved in the field of hyperbaric medicine or wound care. Nurses whose non-direct care influences the care and practice of hyperbaric medicine. Must show proof that they are contributing to the field of hyperbaric nursing i.e., committee member, articles, surveys, etc. Nurses must still meet the requirements for recertification at this level except the direct patient care.

Certified Hyperbaric Registered Nurse Clinician® (CHRNC®)

1. Complete an application for recertification.
2. Have a current Registered Nurse license in the state where practicing hyperbaric nursing.
3. Minimum of 5 years' experience in the field of hyperbaric oxygen therapy.
4. Complete a minimum of sixty hours (60) of continuing education credits (hours) per previous four years, with at least thirty (30) of those credits in the field of hyperbaric oxygen therapy – Category A. All continuing education hours must be submitted in an organized Cat A and Cat B format using the following log: https://nbdhmt.org/wp-content/uploads/2022/06/CHRN_CE_Log.pdf
5. Provide written documentation of at least two of the following:
 - a. Responsible for administrative and nursing care activities of the Hyperbaric Unit/Department.
 - b. Speaker at regional/national hyperbaric conferences and workshops.
 - c. Contributes to hyperbaric materials for regional/national distribution, i.e., journal articles, manuals, videos, books, etc.

- d. Active participation in the Baromedical Nurses Association (BNA), Baromedical Nurses Association Certification Board (BNACB), Undersea and Hyperbaric Medical Society (UHMS), UHMS Chapters, and/or UHMS Associates as an officer or committee member.
- e. Principal investigator or co-investigator in a published hyperbaric or related study.

Certified Hyperbaric Registered Nurse Clinician Administrative (*CHRNC – ADM*)

Nurses who contribute or are directly involved in the field of hyperbaric medicine. Nurses whose non-direct care influences the care and practice of hyperbaric medicine. Must show proof that they are contributing to the field of hyperbaric nursing i.e., committee member, articles, surveys, etc. Nurses must still meet the requirements for recertification at this level except the direct patient care.

Continuing Education (CE)

Category A credits must be directly related to undersea, hyperbaric or aviation medicine. A sample Continuing Education Log is available at www.nbdhmt.org.

1. Continuing education (CE) submitted must be approved by a: Professional organization such as the BNA, the UHMS, ACHM, NBDHMT, Wound Ostomy and Continence Nurses Society, Association for the Advancement of Wound Care, etc. AND/OR State Nursing Practice Board (and related to hyperbaric oxygen therapy).
2. CME credits (Continuing Medical Education)
 - a. CHRNs may submit a maximum of 10 (HBO related) CME towards their Category A requirement during a renewal cycle.
 - b. ACHRNs may submit a maximum of 15 (HBO related) CME towards their Category A requirement during a renewal cycle.
 - c. CHRNCs may submit a maximum of 15 (HBO related) CME towards their Category A requirement during a renewal cycle.
3. Hyperbaric related course development, course presentation, presentation of lectures, posters and/or papers, which are presented for CE, will qualify for continuing education units for recertification of 4 CE/per 1 CE presented. This is to recognize the amount of time required to accomplish the above objectives. For example: if a person presents a two-hour hyperbaric related course, representing 2 CE, that person will then have 8 CE toward the requirement for recertification.
4. Authors contributing to chapters in hyperbaric related books will be given special consideration for each chapter up to 10 Cat A credits per chapter. These Cat A hours will be awarded on an individual basis by the BNACB. Posters and published papers will be awarded 2 CE per presentation/publication. Requester must be listed as author/investigator or co-author/investigator. Poster must be presented at a national or regional conference of a recognized professional organization. This credit will be given only once for each presentation, except as noted above. If the same course is taught several times a year, the person will receive the extra CE only one time for that particular course presentation. If another course with CE is presented, that additional course qualifies for the additional CE academic credits to partially

fulfill CHRN, ACHRN or CHRNC certification and recertification Category B requirements through the contact hour method.

5. Academic credits MUST meet the following criteria to be accepted for recertification:

- a. An accredited educational nursing institution must sponsor courses; each course must fulfill a requirement for a baccalaureate or higher degree.
- b. The course must be taken for credit, although it does not have to be towards a formal degree program.
- c. For each course, you must achieve a grade of C or better.
Repeat courses are not accepted for certification renewal. You may claim a course only once, even if you took that course multiple times during the past 4 years.
- d. Courses acceptable (human healthcare courses) for Category B hours include Anatomy, Health/physical assessment, nursing management/administration, Nursing research, Pathophysiology, Physiology, Pharmacotherapeutics, Sign language and foreign language for medical terminology.
- e. Academic credit received for a thesis or dissertation related to your certification specialty is acceptable.
- f. Courses that are not accepted include: any audited course, Agriculture, Art, Astronomy, Chemistry, Culinary arts, English, Geology, Geography, History, Math, Meteorology, Music, Physics and Public speaking, any course not specifically related to human healthcare subject matter.
- g. You will be required to submit supporting documents, such as a transcript(s) showing the number of academic credits, sponsoring organization, etc. In addition, you may be required to provide evidence of the applicability of the course content to your certification. Please maintain supporting documentation for the entire 4-year certification cycle.
- h. Academic semester hours will equal one CE hour. Not more than half of Category B hours required for recertification will be allowed.

UHMS Surveyors:

For certified members participating as UHMS surveyors, one Category A CE hour will be approved up to a total of five CE hours per renewal period towards recertification. To receive credit as a surveyor, the candidate will provide a letter from lead surveyor confirming participation. Content to your certification. Please maintain supporting documentation for the entire 4- year certification cycle.

The NBDHMT website notes Category A credit hours will be given to committee members who participate in administrative leadership positions within NFPA/ASME/PVHO or those who serve on the UHMS Facility Accreditation Survey Team. These activities will receive a maximum of 9 Category A hours. The BNACB will also accept and follow these NBDHMT guidelines. Please note you must show proof of attendance at those meetings in order to get approval for those hours.

We encourage all committees or organizations presenting hyperbaric related education to contact the BNA education committee, identified on the BNA website. They will assist you in submitting paperwork so nursing Category A hours can be granted. Please visit the hyperbaricnurses.org website for further information.

Inactive Status

1. If the candidate does not recertify, he/she will be considered inactive.
2. If the candidate was denied recertification, the candidate will be notified in writing, listing the reasons. The candidate may reapply for recertification at no additional fee by applying in writing within 90 days of being notified that recertification was denied. If the candidate does not reapply within a 90-day period, he/she will be considered inactive.

Reinstatement to Active Status

1. If CHRN® certification is lapsed, by greater than **60 days** recertification may be obtained by submitting the recertification requirements. Lapse will also incur a reinstatement fee of \$100.00 USD added to recertification fees listed below.

Failing and Retaking the Exam

1. If on the first attempt of taking the examination 70% is not obtained, the CHRN® applicant does not pass and must wait three (3) months before retaking the exam.
2. If on the second attempt the examination is not passed , the CHRN® applicant is required to work an additional 480 hours in hyperbaric before retaking the exam in addition to waiting three (3) months before retaking the exam.
3. If on the third attempt the examination is not passed, the CHRN® applicant is required to work an additional 480 hours in hyperbaric and document ten educational CE in the field of hyperbaric medicine. This can include on-line educational CE but they must be Hyperbaric specific.

Fees

Certification

BNA Members	\$250.00
UHMS or ACHM Members	\$300.00
Non-Member of organizations listed above	\$400.00
Repeat Examination	\$100.00

Recertification

BNA Members	\$150.00
UHMS or ACHM Members	\$200.00
Non-Member of organizations listed above	\$250.00

Registration Forms

Applications can be downloaded from the NBDHMT website, www.nbdhmt.org. or the BNA website; www.hyperbaricnurses.org.

Applications are also available from:

National Board of Diving & Hyperbaric Medical Technology
P O Box 758
Pelion, SC 29123

Telephone: (888) 312-2770
Fax: (866) 451-7231
E-mail NBDHMT@aol.com

Disciplinary Procedures

In applying for certification, the applicant agrees to the following:

1. Compliance with all standards of the BNACB. The Board's certificates, logos, emblems, the name Baromedical Nurses Association Certification Board, the titles and abbreviations of Certified Hyperbaric Registered Nurse® (CHRN®), Advanced Certified Hyperbaric Registered Nurse® (ACHRN®), Certified Hyperbaric Registered Nurse Clinician® (CHRNC®), are all the exclusive property of the Board and may not be used in any way without the Board's express written consent.
2. The certified Registered Nurse will immediately relinquish using the titles of Certified Hyperbaric Registered Nurse®, Advanced Certified Hyperbaric Registered Nurse®, or Certified Hyperbaric Registered Nurse Clinician® in case of suspension, limitation, or revocation from the BNACB, or as otherwise requested by the BNACB.
3. The certified Registered Nurse will immediately relinquish using the abbreviations of CHRN®, ACHRN®, or CHRNC® certificate, card, logo, emblem, and the BNACB's name and related abbreviations in case of suspension, limitation, or revocation from the BNACB, or as otherwise requested by the BNACB.
4. If the certified Registered Nurse refuses to immediately relinquish, refrain from using, or correct at their expense any misuse or misleading use of any of the above items when requested, they must also agree that the BNACB may obtain injunction relief for damages, costs and attorney's fees incurred.

BNACB Guidelines for Certification Review

1. The BNACB does not guarantee job performance of applicants.
2. The BNACB may revoke or otherwise take action with regard to the application or certification in the case of:
 - a. Failure to comply with any rule of the BNACB.
 - b. Any misrepresentation, misleading statement or fraud, by commission or omission, to the BNACB.
 - c. Dishonesty in connection with any certification exam.

Violation of BNACB Standards

When the BNACB has reason to believe that a standard has been violated by any applicant or Certified Hyperbaric Registered Nurse® (CHRN®, ACHRN®, CHRNC®), the BNACB will send a statement of alleged violation(s) to the applicant or CHRN® by certified mail, return receipt requested. The statement will describe:

1. The applicable standard.
2. Facts constituting the alleged violation of the standard.
3. That the nurse may request an oral hearing against the allegations, bearing their own expenses.
4. That the nurse will have 30 days after receipt of the statement to respond to the allegations in writing, and request that the BNACB conduct a hearing.
5. That the nurse may appear in person, with counsel if he/she chooses, may examine and cross-examine any witness under oath, and produce evidence on his/her own behalf.
6. That if the nurse does not request a hearing, then the candidate consents that the BNACB may render a decision and apply available sanctions.

Hearing

If the nurse disputes the allegations or sanctions, or requests a hearing, the BNACB will:

1. Schedule a hearing, consisting of three members of the BNACB.
2. Send a Notice of Hearing to the nurse by certified mail, return receipt requested stating the time and place of the hearing.
3. Gather and review relevant evidence and resolve disputed questions by the BNACB Hearing members.
Resolve all matters relating to the hearing, on the record, by a majority vote.

Sanctions

Sanctions for violation of 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. Report to the Board of Nursing

Appeal

1. If the BNACB Hearing members find the allegations unsubstantiated, no further action will be taken.
2. If the decision rendered by the Hearing members is not favorable to the RN, the RN can appeal the decision to the Executive Board of the Baromedical Nurses Association.
3. The BNA Appeals Panel consists of three members of the BNA Executive Board who were not involved in the original Hearing.
4. The Appeals Panel shall determine the appeal by majority vote.
5. Decisions of the Hearing Panel or the Appeals Panel will be given in writing, following the hearing or briefing. The decision will contain factual findings, conclusions of law and any sanctions applied. It will be sent to the RN by certified mail, return receipt requested.

Submission of Information Concerning Possible Violation of BNACB Standards

1. Anyone concerned with possible violation of BNACB standards should submit the information in writing to the BNACB.
2. The letter must identify the person(s) alleged to be involved, and the facts concerning the alleged conduct in detail and with documentation. Include the name, address, telephone number, and that of others who may have knowledge of the facts and circumstances concerning the alleged conduct.

CHRN® Study Guide

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Introduction

The purpose of this Study Guide is to facilitate your preparation to take the Hyperbaric Nurse Certification Examination. The Study Guide has been divided into twelve sections. Each section is introduced with a brief narrative summary in order to rationalize its inclusion as an important component of each Hyperbaric Nurse's education and training base. Reference are available through the NBDHMT website. Applicants can refer to references obtained during their initial hyperbaric orientation class.

Terminal Objectives

Terminal objectives follow the summary and represent goals that the reader should attain after review of the referenced resources, in conjunction with prior training and experience.

Fundamental Knowledge

Fundamental knowledge is defined as a basic understanding of a given subject in the absence of a more detailed appreciation of specific underlying theory, mechanisms, biochemical or cellular aspects.

Example: A fundamental understanding of oxygen toxicity:

The reader will appreciate that elevated inspired oxygen values are capable of producing clinically manifested central nervous system and pulmonary toxicity and that the development of oxygen toxicity is based upon a combination of absolute pressure and exposure time. The reader will also

appreciate the differential diagnosis of central nervous system vs. pulmonary oxygen toxicity and have a working knowledge of respective immediate management procedures.

The reader is not required to understand the biochemical process, nor cellular, tissue and metabolic effects of oxygen toxicity.

Working Knowledge

Working knowledge is defined as the ability to incorporate subject matter or information into your daily activities in support of the safe and effective application of hyperbaric medicine.

Example: A working knowledge of the wound healing mechanisms and factors that are detrimental to wound healing.

The reader is expected to be familiar with the physiology of wound healing and wound care management by conducting a patient assessment and developing a plan of care for each patient's wound care needs.

Comprehensive Knowledge

Comprehensive knowledge is defined as a detailed in-depth understanding of a given subject.

Example: A comprehensive knowledge of the potentially harmful direct effects of alterations in atmospheric pressure:

The reader is expected to be completely familiar with the concept of Boyle's Law, as it applies to gas filled and potentially gas-filled spaces, during both compression and decompression. The reader will also be completely familiar with the implications of Charles' Law in this setting. Identification of all patients personal and equipment risks is required, as are the methods of both reducing these risks and providing immediate management should resultant barotrauma occur.

Sample questions are provided with each section. They are not taken directly from the certification examination question pool but provide examples of questions, format, style and degree of difficulty.

History of Undersea and Hyperbaric Medicine

Narrative Summary

The early history of clinical hyperbaric medicine was characterized by a number of largely ill-conceived attempts to use hyperbaric and oxygen enriched air for the treatment of a variety of acute and chronic conditions. Later studies reported the efficacy of hyperbaric oxygen to enhance decompression following exposure to elevated pressures and the subsequent insertion of oxygen into the early United States Navy decompression sickness treatment tables. Throughout the first half of the twentieth century hyperbaric treatment facilities were used almost exclusively for the definitive management of decompression illness. By the mid-1960's there was preliminary evidence of additional beneficial mechanisms associated with intermittent, short term, exposure to elevated oxygen pressure. Prior to the laboratory and clinical clarification of these findings there followed a period of over-zealous and often inappropriate application of hyperbaric oxygen

therapy. In 1976 the Undersea and Hyperbaric Medical Society established a committee on Hyperbaric Oxygen Therapy. Under the Committee's guidance there has been a careful reevaluation of the appropriate utilization of hyperbaric medicine with increasing multi-center clinical experience and a growing number of randomized trials, hyperbaric medicine programs are no longer limited to military and research institutions. Today, they range across the continuum of health care institutions with scientific evidence supporting the use of Hyperbaric Oxygen Therapy in clinical practice.

Terminal Objectives

Identify the pioneering contributions and Observations of Behnke, Bert, Boerma, Bond, Boyle, Brummelkamp, Fontaine, Haldane, Henshaw and Yarborough.

Develop a fundamental understanding of the concurrent development of hyperbaric and diving medicine in historical perspective.

Sample Questions

1. In 1878, a French physiologist named published his classic work concerning the effect of oxygen on the central nervous system.
 - a. Bert
 - b. Ernie
 - c. Pascal
 - d. Priestley
 - e. Fontaine
2. An Englishman named _____ built the first known treatment chamber in _____ ?
 - a. Charles, 1987
 - b. Priestley, 1774
 - c. Bakker, 1980
 - d. Henshaw, 1662

The Physical Aspects of Undersea and Hyperbaric Medicine

Narrative Summary

A thorough understanding of the concept of pressure, the gaseous components of the multiplace and monoplace atmospheres and a sound working knowledge of the basic gas laws are essential to safely and effectively operate as a team member within the hyperbaric medicine program.

Terminal Objectives

The ability to differentiate the various terms used to describe pressure, namely: atmospheric, barometric, absolute, gauge and hydrostatic.

The ability to convert units of pressure, namely: atmospheres absolute (ATA); feet seawater (FSW); pounds per square inch (PSI); meters seawater (MSW) and millimeters of mercury (mmHg). The ability to utilize Dalton's, Henry's, Boyle's and Charles' Laws to solve a variety of physical and physiological scenarios as they relate to undersea and hyperbaric environments.

The ability to convert temperature measurements to and from Fahrenheit, Celsius, Rankine and Kelvin.

Sample Questions

3. Which of the gas laws explains why a diver's tissues take up nitrogen during a dive?
 - a. Henry's
 - b. LaPlace's
 - c. Boyle's
 - d. Charles
4. Gas molecules move in motion within a closed space:
 - a. even
 - b. regulated
 - c. random
 - d. circular

The Physiological Aspects of Undersea and Hyperbaric Medicine

Narrative Summary

It is important that all individuals who work within, and in support of, the hyperbaric environment has a comprehensive understanding of the profound physiological changes that occur during exposure to increased atmospheric pressure. The complex interactions of oxygen, nitrogen, helium and carbon dioxide in transfer from the lungs to the blood and into the tissues, and their return to the lungs, must be appreciated in order to fully comprehend the therapeutic benefits, risks and potential side effects associated with exposure to the hyperbaric environment.

Terminal Objectives

A fundamental understanding of normal respiration and circulation in man. A working knowledge of medical terminology as it applies to diving and hyperbaric medicine. A comprehensive knowledge of the beneficial and potentially harmful direct effects of pressure during compression and decompression. A fundamental understanding of the indirect effects of pressure, namely; oxygen toxicity and nitrogen narcosis.

A fundamental appreciation of the advantages and limitations of the various therapeutic gases, namely, air, oxygen, nitrogen-oxygen, and helium-oxygen.

Sample Questions

5. The double layer of tissue surrounding each lung, and lining the inside of the chest cavity is called the:
 - a. pleura
 - b. peritoneum
 - c. pericardium
 - d. meninges
6. Central nervous system oxygen toxicity may occur when the partial pressure of oxygen equals or exceeds:
 - a. 0.21
 - b. 0.5
 - c. 1.0

d. 2.0

Mechanisms and Theory of Decompression

Narrative Summary

Fundamental to the practice of undersea and hyperbaric medicine is the concept of decompression. It is important that all those personnel who function within this field, regardless of chamber type, understand the basic principles of tissue inert gas exchange and principles that range from the early Haldanian Theory to those which involve current miniaturized individual dive computers. The ability to calculate decompression requirements is essential for multi-place and air-filled duo/mono-place chamber personnel. It is also an important requirement in the monoplace, oxygen-filled, chamber diagnosis setting. Evaluation of a series of dive/decompression profiles can be a crucial component in the diagnosis of the diving accident victim.

Inadequate or omitted decompression in a patient's immediate diving history may represent the only "objective" finding. The concurrent growth of recreational diving with an increased geographical availability of monoplace programs has resulted in increasing numbers of decompression illness cases being primarily evaluated and treated in the monoplace chamber setting.

Terminal Objectives

A working knowledge of the United States Navy Standard Air Decompression Table.

A working knowledge of the United States Navy No-Decompression Limits and Repetitive Group Designation Table for No-Decompression Air Dives. A working knowledge of the United States Navy Residual Nitrogen Timetable for Repetitive Air Dives. A fundamental understanding of the limitations of the above referenced tables regarding their ability to prevent decompression sickness. A working knowledge of the physiological and operational factors that increase one's susceptibility to decompression sickness.

Sample Questions

7. For a dive to 6 ATA the US Navy no-decompression limit is ____ minutes.
 - a. 5
 - b. 50
 - c. 10
 - d. 60
8. For a dive to ____ fsw, the no-decompression limit is 60 minutes.
 - e. 33
 - f. 45
 - g. 60
 - h. 66

Therapeutic Mechanisms Associated with Hyperbaric Oxygen Exposure

Narrative Summary

Elevated atmospheric pressure in conjunction with intermittent 100% oxygen breathing combines to produce a number of beneficial effects; effects that cannot be or are poorly duplicated by breathing oxygen at one atmosphere absolute.

Decompression Illness responds to the effects of Boyle's Law and accelerated inert gas elimination during oxygen breathing.

Carbon Monoxide Poisoning responds to both the increased oxygen-carrying capacity of the blood, and newly recognized mechanisms involving mitochondrial function and leukocyte adherence.

Clostridial Gas Gangrene and selected **Mixed Soft Tissue Infections** respond to the bacteriostatic and possibly bactericidal effects of hyperbaric oxygen and HBO's support of partially ischemic tissue.

Acute Traumatic Ischemia, Crush Injuries and Acute Exceptional Blood Loss Anemia benefit from oxygen-mediated vasoconstriction (without component hypoxia) and hyperoxygenation.

Non-healing Ischemic Wounds derive benefit from the angiogenic response of intermittent hyperbaric hypoxia.

Compromised Skin Flaps may respond to the improved oxygen carrying capacity of blood under conditions of hyperbaric hyperoxia. HBO may also limit leukocyte mediated ischemia- reperfusion injury.

Idiopathic Sudden Sensorineural Hearing Loss (ISSHL) response of hyperoxygenation through the cochlear capillary networks into the perilymph and cortilymph.

A fundamental knowledge of these beneficial mechanisms is necessary in order to fully appreciate the underlying basis of the "Accepted Indications" for hyperbaric medicine referral and related investigational indications.

Terminal Objectives

Upon review of the indexed reference sources the reader will appreciate how exposure to partial pressures of oxygen, greater than one atmosphere absolute, produce the following mechanism:

1. antimicrobial effects
2. vasoconstriction
3. hyperoxygenation
4. neovascularization
5. attenuation of reperfusion injury
6. gas bubble reduction

Further, the reader will be able to classify each of the currently 'Accepted Indications' for hyperbaric oxygen by proposed therapeutic mechanism.

Sample Questions

9. Hyperbaric oxygen is an important therapeutic modality in the treatment of decompression sickness due to which of the following mechanisms?
 - a. Increased counter-diffusion gradient at the blood-bubble interface
 - b. Oxygenation of hypoxic tissues
 - c. Gas bubble reduction
 - d. All of the above
 - e. None of the above
10. The hyperoxygenation effects of hyperbaric oxygen therapy cease immediately upon completion of hyperbaric chamber decompression.
 - a. True
 - b. False

Currently Accepted Indications for Hyperbaric Oxygen Exposure

Narrative Summary

Recognizing the need for careful scrutiny of the clinical application of hyperbaric oxygen, the Undersea and Hyperbaric Medical Society established the Hyperbaric Oxygen Committee in 1976. This committee was charged with the responsibility for continuously reviewing research and clinical data and providing recommendations and guidance regarding clinical efficacy. The most recent edition of the Committee Report, 1992, lists 13 indications for which hyperbaric oxygen therapy represents a standard or important adjunct to other measures. Prior to the 1992 publication, the Hyperbaric Oxygen Committee had also included a listing of investigational indications. The Committee considered these latter indications to represent fruitful areas for research. Within this category may be individual life or limb threatening situations for which evidence of hyperbaric oxygen's value exists. In general, patients with disorders in this category should be treated only according to a formal research protocol.

Terminal Objectives

The ability to list all of the 'Currently Accepted Indications' considered appropriate for hyperbaric medicine referral by the Undersea and Hyperbaric Medical Society.

A working knowledge of the commonly utilized treatment protocols, in terms of the absolute pressure, exposure time and frequency of procedures, for each of the 'Currently Accepted Indications'.

Sample Questions

11. Hyperbaric oxygen is an approved therapy for all of the following except:
 - a. carbon dioxide poisoning
 - b. osteoradionecrosis
 - c. selected non-healing wounds
 - d. clostridial gas gangrene

12. A case of neurological decompression sickness responds well to recompression and oxygen at 60 fsw. However, upon completion of the third oxygen breathing cycle, at 60 fsw, resolution is incomplete. The most appropriate physician's order would be to:
- Decompress to 165 fsw, on air
 - Complete Treatment Table 6 and observe
 - Complete Treatment Table 6 and retreat immediately
 - Extend Treatment Table 6 at 60 fsw

Oxygen Toxicity

Narrative Summary

The safe and effective application of oxygen as a therapeutic modality within the hyperbaric environment requires strict adherence to established protocols. The basis for such protocols was the avoidance of toxicity rather than the delivery of a precise dose of oxygen to achieve a specific therapeutic effect. Complicating factors include varying degrees of tolerance from patient to patient, and what appears to be a varying degree of tolerance in the same patient from day to day. While oxygen toxicity will affect all organ systems, it is the central nervous system and the lungs that first become clinically manifest within the undersea and hyperbaric medicine setting.

Modification of oxygen tolerance has been demonstrated with a number of pharmacological agents. Intermittent air breathing, however, is simple to administer and is particularly effective in delaying the onset of central nervous system oxygen toxicity. Appreciation of risk factors, early recognition of oxygen toxicity, and its subsequent management, will do much to lessen both the incidence and morbidity of this potential complication of hyperbaric oxygen exposure.

Terminal Objectives

The ability to differentiate the clinical presentation of central nervous system (Paul Bert Effect) and pulmonary oxygen toxicity (Lorrain Smith).

A working knowledge of commonly used methods to extend patient tolerances to hyperbaric exposure.

A working knowledge of the prevention and management principles for both central and pulmonary oxygen toxicity.

Sample Questions

13. A diver undergoing treatment for decompression sickness suffers what appears to be an oxygen-induced central nervous system reaction, in the absence of an overt seizure, at 0900. Oxygen breathing is immediately discontinued. By 0905 the patient appears able to continue the treatment table. According to U.S. Navy Table 6 protocols, what is the earliest time that oxygen breathing can be resumed?
- 0910
 - 0915
 - 0920 wait 15 minutes after the reaction has entirely subsided
 - 0935

14. During the latter stages of a hyperbaric oxygen procedure in a multiplace chamber, the inside attendant notices intermittent twitching around the corners of a patient's mouth. Appropriate immediate action is to:
- a. Take the patient off oxygen and advise the hyperbaric medical staff
 - b. Do a neurological examination
 - c. Obtain a set of vital signs
 - d. Insure the oxygen delivery hood/mask is secure on the patient's face

Other Potential Complications

Narrative Summary

While an oxygen seizure might be one of the more dramatic side effects associated with exposure to elevated oxygen pressures, it is relatively uncommon. Far more frequent is a patient's inability to compensate pressure changes, usually occurring during the compression phase. The middle ear and sinus spaces are reported as common sites for this form of barotrauma. However, any gas filled space, both within the body, or equipment used to directly support the patient, is a potential barotrauma site. In addition, long-term hyperbaric therapy has been associated with a progressive myopia and isolated reports of cataractogenesis or enhanced cataract maturity. The patient is at risk for a more serious form of barotrauma during the decompression phase. The inability to adequately ventilate the pulmonary spaces during pressure reductions may result in local overpressure. If the resulting increase in pressure reaches a critical point, structural failure of the lung may result in cerebral arterial gas embolism, pneumothorax, mediastinal or subcutaneous emphysema or any combination of these results. Patients with significant degrees of left ventricular dysfunction may go into congestive heart failure during, or immediately following, hyperbaric oxygen exposure.

Terminal Objectives

The ability to recognize all anatomic and equipment gas-filled spaces or potential spaces prior to compression of the hyperbaric patient.

The ability to minimize the risk of barotrauma by patient education and instruction and appropriate venting of equipment prior to pressure changes.

The ability to recognize potential airway compromise, particularly during decompression, and a comprehensive knowledge of the immediate management necessary to reduce the risk of pulmonary barotrauma.

Understand the complicating role of central nervous system oxygen toxicity and reactive airway disease during decompression.

Sample Questions

15. Maintenance of effective mechanical ventilation through an endotracheal tube in the hyperbaric chamber is accomplished easily and effectively by:
- increasing the amount of air in the cuff
 - overinflating the cuff with saline
 - replacing the air in the cuff with an equal amount of sterile water. (*Sodium from saline will leak out and doesn't keep the cuff inflated as well, potentially leading to a cuff leak.*)
16. When monitoring an intravenous fluid infusion in the hyperbaric chamber, one can expect the drip chamber to ____ during decompression.
- empty
 - stay the same
 - fill with fluid
 - implode

The Hyperbaric Medicine Facility

Narrative Summary

Central to the therapeutic application of increased atmospheric pressure is the hyperbaric chamber. The chamber is constructed to withstand internal pressurization so that oxygen, and other therapeutic gases, can be administered at pressures greater than one atmosphere absolute (sea level). Early recompression chambers were constructed of steel, had two compartments and were designed for the management of decompression illness in divers and compressed air workers. The increased utilization of hyperbaric oxygen therapy in recent years, for a wide variety of disease states, has dictated that chamber construction take into account varying patient needs as well as economic considerations/constraints. Today, chambers are classified as either multi-place (with varying patient capacity), monoplace (single patient, not internally attended) or duo-place (patient and attendant). In order to adequately manage the broad cross-section of patients referred for hyperbaric therapy, a number of important ancillary services must be integrated into the chamber facility. They include, but are not limited to:

1. An air compression and air reserve capability
2. An oxygen supply, either directly into the chamber or to individual patient delivery systems
3. Fire suppression equipment (internal in the case of multiple occupancy chambers and external regardless of chamber type)
4. Gas sampling/monitoring equipment (internal atmosphere and supply gases)
5. Diagnostic equipment (examples include ECG, transcutaneous oxygen monitors, EEG)
6. Patient monitoring equipment (invasive and non-invasive arterial blood pressures, central venous pressures)

Terminal Objectives

A fundamental knowledge of each hyperbaric chamber type, to include a working knowledge of their respective advantages and disadvantages.

A fundamental knowledge of the operating characteristics of each chamber type.

Sample Questions

17. In a multiplace chamber, oxygen may be delivered to a patient via
 - a. BIBS mask
 - b. hood
 - c. endotracheal tube
 - d. any of the above
18. NFPA defines an oxygen-filled monoplace chamber as a class ____ chamber.
 - a. A
 - b. B
 - c. C
 - d. D
19. Timed Fire drills shall be conducted annually by the department safety director.
 - a. True
 - b. False

Hyperbaric Safety

I. Protecting the Environment

Narrative Summary

The safe and effective operation of a hyperbaric medicine facility requires a thorough understanding of system design and operational characteristics. Various aspects of chamber safety include:

1. maintenance of pressure integrity
2. handling of high pressure gas cylinders
3. patient breathing systems
4. fire prevention and control
5. electrical safety, and
6. operating and emergency procedures

Pressure Integrity

Abrupt loss of pressure may cause pulmonary barotrauma, as well as decompression sickness in individuals who have been exposed to compressed air. Decompression sickness is not anticipated in patients undergoing hyperbaric oxygen therapy unless operational error or system failure results. Careful attention therefore, should be given to maintenance of the chamber's structural integrity. Damage to seals, doors, view ports, acrylic tubes or the chamber shell must be evaluated and addressed without delay.

Gas Cylinders

Non-flammable high pressure gas cylinders are commonly incorporated within the hyperbaric complex. They are used to provide oxygen or air to patient breathing systems in all types of chambers, and mixtures of certain other therapeutic gases are often found in the multiplace chamber setting. The contents of all gas cylinders must be clearly identified, with a clear understanding of what color each cylinder contents contain. Pressure reducing valves should be installed as close to the high pressure source as possible. Relocation, storage and operation must be in strict compliance with published recommendations.

Patient Breathing Systems

Face masks and hoods are used to deliver therapeutic gases to patients in multi and duoplace chambers. In the monoplace chamber, face masks or hoods are utilized for the intermittent delivery of compressed air.

Fire Prevention and Control

The hyperbaric chamber represents a unique environment with regard to fire safety. Physical isolation and an oxygen enriched atmosphere can combine to produce a potentially devastating setting should a fire occur. The need to protect chamber occupants and operational personnel, difficulties associated with escape, and the potential for significant increases in chamber pressure, secondary to the effects of Charles' Law, dictate that fire prevention remains a primary safety goal. Strict operational guidelines have been established for multi and single occupancy chambers, and should be incorporated into the operating policies of every hyperbaric medicine program.

Electrical Safety

As the majority of reported chamber fires have occurred as a result of faulty electrical apparatus, there has been a concerted effort to minimize the internal electrical requirements of the hyperbaric chamber. Where necessary, in communications for example, equipment and associated wiring must be certified as intrinsically safe for the maximum conditions anticipated.

Operating Procedures

Clearly established supervision and well-trained personnel are imperative for safe chamber operation. Each program should have available a set of operational and emergency procedures based upon the equipment, manufacturers recommendations and nationally published guidelines. Emergency drills should be discussed and practiced. Regularly scheduled maintenance and testing by competent personnel represent important components of a comprehensive program of chamber safety.

Terminal Objectives

A fundamental understanding of hyperbaric chamber design and configuration to include both acrylic and steel hulled vessels.

A working knowledge of the recommendations for the safe handling of compressed gas cylinders.

A working knowledge of the color codes for oxygen, compressed air, nitrogen-oxygen mixtures, helium-oxygen mixtures, nitrogen and helium.

A comprehensive understanding of the measures necessary to reduce the risk of chamber fires; to include ancillary equipment, chamber material and personal perspectives.

Sample Questions

20. According to NFPA codes for hyperbaric facilities, the maximum direct current of communications systems should not exceed ____ volts.

- a. 5
- b. 12
- c. 28
- d. 10

21. Oxygen

- a. explodes easily
- b. is lighter than air
- c. will not burn
- d. is necessary for combustion

Hyperbaric Safety

II. Protecting the Patient

Narrative Summary

The safety and well-being of any patient is paramount. This is particularly the case in those patients undergoing hyperbaric oxygen therapy. Physical and physiological risk factors, initially evaluated by the consulting hyperbaric physician, must be continually monitored throughout the treatment course. It is the responsibility of the hyperbaric medicine team to develop and implement a coordinated patient care plan designed to insure the highest possible level of safety.

Terminal Objectives

A working knowledge of the physical effects of alterations in atmospheric pressure on gas-filled spaces and potential gas-filled spaces within the body.

A working knowledge of the physical effects of alterations of atmospheric pressure on gas-filled spaces within patient vascular access lines, direct patient support and patient monitoring equipment.

A working knowledge of the special physical hazards associated with alterations in atmospheric pressure in patients with known pulmonary pathology.

A working knowledge of the special physiological risks associated with hyperbaric oxygen exposure in patients who are insulin and non-insulin dependent diabetics, patients with a seizure history or recent head injury, patients who are febrile, patients with a history of chest surgery or thoracic procedures, penetrating chest injury and patients with a history of reconstructive ear surgery.

A comprehensive knowledge of patient assessment requirements prior to each hyperbaric oxygen exposure. Namely, patient education regarding pressure equalization methods, anticipated chamber temperature changes, patient preparation (removing restricted items), namely, static producing clothing, h air pieces, recently applied nail polish, make-up and body lotions, loose dentures, Velcro attachments, battery operated equipment such as hearing aids and Holter monitors.

The ability to recognize the signs and symptoms of pulmonary barotrauma of ascent.

The ability to recognize pre-monitory signs and symptoms of central nervous system oxygen toxicity.

Sample Questions

- 22.** A patient has recently undergone a subclavian IV placement. Before continuing hyperbaric therapy, the following is indicated:
- Chest x-ray to rule out pneumothorax
 - Blood cultures
 - Discontinue hyperbaric therapy
 - IV heparin to prevent clotting during hyperbaric therapy
- 23.** Insulin dependent diabetic patients being treated with hyperbaric oxygen are:
- More likely to go into hypoglycemic shock
 - Less likely to go into hypoglycemic shock
 - There is no effect on blood glucose levels

Transcutaneous Oxygen Monitoring

Narrative Summary

Tissue oxygen tension is a direct, quantitative assessment of the oxygen available to tissue. Tissue oxygen studies are used in medical decision making by wound care and hyperbaric medicine specialists. Several types of oximeters have been used, but most common is the non-invasive transcutaneous oximeter. Transcutaneous oximetry (TcP02) has gained importance as a non-invasive tool for predicting potential candidates for hyperbaric oxygen (HB02) therapy. Clinicians use these data as an aid in vascular assessment to help predict non-responders to treatment and to choose successful amputation sites. The data are also used to select candidates for HB02 by identifying the presence of tissue hypoxia and the responders to hyperoxia. In some instances, tissue oxygen data are used to determine when HB02 treatment is complete.

Terminal Objectives

A working knowledge of TcP02 technology.

A working knowledge of a TcP02 monitor and ancillary equipment.

Be able to demonstrate knowledge of TcPO₂ test that is consistent with current industry standards.

Be able to demonstrate knowledge of obtaining the subject's consent for the TcPO₂ procedure.

Be able to demonstrate knowledge of inspection procedures for equipment needed to conduct a TcPO₂ study.

Sample Questions

24. Proper site preparation for transcutaneous oximetry requires the hair to be removed from the skin, cleaned and degreased.
 - a. True
 - b. False
25. A commonly accepted definition of critical limb ischemia is a dorsal foot transcutaneous oxygen value of less than ____ mmHg
 - a. 60
 - b. 50
 - c. 40
 - d. 30

Nursing Management of the Patient Undergoing Hyperbaric Oxygen Therapy

Narrative Summary

Patients undergoing hyperbaric oxygen therapy represent a range of acuity from chronically ill outpatients to the critically ill and from pediatrics to geriatrics. The hyperbaric nurse must be knowledgeable and experienced in the care of a multi-faceted population of patients. Application of the nursing process is essential to the appropriate planning and delivery of nursing care in the hyperbaric hyperoxic environment.

Terminal Objectives

A working knowledge of human responses to actual or potential problems related to an altered health status (physiological, psychological, sociological and cognitive).

A fundamental knowledge of the application of the nursing process in the development of a patient care plan.

A working knowledge of pharmacology and the interaction or an iteration of drug effects in the hyperbaric hyperoxic environment.

A comprehensive knowledge of wound healing and adjunctive therapies that stimulate and/or enhance the healing process.

A fundamental knowledge of the care of critically ill patients and pediatric patients.

Sample Questions

26. Patients are at risk of losing body heat:

- a. during compression
- b. at pressure
- c. during decompression
- d. immediately after treatment

27. Patients with high fevers may be predispose to oxygen seizures.

- a. True
- b. False

28. A patient present for hyperbaric treatments and during the initial nursing assessment the nurse recognizes the patient to be anxious about being inside the monoplace hyperbaric chamber. The action for the nurse to help alleviate the patient's anxiety includes:

- a. Not letting the patient know the potential hazards of HBO therapy so as not to increase the anxiety level
- b. Telling the patient that the chamber operator will be busy in the next room during the HBO treatment but will check on them at regular intervals so there is no need to be anxious
- c. Telling the patient they are being anxious for no good reason
- d. Provision of initial and continual opportunities for education and discussion throughout the hyperbaric treatment course.

Additional study materials are available. Please contact the NBDHMT or BNA for references and resources.

**ANSWER
KEY**

1. In 1878, a French physiologist named published his classic work concerning the effect of oxygen on the central nervous system.
A. Bert
2. An Englishman named ____ built the first known treatment chamber in ____?
D. Henshaw, 1662
3. Which of the gas laws explains why a diver's tissues take up nitrogen during a dive?
A. Henry's
4. Gas molecules move in ____ motion within a closed space:
C. Random
5. The double layer of tissue surrounding each lung, and lining the inside of the chest cavity is called the:
A. Pleura
6. Central nervous system oxygen toxicity may occur when the partial pressure of oxygen equals or exceeds:
D. 2.0
7. For a dive to 6 ATA the US Navy no-decompression limit is ____ minutes.
A. 5
8. For a dive to fsw, the no-decompression limit is 60 minutes.
C. 60
9. Hyperbaric oxygen is an important therapeutic modality in the treatment of decompression sickness due to which of the following mechanisms?
D. All of the above
10. The hyperoxygenation effects of hyperbaric oxygen therapy cease immediately upon completion of hyperbaric chamber decompression.
B. False
11. Hyperbaric oxygen is an approved therapy for all of the following except:
A. Carbon dioxide poisoning
12. A case of neurological decompression sickness responds well to recompression and oxygen at 60 fsw. However, upon completion of the third oxygen breathing cycle, at 60 fsw, resolution is incomplete. The most appropriate physician's order would be to:
D. Extend Treatment Table 6 at 60 fsw
13. A diver undergoing treatment for decompression sickness suffers what appears to be an oxygen-induced central nervous system reaction, in the absence of an overt seizure, at 0900. Oxygen breathing is immediately discontinued. By 0905 the patient appears able to continue the treatment table. According to U.S. Navy Table 6 protocols, what is the earliest time that oxygen breathing can be resumed?
C. 0920 wait 15 minutes after the reaction has entirely subsided
14. During the latter stages of a hyperbaric oxygen procedure in a multiplace chamber, the inside attendant notices intermittent twitching around the corners of a patient's mouth. Appropriate immediate action is to:
A. Take the patient off oxygen and advise the hyperbaric medical staff
15. Maintenance of effective mechanical ventilation through an endotracheal tube in

the hyperbaric chamber is accomplished easily and effectively by:

C. Replacing the air in the cuff with an equal amount of sterile saline

16. When monitoring an intravenous fluid infusion in the hyperbaric chamber, one can expect the drip chamber to_ during decompression.
A. Empty
17. In a multiplace chamber, oxygen may be delivered to a patient via?
D. Any of the above
18. NFPA defines an oxygen-filled monoplace chamber as a class ____ chamber.
B. B
19. Timed Fire drills shall be conducted annually by the department safety director.
A. True
20. According to NFPA codes for hyperbaric facilities, the maximum direct current of Communications systems should not exceed ____ volts.
C. 28
21. Oxygen
D. Is necessary for combustion
22. A patient has recently undergone a subclavian IV placement. Before continuing hyperbaric therapy, the following is indicated:
A. Chest x-ray to rule out pneumothorax
23. Insulin dependent diabetic patients being treated with hyperbaric oxygen are:
A. More likely to go into hypoglycemic shock
24. Proper site preparation for transcutaneous oximetry requires the hair to be removed from the skin, cleaned and degreased.
A. True
25. A commonly accepted definition of critical limb ischemia is a dorsal foot transcutaneous oxygen value of less than ____ mmHg.
D. 30
26. Patients are at risk of losing body heat:
A. During decompression
27. Patients with high fevers may be predispose to oxygen seizures.
A. True
28. A patient present for hyperbaric treatments and during the initial nursing assessment the nurse recognizes the patient to be anxious about being inside the monoplace hyperbaric chamber. The action for the nurse to help alleviate the patient's anxiety includes:
D. Provision of initial and continual opportunities for education and discussion throughout the hyperbaric treatment course