SAFETY & EDUCATION MANUAL

HYPERBARIC OXYGEN THERAPY

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SerenaGroup
Building the Nation's Leading Wound Care Team

SerenaGroup Hyperbaric Medicine Programs

Section One: The Fire Safety Plan

1. Purpose

A Fire Safety plan provides hyperbaric personnel with an emergency plan in the event of a fire in the hyperbaric area. A predetermined plan is expected to reduce injury and potentially catastrophic outcomes. Hyperbaric centers must develop their own fire safety plan. This document will guide the development of the plan.

2. Policy

2.1. In the event of an emergency, the Hyperbaric Medicine Center personnel will be prepared to respond.
2.2. The Safety Director shall be designated by the Program Director / Manager or designee.

NFPA 99 Health Care Facilities, 2018 edition, (page 118):

"14-3.1.3.2 A safety director shall be designated in charge of all hyperbaric equipment. The safety director shall work closely with facility management personnel and the hyperbaric physician(s) to establish procedures for safe operation and maintenance of the hyperbaric facility. He/she shall make necessary recommendations for departmental safety policies and procedures. The safety director shall have the authority to restrict or remove any potentially hazardous supply or equipment items from the chamber."

2.3. The plan is a collaborative effort developed between SerenaGroup® and hospital representatives responsible for fire safety in accordance with NFPA standards.
2.4. There will be no smoking or open flames in the hyperbaric area.
2.5. The area will be kept meticulously clean and free of fire hazards in accordance with the National Fire Protection Association (NFPA) guidelines for Hyperbaric health care facilities.
2.6. The chamber(s) must be kept free of lint and dust particles. These are hazardous when inside the chamber during operation.
2.7. Each hyperbaric patient will be searched and questioned about possession of an ignition source before entering the chamber.
2.8. Items listed as unsafe in the chamber safety policy manual, are NOT allowed in the chamber.

3. Scope

This manual applies to all Hyperbaric Medicine Center staff, overseeing physicians, and patients.

4. Responsibility

It is the responsibility of the center's Safety Director to implement and ensure that fire safety practices are followed within the department.

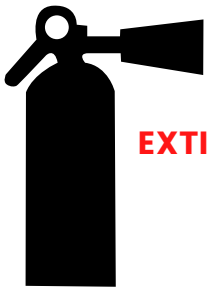
5. Elements of the Fire Safety Plan

5.1. The Program Director/Manager shall obtain the hospital fire safety plan.
5.2. A comprehensive plan will be developed and incorporated into the overall emergency plan for the center. It shall include at a minimum:
5.2.1. Identification of signage locations
5.2.2. Extinguishing (sprinklers, smoke detectors, fire extinguishers, etc.) methods, equipment and location
5.2.3 The Rescue, Alarm, Contain, Extinguish (RACE) protocol:

RESCUE = **Assist anyone who is in immediate danger.**

ALARM = **Activate the nearest fire alarm. Immediately after activating the alarm, go to the nearest phone and call 911. Let the operator know there is a fire and give the exact location.**

CONTAIN = **Attempt to contain the fire by closing all doors and windows in the area where the fire is located. If smoke is observed coming from underneath any of the doors that were closed, dampen towels and place them at the door base.**



EXTINGUISH = **Try to extinguish the fire. Retrieve the nearest fire extinguisher and use it on the fire. Note: if the fire is out of control, do not attempt to extinguish it. Close the door immediately!**

5.2.4. Emergency phone numbers: who to contact, when and where
5.2.5. Oxygen leak testing-frequency and procedure
5.2.6. Electrical equipment-location, preventive maintenance schedule
5.2.7. Specific fire prevention requirements for hyperbaric suite
5.2.8. Mock Drill-frequency
5.2.9. General response to fire-code announcement door and window handling

5.3. All SerenaGroup® personnel and hospital employees working in the hyperbaric suite will be knowledgeable of the fire safety plan. They will be fully prepared to prevent a fire or in the case of a fire, extinguish it immediately.
5.4. Assure appropriate signage in the center prohibiting smoking (readable from a distance of 5 feet).
5.5. Ensure patients, staff and visitors do not smoke. There should never be an open flame within the center.
5.6. Ensure the patient has changed into 100% cotton clothing prior to the therapy.
5.7. Ensure all linens are 100% cotton. This includes pillowcases, blankets, and sheets.
5.8. No clothing is permitted in the chamber except that provided by the hyperbaric staff in accordance with safety policies and procedures. This includes but is not limited to undergarments even if they are 100% cotton, street clothes, hospital gowns, and scrubs.
5.9. All patients are searched prior to every hyperbaric treatment for prohibited items.
5.10. Patients must remove any petroleum-based products including but not limited to make-up, hair spray, nail polish, perfume, after shave lotion, oil-based creams or ointments with a petroleum base.
5.11. Allow only items necessary for patient care during therapy such as nasogastric tubes, external fixation devices, wound dressings, soft contact lenses, Foley catheters, vented drains, monitoring leads and cables for cardiac monitoring as long as they have been tested for hyperbaric safety.
5.12. Cover dressings with 100% cotton linens. If patient has a post-op skin graft and physician does not want the dressing removed, cover existing dressing with 100% damp cotton towel. Do not expose a wound covered with an ointment in the chamber.
5.13. Devices with a power source such as external pacemakers, holter monitors, external TENS units, or insulin pumps are not permitted in the chamber.

5.14. Turn off the main oxygen supply to the chambers at the end of operations each day to prevent oxygen leakage into the hyperbaric suite.
5.15. According to policy, analyze the oxygen concentration in the room around the gaskets of the chamber and various sites in the room to ensure no leakage of oxygen is occurring.
5.16. Complete the pretreatment checklist before every hyperbaric treatment.

6. Action depending on the location of the fire

6.1. Fire inside the building housing the hyperbaric unit.
6.1.1. In the case of a fire inside the building but outside of the chamber area follow the hospital fire plan.
6.1.2. Only remove patients from the chamber or chamber room if the fire threatens the suite.
6.2. Fire in the hyperbaric unit but outside of the chamber(s)
6.2.1. Pull the fire alarm and activate hospital fire plan informing fire station of the fire location.
6.2.2. If chamber is directly threatened, inform the patients in the hyperbaric chamber that rapid emergency decompression is necessary and they should try to stay calm, breathe normal and do not hold their breath.
6.2.3. Follow the procedure to emergency vent the chamber(s) (see SerenaGroup® Policy 401. Emergency Procedures for Monoplace Chamber).
6.2.4. Remove the patients from the chamber(s).
6.2.5. Turn off the oxygen supply located outside chamber room.
6.2.6. Assist in the evacuation of the area per hospital evacuation plan.

6.3. Fire inside the Monoplace Hyperbaric Chamber
6.3.1. A fire inside a monoplace hyperbaric chamber pressurized with 100% oxygen during operation is a fatal event. The patient inside the chamber in which a fire has occurred has no chance of survival; therefore, no attempt to save this patient by emergency decompression is warranted.
6.3.2. Pull the fire alarm.
6.3.3. Immediately follow the procedure to emergency vent the unaffected chamber(s).

6.3.4. When assistance arrives, have them activate the hospital fire plan informing firefighting personnel of location of the fire.
6.3.5. Inform the patient that emergency decompression is required.
6.3.6. Have the patient breathe from the air break mask during emergency decompression.
6.3.7. Evacuate the patient(s).
6.3.8. Turn off oxygen supply to the chamber(s).

Section Two: Emergency Preparedness

1. Purpose

The purpose of this section is to establish an Emergency Preparedness plan specific to the hyperbaric center.

2. Policy

2.1. To provide optimal patient care and support in the event of an emergency or natural disaster such as a flood, hurricane, ice storm, earthquake, or tornado.
2.2. Patients are informed of alternative care options in the case of a disaster that may impact the hyperbaric center.
2.3. Hyperbaric units and supporting staff will receive education on emergency preparedness plan to promote safety during a disaster.
2.4. The Hyperbaric Medicine Center Emergency Preparedness plan compliments the hospital's plan; it does not supersede the hospital emergency preparedness.

3. Scope and Responsibility

This policy applies to all members of the Hyperbaric Medicine staff, physicians and patients.

4. Procedure

4.1. In the case of a disaster, it may become necessary to remove patients from the hyperbaric chambers. The following steps should be taken:
4.1.1. Explain to the patients the reason for ending the treatment early.
4.1.2. Decompress chambers at a normal rate. **DO NOT EMERGENCY VENT THE CHAMBERS.**

4.1.3. Once the chambers are empty and all the patients have exited the center, secure the chambers in the following manner:

4.1.3.1. Close the doors on the chambers.

4.1.3.2. Switch off both the Oxygen and Air supply to the chambers at the wall source.

4.1.3.3. Disconnect the transformer from the electrical outlet at the wall interrupting the power supply to the battery charger.

4.1.3.4. Cover the chambers with the cloth chamber cover.

Section Three: 2025 Monthly Safety Program Schedule

January - Reducing Risks and Pre-Treatment Testing

February – Safe Wound Dressings

March – Barotrauma

April – Seizures

May – UHMS, CMS, and Insurance Medical Policies

June – Clinical and Non-Clinical Emergencies and Preparedness

July – What Can and Cannot Go into the chamber?

August – To Dive or NOT to Dive?

September – Chamber Care

October – Physiology of HBOT for Each Indication and When to Consider Continuation

November – Diabetes Management for the Hyperbaric Patient

December – Compliance Checklist and Survey Preparation

January - Reducing Risks and Pre-Treatment Testing

Overview:
Hyperbaric oxygen therapy is a very safe treatment overall. Precautions are taken to lessen risks. Risks of HBOT include, but are not limited to, ear and sinus pain, middle ear injuries including tympanic membrane rupture, vision changes, pulmonary barotrauma, and fire.

Ear and Sinus Pain:

- Discussed in the previous chapter, ear and sinus pain associated with barotrauma may be treatable or preventable through the use of decongestants, nasal sprays, and as a last resort tympanostomy tubes.

Vision Changes:

- Unfortunately, there is no way to reduce the risk of vision changes with HBOT. These changes are temporary, unless the vision changes are caused by cataracts. HBOT may mature existing cataracts which would need to be corrected surgically. The timing of this surgical correction is up to the ophthalmologist and the patient. This surgery has no bearing on HBOT and can be performed prior, during, or after the hyperbaric series. Non-cataract vision changes should return to normal within four months after stopping hyperbaric.

Pulmonary Barotrauma:

- Pulmonary barotrauma is an incredibly rare side effect of hyperbaric and would most likely be associated with an increased speed of chamber travel, such as emergency decompressing a patient. However, there are certain comorbidities that may put a patient at higher risk for developing pulmonary barotrauma. For this reason, patients undergo pre-treatment testing to evaluate for higher-risk conditions in patients to assist in reducing risks.

Fire Risks:

- As we know, HBOT uses a large quantity of high-pressured oxygen. Fires in the hyperbaric setting can be deadly; therefore, fire prevention plays a large role in our centers and the below risk-reducing factors are to be followed:
  - Strict adherence to prohibited items
  - Grounding of the patient, gurney, and chamber
  - Static reduction through use of appropriate linens, humidifiers, and anti-static materials in the chamber room (e.g. floor buffer)
  - Usage of safe dressings
  - Unit precautions (sprinkler systems, fire extinguishers, alarm, fire plan)

Policies and procedures dictate that all hyperbaric patients should receive a pre-treatment chest x-ray and electrocardiogram (ECG, better known as EKG). These tests should be performed within the last 6 months prior to HBOT in an asymptomatic patient. If a patient has symptoms associated with cardiac or pulmonary distress, these tests may need to be repeated and/or the patient may require a referral for disease management with a specialist.

Chest X-Ray:

Key findings to assess:

1. Pneumothorax
   - Why Check: Pneumothorax is an absolute contraindication for HBOT. Increase pressure during HBOT could worsen the condition, leading to like-threatening tension pneumothorax
   - What to Look For: Air outside the lung margin (black area); shift of mediastinal structures
2. Bullae or Blebs (Emphysematous Changes)
   - Why Check: Large bullae or blebs can rupture under hyperbaric pressure, causing a pneumothorax
   - What to Look For: Large, air-filled spaces in the lung fields; hyperlucency without vascular markings
3. Pulmonary Infections or Infiltrates
   - Why Check: Active lung infections, such as pneumonias, can worsen under hyperbaric conditions due to oxygen toxicity or pressure changes
   - What to Look For: Patchy or consolidated opacities; pleural effusion or other signs of infection
4. Interstitial Lung Disease (Fibrosis or Restriction)
   - Why Check: Restrictive lung disease can impair oxygen exchange and increase the risk of complications
   - What to Look For: Reticular (net-like) or honeycombing patterns; reduced lung volumes
5. Pulmonary Edema
   - Why Check: Fluid in the lungs could worsen or shift under HBOT and compromise oxygenation and/or lead to severe acute pulmonary edema
   - What to Look For: Bilateral hazy opacities; enlarged heart size (if associated with heart failure)
6. Tumors or Masses
   - Why Check: Certain tumors might be sensitive to hyperoxia, and the presence of a mass may indicate the need for further evaluation.
   - What to Look For: Well-defined or irregular opacities; mediastinal or hilar enlargement

7. Pleural Effusion
    - Why Check: Fluid in the pleural space can impair lung function and oxygenation
    - What to Look For: Blunted costophrenic angles; meniscus sign

Interpreting the Chest X-Ray

- Normal Findings
    - Clear lung fields, normal heart size, no air or fluid in the pleural space, and no visible masses
- Abnormal Findings
    - If any concerning features are noted, further evaluation (e.g., CT scan or pulmonary consultation) may be necessary before proceeding with HBOT.

Electrocardiogram (ECG/EKG)

1. Baseline Rhythm and Rate
    - Why Check: Cardiac arrhythmias can worsen under hyperbaric conditions due to oxygen toxicity or changes in autonomic tone
    - What to Look For: Sinus rhythm with a normal rate (60-100 bpm); abnormal rhythms, such as atrial fibrillation, atrial flutter, or ventricular arrhythmias
2. Evidence of Ischemia or Infarction
    - Why Check: Patients with active ischemia are at risk for worsening cardiac events during HBOT
    - What to Look For: ST-segment elevation or depression; T-wave inversions; Pathological Q waves (indicative of prior infarction)
3. QT Interval Prolongation
    - Why Check: Prolonged QT intervals increase the risk of life-threatening arrhythmias (e.g., torsades de pointes), which may be exacerbated by oxygen toxicity
    - What to Look For: QTc> 450 ms in men or >460 ms in women
4. Left Ventricular Hypertrophy (LVH)
    - Why Check: LVH may indicate underlying hypertension or other cardiac conditions that could affect tolerance to HBOT
    - What to Look For: Increased R-wave amplitude in V5/V6 and/or deep S-wave in V1

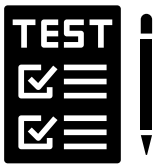
5. Conduction Abnormalities
   - Why Check: Conditions such as bundle branch blocks or heart block may impact the heart's ability to respond to oxygenation changes during HBOT
   - What to Look For: Right or left bundle branch block; first-, second-, or third-degree atrioventricular (AV) block
6. Signs of Pulmonary Hypertension or Strain
   - Why Check: Pulmonary hypertension can affect right heart function, which may be stressed by increased oxygen levels
   - What to Look For: Right axis deviation; peaked P waves (P pulmonale); S1Q3T3 pattern (suggestive of pulmonary embolism or strain)
7. Pacemaker or ICD Function
   - Why Check: HBOT can interfere with pacemakers or implantable cardioverter-defibrillators (ICDs). A baseline EKG helps identify dependence or device-related rhythm abnormalities
   - What to Look For: Capture beats or pacing spikes

Conditions That May Require Further Evaluation

1. Chronic Obstructive Pulmonary Disease (COPD)
2. History of Tuberculosis
3. Pulmonary Vascular Disease
4. Active Cardiac Ischemia or Recent Myocardial Infarction
5. Uncontrolled Arrhythmias
6. Heart Failure or Significantly Reduced Ejection Fraction

Conclusion

The hyperbaric consultation should be used to identify risks and order pre-treatment testing, if they are not within the past 6 months of an asymptomatic patient. Remember, the only ABSOLUTE contraindication is an untreated pneumothorax. Most comorbidities or identified risks can be medically managed to make HBOT safe. The ordering provider can also amend the standard HBOT protocol, such as lower, slower, or with additional air breaks, to accommodate patients that are at an increased risk.



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Date: _____

Post-Test: Reducing Risks and Pre-Treatment Testing

1.What are the 2 pre-treatment tests?

_____

2.Pre-treatment tests should be performed within 3 months of starting HBOT.
True or False

3.Which of the following is NOT an element that would describe an "asymptomatic patient as it relates to HBOT pre-treatment testing?

a. tripod breathing
b. shortness of breath upon exertion
c. leg swelling/fluid retention
d. tooth pain

4. Name something we should be looking for on an EKG.

_____

February – Safe Wound Dressings

Overview:
Wound dressings used in a hyperbaric oxygen therapy environment must be safe under high-pressure oxygen conditions, non-flammable, and compatible with the therapy.

Safe Dressings for HBOT:

- Hydrocolloids
  - Example: Tegaderm, Duoderm, Hydrocoll, Subrasorb
  - Benefits: Provide a moist wound environment and are oxygen permeable
- Hydrogels
  - Example: Aquaflo, Intrasite Gel
  - Benefits: Keep the wound moist. Non-flammable
- Foam Dressings
  - Example: Mepilex, Allevyn, Optifoam, Hydrofera Blue
  - Benefits: Absorb exudate while maintaining a moist environment
- Non-Adherent Dressings
  - Example: Adaptic, Xeroform (if not petroleum-based)
  - Benefits: Protecting the wound bed or graft without sticking
- Silicone-Based Dressings
  - Example: Mepitel, Safetec
  - Benefits: Gentle on the skin and prevent wound/peri-wound trauma during dressing changes
- Calcium Alginates With or Without Silver
  - Example: Maxorb, Algisite, Aquacell
  - Benefits: Highly absorbent and safe for wounds with moderate to heavy exudate
- Secondary Dressings
  - Example: dry dressings (conform bandage, ABDs, gauze)
  - Benefits: Absorption, securing dressing

Dressings to Avoid:

- Petroleum-Based Products: These are highly flammable and unsafe in high oxygen environments
  - Example: Adaptic Petrolatum Gauze, Vaseline Gauze, Xeroform with Petroleum base
- Ointments with Flammable Ingredients: Avoid dressings or creams containing alcohol or oil bases. Alcohol is highly volatile and flammable, and oil-based products have a low flash point.
  - Alcohol Base Examples: Santyl Collagenase Ointment (if compounded with alcohol), some antiseptic gels, some liquid skin adhesives

    - Oil Base Examples: Aquaphor, Neosporin, Bacitracin (Petrolatum-based formulations)
- Adhesives with Volatile Components: Some adhesives contain flammable solvents which may emit flammable vapors under high oxygen pressure
    - Example: certain brands of waterproof adhesive dressings with solvent-based adhesives, some Steri-Strips
- Charcoal-Containing Dressings with Adhesives: Charcoal-based dressings may have binding agents that contain solvents which can pose risks
    - Examples: Actisorb (if combined with adhesives containing solvents)
- Silver or Antimicrobial Dressings with Incompatible Carriers: The antimicrobial agent itself may be safe, but the carrier medium (e.g., petrolatum or solvent) may not be
    - Example: Silvadene Cream (in petrolatum base), some silver-impregnated dressings with volatile compounds in their layers

NFPA 99 guidelines state that the physician in charge of HBOT in concurrence with the safety director, may allow ONE of the following prohibited items into the chamber, if stated in writing.

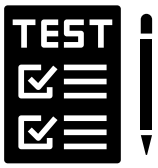
- Suture material
- Alloplastic devices
- Bacterial barriers
- Surgical dressings
- Biological interfaces
- Synthetic textiles.

If a dressing is not safe for use in HBOT, can we make it safe or safer? Sometimes, we can. If a dressing is deemed necessary and a safer option cannot be identified, we can attempt several accompanying techniques to minimize the risk. You could use a very minimal amount of the prohibited item, cover it with moistened gauze or towel, use a secondary dressing to cover the flammable primary dressing. Remember that if the physician and the local safety director make an allowance for a prohibited item, the item and allowance must be documented in writing, per the NFPA.

General Rule - Always check product labels for terms like “petrolatum”, “alcohol”, “solvent”, or “flammable”. For safety, opt for water-based, silicone-based, or oxygen-permeable dressings.

Sources:

- NFPA 99, Chapter 14



Date: _____

Post-Test: Safe Wound Dressings

1. Which dressing base is safe for use in hyperbaric?
   a. oil-based dressing
   b. alcohol-based dressing
   c. silicone-based dressing
   d. benzene-based dressing

2. Name a common dressing used in your center that is safe for HBOT?

   _____

3. A wound dressing that is prohibited cannot be made safe for HBOT.
   True or False

March – Barotrauma

Overview:

Middle ear barotrauma is the most common complication of hyperbaric therapy. During compression clearing the ears, auto inflation, equalizes the pressure between the middle ear and the pressure in the chamber. Recall from Boyle's Law that as pressure is increased, air-filled spaces will decrease in volume. Auto inflation maneuvers open the eustachian tubes in the nasopharynx permitting communication between the middle ear space and the atmosphere. A patient that cannot equalize the pressure between the middle ear and the chamber by using an auto inflation maneuver or yawning, swallowing, or taking a drink, may experience severe pain and potentially damage the tympanic membrane. Middle ear damage from pressure is called barotrauma. The underlying causes of barotrauma include an inability to auto inflate, artificial airways and damage to the eustachian tubes.

Techniques for Equalizing:

1. Valsalva Manuever – pinch your nostrils and blow through your nose.
2. Tonybee Manuever – With your nostrils pinched, swallow. This will pull open your Eustachian tubes while the movement of the tongue with your nose closed, compresses air against them.
3. Lowry Technique – While closing your nostrils, blow and swallow at the same time.
4. Edmonds Technique – While tensing the soft palate and throat muscles, push the jaw forward and down.
5. Frenzal Maneuver – Close your nostrils and close the back of your throat as if straining to lift weight. Then make the sound of the letter "K" forcing the back of your tongue upward, compressing air against the opening of the Eustachian tubes.
6. Voluntary Tubal Opening – Tense the muscles of the soft palate and throat while pushing the jaw forward and down, as if starting to yawn. These muscles pull the Eustachian tubes down.

Procedure:

If the patient experiences mild to moderate pain during compression, stop the pressurization and decrease the pressure until the patient no longer experiences pain. Advise the patient not to auto inflate while the chamber is decompressing. Once a stable pressure has been reached, have the patient perform several auto inflation maneuvers. Once the patient and technician are satisfied, pressurization can recommence. If patient experiences severe pain

that is not relieved by stopping the pressurization or decompressing, remove patient from the chamber and notify the Hyperbaric Physician. It is reasonable to attempt to compress a patient up to three times. If the patient experiences pain on the third attempt at compression the treatment is aborted. Remember the adage “three strikes and you’re out.”

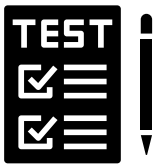
Ear Exam:
The classification system used to grade the appearance of the tympanic membrane following HBOT is called the Teed Scale. It is named for Wallace Teed, a United States Navy Submarine Medical Officer during World War II, who first described middle ear barotrauma related to changes in pressure.
https://www.ncbi.nlm.nih.gov/books/NBK499851/

- TEED 0 – Symptoms, such as pain or stuffiness, with no physical findings
- TEED 1 - Erythema or injection around the handle of the malleus, congestion around the umbo
- TEED 2 – Erythema, injection, or congestion of the entire tympanic membrane
- TEED 3 - Hemorrhage into the tympanic membrane appearing as bright red patches
- TEED 4 - Deep blue/black appearance of the tympanic membrane due to blood filling the middle ear with the possibility of rupture present.
- TEED 5 - Perforated ear drum

Middle ear barotrauma is not the only concern as any air-trapped space is subject to barotrauma. Although rarer than ear barotrauma, blocked sinuses or an air pocket in the tooth are also at risk for squeezing as the pressure changes in the chamber. Barotrauma can be extremely painful and will usually occur upon descent.

Pulmonary barotrauma refers to the spontaneous rupture of alveoli and the subsequent release or dissection of air into the various extra alveolar spaces resulting in pneumothorax, pneumomediastinum, pulmonary interstitial emphysema, pneumatocele or air cyst formation, subcutaneous emphysema, pneumopericardium, and or pneumoperitoneum. We use a pre-treatment chest x-ray to rule out risk factors for pulmonary barotrauma.

References:
Eric P. Kindwall, Hyperbaric Medicine Practice, Chapter 4 pp. 51 Larson-Lohr, Norvell, Hyperbaric Nursing, pp. 87,127,140 :
https://www.ncbi.nlm.nih.gov/books/NBK499851/



Name: _____

Date: _____

Post-Test: Barotrauma

1. What is the most common complication of hyperbaric oxygen therapy?

_____

2. Name 3 areas that can be affected by barotrauma.

_____

3. Hemorrhage in the tympanic membrane is classified as a TEED 3.
   True or False

4. How many times is considered reasonable to attempt to compress a patient during a single dive?

_____

5. Boyle's Law: as pressure is increased, air-filled spaces will _____ in volume.

Extra Credit Question: Have you ever put an inflated glove into the chamber during a test cycle? What occurs?

_____

April- Seizures

Initially described by Paul Bert in the late 19th century, exposure to high levels of oxygen can lead to acute oxygen toxicity. In hyperbaric conditions, the central nervous system is exposed to higher partial pressures of oxygen. This can increase excitatory neurotransmission, decrease inhibitory neurotransmission, and enhance the neurotoxic effects of drugs that already lower the seizure threshold. The manifestations of these hyperbaric-induced seizures are neurologic in nature. The early signs are nonspecific such as twitching of the lip, changes in vision, tinnitus, or a sudden change in behavior. Left untreated the toxicity could progress to seizures.

Oxygen toxicity seizures are uncommon, occurring only 0.52 times per 10,000 hyperbaric treatments. Air breaks reduce the potential for acute oxygen toxicity. If a patient undergoing HBOT exhibits the early signs of oxygen toxicity give him or her an air break and consider lowering the pressure in the chamber. Alternatively, the physician can choose to end the treatment. In addition, eliminating fluorescent lighting in the chamber room decreases the risk of seizure.

Signs and Symptoms

Oxygen toxicity can lead to mild symptoms or progress rapidly to a seizure without prodromal symptoms. Careful attention to the patient throughout the treatment is key to identifying oxygen toxicity and intervening in a timely fashion. The acronym VENTID identifies the early signs of oxygen toxicity:

V=changes in vision
E= ears including symptoms such as tinnitus
N=nausea
T=twitching
I=irritability
D=dizziness

Differential Diagnosis

Most Seizures in a hyperbaric environment are not due to oxygen toxicity. The differential diagnoses include hypoglycemia, fever, seizure disorder, medications that lower the seizure threshold, electrolyte abnormalities, and substance or alcohol abuse. Both withdrawal and overdose of many medication types could lead to seizures. The risk of HBOT-induced seizures in patients with a history or recent brain surgery is unknown.

Lowered Seizure Threshold

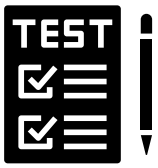
Disulfiram, by blocking superoxide dismutase, can increase the risk of oxygen toxicity, and should not be used concurrently with HBOT. Other medications that may cause concern for seizures include the following list:

- Antidepressants
  - Tricyclic antidepressants (e.g., amitriptyline, nortriptyline)
  - Selective serotonin reuptake inhibitors (e.g., fluoxetine, sertraline)
  - Serotonin-norepinephrine reuptake inhibitors (e.g., venlafaxine, duloxetine)
  - Bupropion/Wellbutrin® is especially notable for its seizure risk
- Antipsychotics
  - Clozapine
  - Chlorpromazine
  - Olanzapine
- Stimulants
  - Amphetamines (e.g., Adderall)
  - Methylphenidate (e.g., Ritalin)
- Antibiotics
  - Fluoroquinolones (e.g., ciprofloxacin, levofloxacin)
  - Imipenem
- Anesthetics and Analgesics
  - Lidocaine at high doses
  - Tramadol: especially in overdose or when combined with other serotonergic agents
- Recreational Drugs
  - Cocaine
  - Methamphetamine
- Miscellaneous Medications
  - Theophylline: commonly used in respiratory conditions
  - Meperidine: a pain medication with neurotoxic metabolites
  - Isoniazid: used for tuberculosis

The above listed drugs do not rule a patient out of hyperbaric oxygen therapy. Disulfiram is the only medication with a seizure risk that has made it on the relative contraindications list for HBOT.

Procedures

If the patient is observed or complains of any unusual neurologic symptoms, have the patient take an air break. Immediately, notify the physician supervising the treatment. Under the direction of the physician, consider decreasing the pressure in the chamber or discontinuing the treatment. In the case of a seizure, do not decompress the patient until seizure activity ceases (postictal phase). In diabetic patients, check a blood glucose level to rule out hypoglycemia as the source of the seizure. The patient is sent to the emergency room for a seizure work up. If the seizure is secondary to oxygen toxicity, the patient can resume HBOT. Prior to the next treatment incorporate an air break or more air breaks in the treatment protocol. If a patient has a seizure that is not due to oxygen toxicity, the cause of the seizure should be determined and medically managed using anticonvulsant prophylaxis prior to returning to HBOT.



Name: _____

Date: _____

Post-Test: Seizures

1. Patients will always exhibit one or more signs/symptoms prior to having a seizure in the chamber.

True or False

2. Initially described by _____ in the late 19th century, exposure to high levels of oxygen can lead to acute oxygen toxicity.

A. Dan Kelly
B. Antonine Lavoisier.
C. Paul Bert
D. Ida Boerema

3. Immediately decompress a patient that begins seizing.

True or False

4. Most seizures that occur in the hyperbaric chamber are due to oxygen toxicity.

True or False

May – UHMS, CMS, and Insurance Medical Policies

Abbreviations:
UHMS- Undersea Hyperbaric Medical Society
CMS- Centers for Medicare & Medicaid Services

UHMS Approved Indications

- 01. Air or Gas Embolism
- 02a. Carbon Monoxide Poisoning
- 02b. Carbon Monoxide Poisoning Complicated by Cyanide Poisoning
- 03. Clostridial Myositis and Myonecrosis (Gas Gangrene)
- 04. Crush Injury, Compartment Syndrome, and Other Acute Traumatic Ischemias
- 05. Decompression Sickness
- 06a. Arterial Inefficiencies: Central Retinal Artery Occlusion
- 06b. Arterial Inefficiencies: Enhancement of Healing in Selected Problem Wounds
- 07. Severe Anemia
- 08. Intracranial Abscess
- 09. Necrotizing Soft Tissue Infections
- 10. Osteomyelitis (Refractory)
- 11. Delayed Radiation Injury (Soft Tissue and Bony Necrosis)
- 12. Compromised Grafts and Flaps
- 13. Acute Thermal Burn Injury
- 14. Idiopathic Sudden Sensorineural Hearing Loss
- 15. Avascular Necrosis (Aseptic Osteonecrosis)

CMS Approved Indications

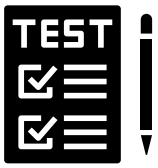
- Acute Carbon Monoxide Intoxication
- Decompression Illness
- Gas Embolism
- Gas Gangrene
- Acute Traumatic Peripheral Ischemia
- Crush Injuries and Suturing of Severed Limbs
- Progressive Necrotizing Infections (Necrotizing Fasciitis)
- Acute Peripheral Arterial Insufficiency
- Preparation and Preservation of Compromised Skin Grafts
- Chronic Refractory Osteomyelitis
- Osteoradionecrosis
- Soft Tissue Radionecrosis
- Cyanide Poisoning
- Actinomycosis
- Diabetic Wounds of the Lower Extremities

Many insurances dictate either the CMS or UHMS approved indications in their medical policy. However, they may add or subtract indications. This is why it is crucial that we consult the medical policy for patients to ensure we follow their medical policy. Oftentimes we will receive calls that are not a common indication for hyperbaric. A good rule of thumb is to obtain their insurance details and review their medical policy to confirm their candidacy for hyperbaric oxygen therapy. It's also important to remember that just because it's listed on the medical policy, it does not mean there aren't still elements of medical necessity that need to be met or that the indication is appropriate in the outpatient setting.

How do you check an insurance medical policy? Finding a medical policy is not difficult. Often the back of the insurance card will have a website where you can find this information. If not, a simple google search of the insurance plan followed by the key phrase "medical policy" should lead you to their page where you can then search for "hyperbaric." If you cannot find a posted medical policy online, you may be able to use the associated insurance portal or call the provider line for that insurance and provide the ICD 10 codes to have an agent reference their policy.

Sources:

- HBO Indications - Undersea & Hyperbaric Medical Society (uhms.org)
- NCD - Hyperbaric Oxygen Therapy (20.29) (cms.gov)



Name: _____

Date: _____

Post-Test: UHMS, CMS, and Insurance Medical Policies

1. Idiopathic Sudden Sensorineural Loss is an approved indication. (True or False? Explain below.)

_____

_____

2. All approved indications by CMS are able to be treated in an outpatient setting. (True or False?)

3. Name an indication that is on the UHMS list but is not on the CMS list.

_____

June - Clinical and Non-Clinical Emergencies and Preparedness

Every emergency should be handled in a calm, collected, comprehensive manner. The best way to ensure this is to practice and know the emergency procedures! We perform clinical emergency drills quarterly and fire drills semi-annually in the hyperbaric center, per SerenaGroup® Policies and Procedures; however, every hospital system may have a different standard so make sure you are aware of what is necessary for your center to be compliant. Medical emergencies such as seizures, respiratory distress, hypoglycemia, and oxygen toxicity put patients at severe risk that could lead to injury or death. Non-clinical or environmental emergencies such as fire, active shooter, aggressive patients, and hospital evacuations or lockdowns are equally as important to practice. In the event of any emergency, you should know how to manage the hyperbaric department. Emergency drill cards are located on each chamber. All drills that are performed should be documented and saved in your center's safety binder.

Preventing Fires in the Chamber Room

- Mandatory no smoking/oxygen in use signs
- Prohibited items poster easily located
- Checklist reviewed with each patient prior to every dive
- Grounding (chamber, gurney, wrist strap)
- Anti-static flooring or cleaner
- Humidifier
- Use of hyperbaric only linens
- No floor or low electrical outlets
- No power strips or unauthorized electrical devices plugged in in chamber room
- Fire drills performed and documented
- Daily and weekly maintenance performed, and any questions, concerns, or inconsistencies reported to the National Safety Director and Hyperbaric Service Technician
- Annual Preventative Maintenance performed by Hyperbaric Service Technician

Preventing Hypoglycemia

- Check the blood glucose level of diabetic patients pre and post hyperbaric treatment
- Make sure blood glucose is above 100 mg/dL or whatever level the overseeing physician is comfortable with for that patient. 120 mg/dL is

SerenaGroup®'s ideal pre-treatment number, but not for all patients. Cases in which diabetes is managed, 100 mg/dL may be sufficient, but in an uncontrolled diabetic or a patient that admits to only having had sugary cereal with their insulin that morning, an elevated blood glucose level may be more ideal

Preventing Oxygen Toxicity

- Treat patients at 2.4 ATA or below to lower the likelihood of oxygen toxicity, unless a higher ATA is required
- Incorporate air breaks in treatment protocols (SerenaGroup® recommends two 5-minute air breaks, 30 minutes apart)
- Know the signs and symptoms of oxygen toxicity
  - Blurry vision
  - Coughing
  - Chest pain
  - Confusion
  - Dizziness
  - Feeling of unease
  - Muscle twitching in hands and face
  - Nausea
  - Seizures
  - Throat irritation
  - Trouble breathing

Preventing Barotrauma

- Patients should be treated at a standard rate of 1.5 psi/minute unless otherwise ordered by their physician
- Lower the set rate if patients have difficulty equalizing their ears during descent or complain of tooth squeeze, pain in the sinus cavity areas, and/or pain in the ears
- If a patient experiences respiratory distress, abort treatment
- If a patient is complaining of difficulty equalizing, lower the set pressure and wait for the pressure to decrease, guide the patient through equalizing techniques until their ears "pop" or are no longer uncomfortable, then attempt pressurization again. It is suitable to attempt this approximately three times before aborting treatment

Emergency Procedures

Pneumothorax

Signs and Symptoms:

- Sudden, stabbing chest pain
- Sudden shortness of breath
- Uneven chest excursion during respiration
- Increasing respiratory distress
- Deviated trachea
- Distended neck veins
- Acute cardiovascular changes

1. Halt further pressure reduction immediately. Note time and complaint
2. Notify hyperbaric physician
3. Increase pressure slightly to relieve symptoms
4. Prepare chest tube tray
5. Once all necessary thoracenthesis equipment is assembled, decompress patient as ordered
6. Inform patient of what is suspected and its likely required management
7. Order STAT chest x-ray

SerenaGroup

Oxygen Toxicity

Premonitory signs & symptoms of oxygen toxicity:

1. Immediately convert patient to air breathing. (Note complaint and time of occurrence)
2. Within 1-2 minutes of patient beginning air breathing, ask patient if complaint has resolved, improved, remained the same or worsened
3. If patient complaint/problem has resolved/improved - have patient complete an entire air break (10 minutes); the decision to continue or abort therapy will rest with the hyperbaric physician. It is important that staff maintain direct visual observation of patient throughout the ascent
4. If patient complaint/problem is unresolved or unchanged return patient immediately to surface pressure while patient continues breathing from air mask
5. With seizure activity DO NOT reduce to increase pressure until free air movement is clearly established

SerenaGroup

Uncontrollable Depressurization

Should the automatic pressure control system malfunction and the chamber starts depressurizing perform the following steps:

1. Notify the patient that the chamber is depressurizing
   a. Warn not to hold breath
2. Flip the system NO/OFF switch to the OFF position
3. Adjust the rate of depressurization with the VENTILATION CONTROL valve
   a. The rate of depressurization can be slowed slightly by turning the ventilation control valve fully clockwise, to the minimum setting
4. When chamber pressure reaches zero (0), open the chamber door

SerenaGroup

Oxygen Leak

- Pressurize the chamber to 30psig (3 ATA)
- Use snoop or an equivalent leak testing solution
  - (a few drops of soap or detergent mixed with water for example)
- Leak-check all control and hose connections
- Tighten all connections that leak
- If unable to stop leaking, contact National Safety Director

WARNING!
Before tightening the leak fittings, make sure that all pressure is relieved

SerenaGroup

Cardiopulmonary Arrest

- Activate hospital code system. Note time of occurrence
- Turn set pressure to zero
- Emergency decompress the chamber. Observe patient continually
- Move patient away from chamber
- Remove stretcher mattress, sheets, gown and blankets from patient and stretcher (or patient may be moved to another stretcher if available)
- Assist code team as required
- Document on code record.
- Complete charting as time permits

NOTE: Defibrillation/Cardioversion should be held until the patient is clear of the chamber entrance and all linens and mattress removed

SerenaGroup

FIRE

RACE = Rescue, Alarm, Contain, Escape/Extinguish

In Hyperbaric Facility:

- Put on smoke hood
- Turn Chamber oxygen valve off
- Remove anyone in immediate danger
- Activate hospital alarm
- Contain fire (extinguish with hand held equipment)
- Inform patient
- Turn chamber master valve off - remain by chamber
- When immediate flames contained, open door and remove patient
- Evacuate room and close doors
- Turn off main zone value (in hall)

In-Chamber Fire:

- Do not remain at either end of the chamber
- Emergency decompress the chamber
- Turn chamber oxygen value off
- Activate hospital alarm
- Unplug and/or turn off all electrical equipment
- Notify medical director and nurse manager

In the immediate/adjacent area:

- Call security
- Ensure doors to the HBO room are closed
- Inform patients and decompress at 5 psi/min
- Evacuate area if warranted
- Resume treatments when possible, and when cleared by hospital emergency personnel

SerenaGroup

Emergency Procedures Cont.

Emergency Decompression

Any situation where it is necessary to have the most rapid access possible to the patient:

1. Set chamber pressure to zero
2. Inform patient
3. Turn master valve to EMERGENCY VENT 3 sec on/3 sec off
4. Open door when pressure indicator shows black
5. Remove patient, proceed as ordered and patient's condition dictates
6. Consider STAT chest x-ray to rule out pulmonary barotrauma

SerenaGroup

Safety Pin Jam Communication Failure

Door Safety Pin Jammed

If the chamber door will not open with the chamber pressure gauge showing zero, the pressure safety lock pin may be jammed in the extended position.

To release the safety lock pin:

1. Insert a blunt instrument (pencil, etc.) into the hole
2. Push safety lock pin into the retracted position.
3. Note this in the maintenance log, and inform nurse manager

Communication Failure

1. Use cue-cards to advise patient of communication failure
2. Begin ascent to surface pressure, continue to communicate with patient via cue-cards
3. Report failure to the nurse manager and Clinical Engineering

SerenaGroup

Failure of Oxygen Supply

In the event that the oxygen supply/storage system is depleted or interrupted during operation, perform the following procedure:

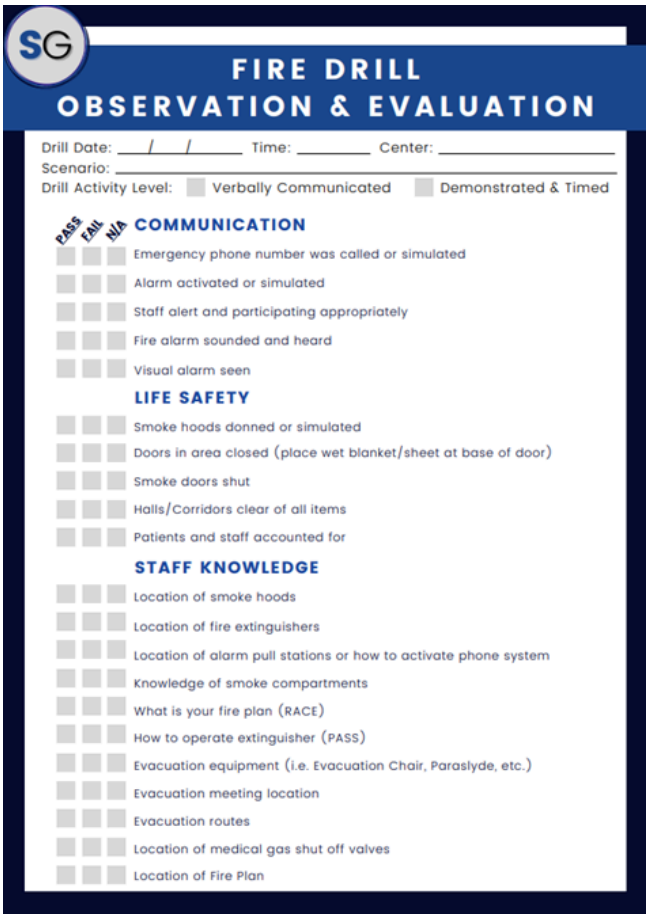
1. Notify the patient that the chamber is depressurizing
   a. Depressurization will already be in progress - when loss of supply pressure occurs, the chamber will automatically begin depressurizing by venting off through the ventilation control valve
2. Flip the system ON/OFF switch to the OFF position
3. Adjust the rate of depressurization with the VENTILATION CONTROL valve
   a. The rate of depressurization can be slowed somewhat by turning the ventilation control valve fully clockwise to the minimum setting
4. When chamber pressure reaches zero (0), open chamber door

Uncontrolled Pressurization

If the automatic pressure control system malfunctions and the chamber starts pressurizing, perform the following steps:

1. Flip the system ON/OFF switch to the OFF position
   a. This will stop chamber compression and start the decompression of the chamber
   b. The rate of decompression can be controlled by opening (increase) or closing (decrease) the vent value
2. Notify the patient that the treatment has been aborted, and that the chamber is depressurizing
3. Adjust the rate of depressurization with the VENTILATION CONTROL valve
4. When chamber pressure reaches zero (0), open the chamber door

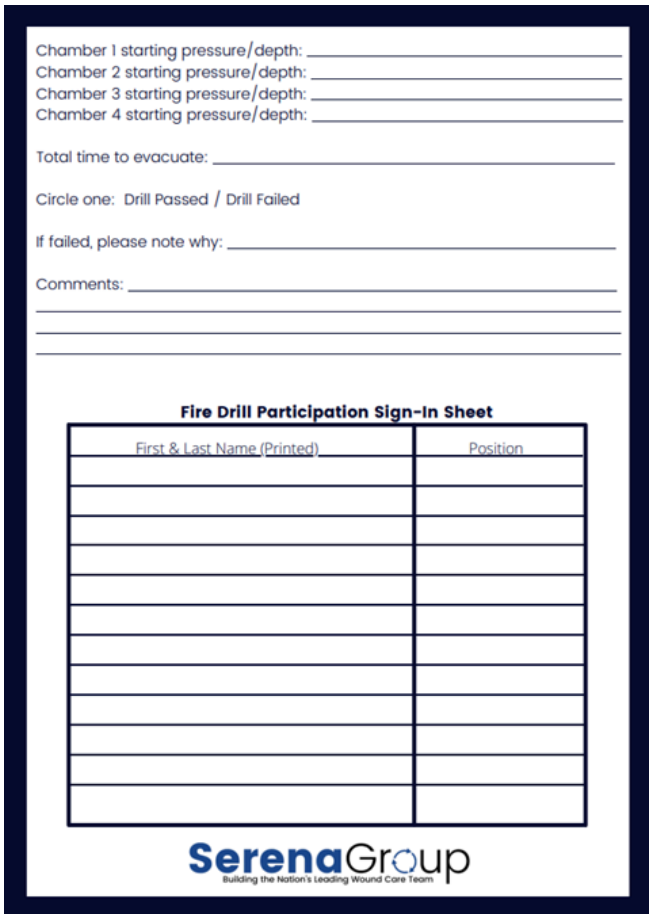
Use the below SerenaGroup Fire Drill Observation and Evaluation Form



FIRE DRILL
OBSERVATION & EVALUATION

Drill Date: ___/___/___ Time: _____ Center: _____
Scenario: _____
Drill Activity Level: ☐ Verbally Communicated ☐ Demonstrated & Timed

PASS	FAIL	N/A	COMMUNICATION
☐	☐	☐	Emergency phone number was called or simulated
☐	☐	☐	Alarm activated or simulated
☐	☐	☐	Staff alert and participating appropriately
☐	☐	☐	Fire alarm sounded and heard
☐	☐	☐	Visual alarm seen
			LIFE SAFETY
☐	☐	☐	Smoke hoods donned or simulated
☐	☐	☐	Doors in area closed (place wet blanket/sheet at base of door)
☐	☐	☐	Smoke doors shut
☐	☐	☐	Halls/Corridors clear of all items
☐	☐	☐	Patients and staff accounted for
			STAFF KNOWLEDGE
☐	☐	☐	Location of smoke hoods
☐	☐	☐	Location of fire extinguishers
☐	☐	☐	Location of alarm pull stations or how to activate phone system
☐	☐	☐	Knowledge of smoke compartments
☐	☐	☐	What is your fire plan (RACE)
☐	☐	☐	How to operate extinguisher (PASS)
☐	☐	☐	Evacuation equipment (i.e. Evacuation Chair, Paraslyde, etc.)
☐	☐	☐	Evacuation meeting location
☐	☐	☐	Evacuation routes
☐	☐	☐	Location of medical gas shut off valves
☐	☐	☐	Location of Fire Plan



Chamber 1 starting pressure/depth: _____
Chamber 2 starting pressure/depth: _____
Chamber 3 starting pressure/depth: _____
Chamber 4 starting pressure/depth: _____

Total time to evacuate: _____

Circle one: Drill Passed / Drill Failed

If failed, please note why: _____

Comments: _____

Fire Drill Participation Sign-In Sheet

First & Last Name (Printed)	Position

SerenaGroup
Building the Nation's Leading Wound Care Team

Use the below SerenaGroup Emergency Drill Observation and Evaluation Form

EMERGENCY DRILL
OBSERVATION & EVALUATION

Drill Date: ___/___/___ Time: _____ Center: _____

Scenario: _____

Drill Activity Level: ☐ Verbally Communicated ☐ Demonstrated & Timed

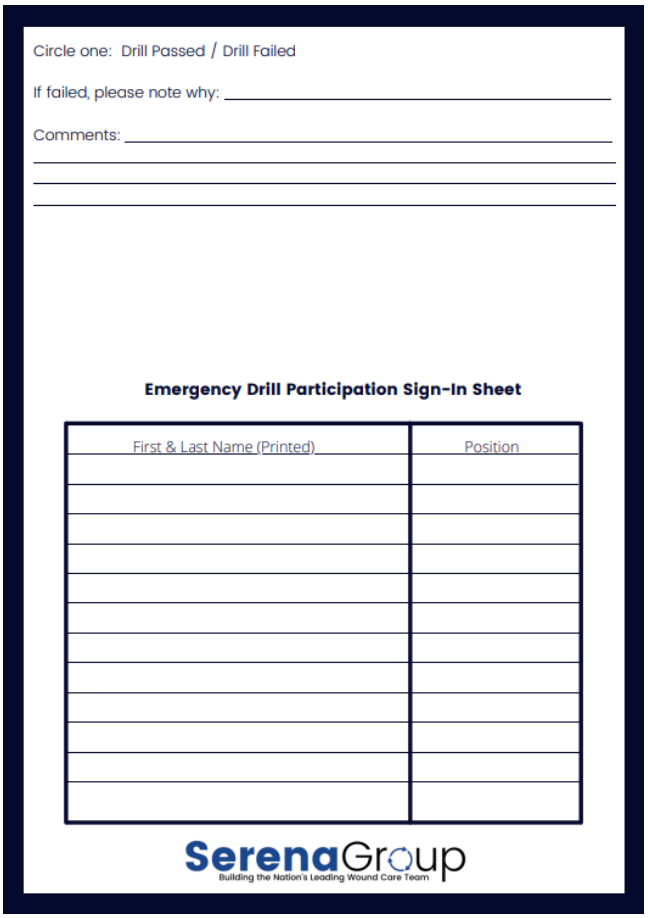
PASS	FAIL	N/A	COMMUNICATION
☐	☐	☐	Emergency phone number was called or simulated
☐	☐	☐	Alarm activated or simulated
☐	☐	☐	Staff alert and participating appropriately
☐	☐	☐	Simulate communication and explanation to patient

LIFE SAFETY

☐	☐	☐	Halls/Corridors clear of all items
☐	☐	☐	Patients and staff accounted for

STAFF KNOWLEDGE

☐	☐	☐	Location of alarm pull stations or how to activate phone system
☐	☐	☐	Evacuation equipment (i.e. Evacuation Chair, Paraslyde, etc.)
☐	☐	☐	Evacuation meeting location
☐	☐	☐	Evacuation routes
☐	☐	☐	Appropriate and correct responses to the scenario
☐	☐	☐	Verbalized or practiced decompression specific to the scenario
☐	☐	☐	Location of chest tube tray
☐	☐	☐	Location of defibrillator
☐	☐	☐	Safety measures taken or simulated if defibrillation is required



Circle one: Drill Passed / Drill Failed

If failed, please note why: _____

Comments: _____

Emergency Drill Participation Sign-In Sheet

First & Last Name (Printed)	Position

SerenaGroup
Building the Nation's Leading Wound Care Team

For further procedural guidelines regarding emergencies and preparedness, review the SerenaGroup® Policies and Procedures located in every center and online at serenagroupinc.com on the member's portal. Full page copies of these forms can be found on the member's portal.

Name: _____

Date: _____

Post-Test: Clinical and Non-Clinical Emergencies and Preparedness

1. Per SerenaGroup® guidelines, how often should a fire drill be performed?

a. Monthly
b. Quarterly
c. Biannually
d. Yearly

2. Name 3 measures taken to prevent fires in the chamber room.

_____

_____

_____

3.Who has responsibility for maintaining the Hyperbaric Center's Safety Binder?

_____

4.An announcement comes over the loudspeaker to initiate lockdown procedures. The hyperbaric technician should _____

a. Emergently decompress the patient (2 minutes)
b. Decompress the patient at the normal rate of 1.5 psi/min
c. Decompress the patient at an increased rate as tolerated
d. Wait for verification of why the facility is being locked down to determine if your area is threatened or at-risk

5. If you suspect oxygen toxicity, you should put the patient on an air break and abort the treatment.

True or False

July - What Can and Cannot Go in the Chamber?

This question can confound HBO techs daily: some have gone to the extreme of removing all medical related dressings and skin barriers prior to HBOT; with the thought process being, you cannot be too safe. This is not necessarily factual. You do run the risk of making the patient's wound worse by drying it out and exposing it to the atmosphere, as well as denying the patent a treatment that a physician has deemed necessary.

"The physician or surgeon in charge, with the concurrence of the safety director, shall be permitted to use prohibited items in the chamber that are one of the following:

1. Suture material
2. Alloplastic devices
3. Bacterial barriers
4. Surgical dressings
5. Biological interfaces" (NFPA 14.3.5.4.3)

The answer lies in the balance between the risks associated with the dressing and its potential benefits in treating the wound. First ask, "is the dressing necessary?" If the answer is no, the dressing is removed prior to treatment. If the answer is yes, decide whether to cancel the treatment or mitigate the risk.

When evaluating a dressing it is important to first understand the roll of fuel in the chemical reaction know as fire. Normally this reaction is between oxygen in the atmosphere and some sort of fuel (wood or gasoline, for example). Of course, wood and gasoline do not spontaneously catch on fire just because they are surrounded by oxygen. Fuel must be heated to its ignition temperature for combustion to occur. The reaction will keep going as long as there is enough heat, fuel, and oxygen. This is known as the fire triangle.

Fuels can be solids, liquids or gases. During the chemical reaction that produces fire, fuel is heated to such an extent that (if not already a gas) it releases gases from its surface. Only gas can be used as fuel. Gas is made up of molecules (groups of atoms). When these gases are hot enough heated molecules are loosened, moving apart to form a gas. The gas molecules combine with oxygen in the air resulting in fire. This is important for us for two reasons: first they hyperbaric environment is 100% oxygen under pressure. There are 15 times more molecules of oxygen available to "mix" with molecules

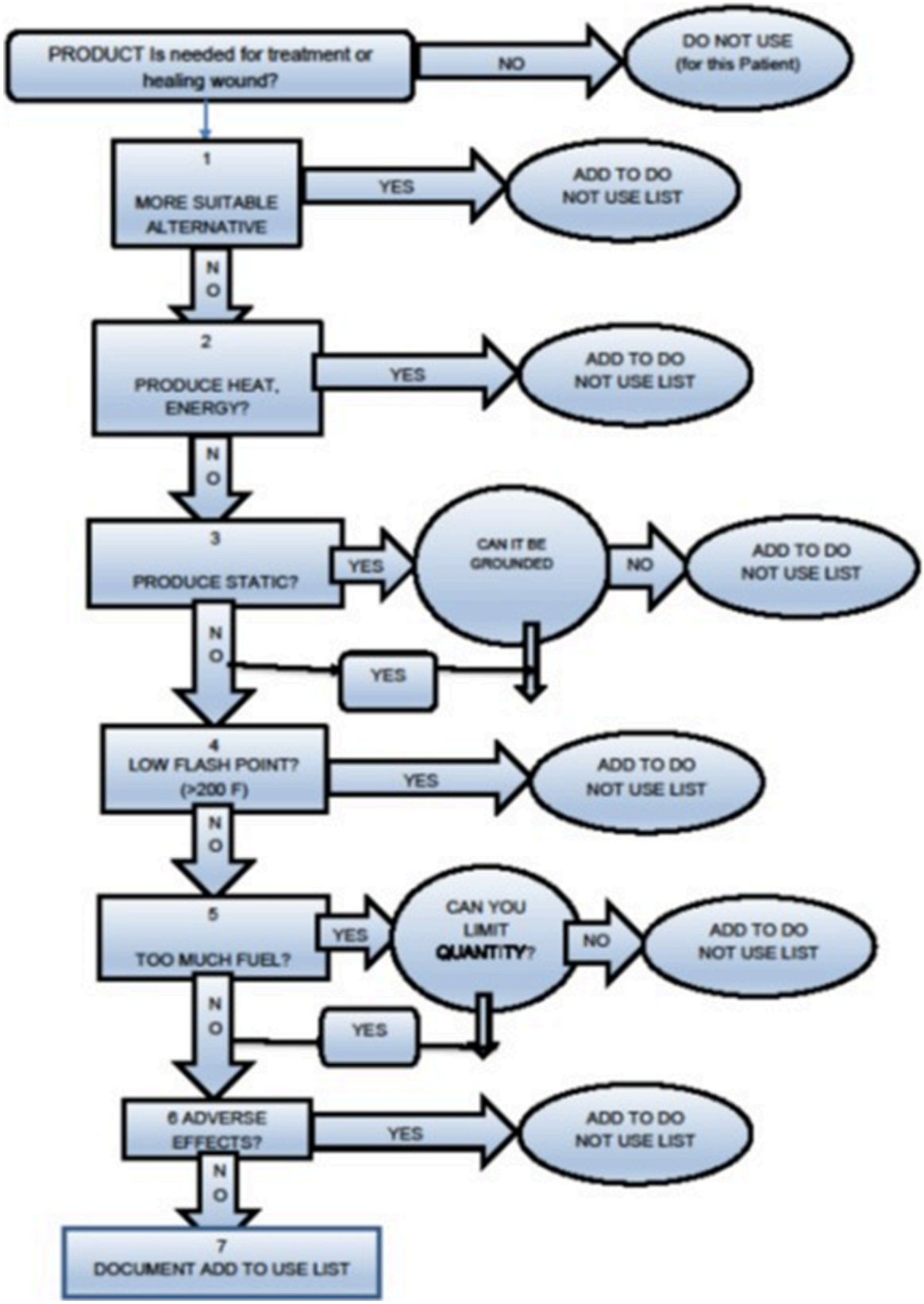
of fuel. This lowers the heat required for combustion, or flash point. The second factor is the need to convert fuel to gas, meaning that any product that evaporates or 'off gases' at room temperature becomes exceptionally rich fuel as no heat is required to convert the solid or liquid to gas. An example of this can be found in the oily rags left in the attic that on a hot summer day spontaneously combust. This happens at temperatures as low as 120 degrees Fahrenheit in room air (21% oxygen).

Most skin and wound care products have petroleum, alcohol, or benzine base. These are all rich fuels and according to our prohibited items list should not enter the chamber. Let's examine this a little more closely. These highly flammable products are used in most cases as 'carriers'; in others words they keep the product moist or pliable for storage and once exposed to air they evaporate. Once they evaporate, they are no longer a 'rich fuel' and no longer pose an unacceptable fire risk.

Fuel is not the only consideration in deciding on whether an item can enter the chamber. We must consider the amount of fuel, potential energy sources, interactions with high dose oxygen, ability to produce a static charge, and potential damage to the chamber acrylic.

When developing a "go" or "no go" list, it is also important to consider ways to mitigate risk, minimizing the likelihood of an incident. Mitigating risk can include covering a dressing with a damp cloth, increasing the vent rate, padding over a device, and substitution with a compatible product.

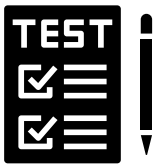
Utilizing the decision tree below, let's walk through a go/no-go list.


PRODUCT Is needed for treatment or healing wound?
NO
DO NOT USE (for this Patient)
1
MORE SUITABLE ALTERNATIVE
YES
ADD TO DO NOT USE LIST
NO
2
PRODUCE HEAT, ENERGY?
YES
ADD TO DO NOT USE LIST
NO
3
PRODUCE STATIC?
YES
CAN IT BE GROUNDED
NO
ADD TO DO NOT USE LIST
NO
YES
4
LOW FLASH POINT? (>200 F)
YES
ADD TO DO NOT USE LIST
NO
5
TOO MUCH FUEL?
YES
CAN YOU LIMIT QUANTITY?
NO
ADD TO DO NOT USE LIST
NO
YES
6 ADVERSE EFFECTS?
YES
ADD TO DO NOT USE LIST
NO
7
DOCUMENT ADD TO USE LIST

	**Unna Boot**	YES OR NO
	**Continuous Glucose Monitoring (CGM)**	YES OR NO
	**Loop Recorder Implant**	YES OR NO
	**External Fixator Device**	YES OR NO
	**Pacemaker**	YES OR NO
	**Vaseline Gauze**	YES OR NO
	**Silver Alginate**	YES OR NO

Procedure:
When evaluating a dressing for use in HBOT, employ a logical method and document the reasoning underpinning the decision. To lesser extent, consider the psychosocial results when considering low risk personal items; however, never compromise safety: when in doubt leave it out.

References:
**“Hyperbaric Medicine Practice” 2nd edition by Dr. Kindwall (pp. 417). NFPA 99, 2012 addition chapter 14 SerenaGroup policy and procedure.2020



Name: _____

Date: _____

Post-Test: What Can and Cannot Go in the Chamber?

1. A 2 x 2 Vaseline gauze dressing may be permitted in the monoplace chamber.
   True or False

2. The first question to ask is

_____

3. The physician or surgeon in charge, with the concurrence of the safety director, shall be permitted to use prohibited items in the chamber that are one of the following: (list two)

_____

_____

4. If the doctor orders a dressing, then it is safe to go in the chamber without further investigation.
   True or False

5. If a product contains a small amount of a questionable ingredient, such as a petroleum base, a good practice is simply to cover it during treatment.
   True or False

August - To Dive or NOT to Dive?

Overview:
Comorbidities can add additional complications to a patient undergoing hyperbaric oxygen therapy. It is important to know when it is safe to treat a patient and how risks can be reduced. Pre-treatment testing can rule out contraindications before the patient begins HBOT. Working with your overseeing hyperbaric physician to create the safest treatment protocol for a complex patient, can produce better outcomes.

Comorbidities that pose a risk and how:

Chronic Obstructive Pulmonary Disorder (COPD) – COPD is a respiratory disorder. Pulmonary barotrauma from lung overinflation is a rare, but potential side effect of HBOT in patients that are at risk for air trapping during decompression with active bronchospasm, mucous plugging, and bullous lung disease.

Congestive Heart Failure (CHF) – CHF is a condition in which the heart does not pump blood as well as it should. Patients with CHF, especially those with ejection fractions less than 30%, are at a higher risk for CHF exacerbation and acute pulmonary edema during HBOT due to fluid shift because of the pressure increase and decrease. Patients should not be fluid overloaded and a pre-treatment, baseline echocardiogram may be considered.

Renal Dialysis Patients – Patients receiving dialysis are at a higher risk of complications during hyperbaric treatment due to sudden fluid shifts from volume overload, causing acute pulmonary edema.

Seizure Disorders - Hyperbaric conditions can lead to central nervous system oxygen toxicity seizures. Although the chapter on seizures reminds us that most seizures occurring in the hyperbaric chamber are related to other conditions such as high fever, epilepsy, recreational drug use, or medications that lower the seizure threshold, we should be aware that patients with known seizure disorders should be medically managed with anti-epileptic medications to reduce the risk of seizures.

Procedure:
1.Complete hyperbaric consultation as normal, but ensure the physician clearing the patient is aware of the patient's comorbidities.

2.Discuss the treatment protocol with the physician, such as treating at 2.0 ATA.

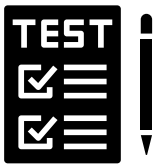
3.Make sure the pre-treatment testing that was ordered, has been carefully reviewed and signed off by the physician.

4.Obtain additional clearances if the hyperbaric physician has requested this be obtained from the patient's specialist, i.e., cardiac clearance from the patient's cardiologist or pulmonology clearance from the patient's pulmonologist.

5.Watch the patient closely during treatment. Do not hesitate to abort the treatment if the patient exhibits any sign of respiratory distress. Address any concerns with the overseeing physician, whether it is in pre-treatment vital signs, after the treatment, or anything in between.

Safe Treatment Protocols

- The clearing HBO physician will determine the treatment protocol. Dr. Serena, SerenaGroup's National Hyperbaric Safety Director, can work with the physician to answer any questions. The general recommendation from SerenaGroup for patients that are not deemed "at-risk" is 2.4 ATA for 90 minutes with one 10-minute air break with a rate set of 1.5 psi/min.
- Why do we treat patients at 2.4 ATA? The deeper you go; the more oxygen is driven into the body's compartments.
- A patient deemed "at-risk", should have a modified treatment protocol. 2.0 ATA is a therapeutic treatment pressure and does not require air breaks. Why should we treat "at-risk" patients at a lower pressure? We lower the treatment pressure to decrease the likelihood of HBOT side effects.
- When should you lower the rate set? Rate set should be lowered when patients are new to treatment and are still adjusting to pressure differentials, as well as when patients have potential air-trapping diseases.



Name: _____

Date: _____

Post-Test: To Dive or NOT to Dive?

1. The physician clears a patient with a medical history of CHF for treatment today. You take the patient's blood pressure and it is 220/108. Their BP at every other treatment has been between 112-140 systolic and 70-90 diastolic. What should you do, primarily?

a. Dive the patient but keep a watchful eye.
b. Chart the BP and make sure the physician signs off on it when he/she completes the note.
c. Notify the physician for further instruction before diving the patient.
d. Wait 15 minutes and retake the BP.
e. Do not treat the patient that day.

2."At-Risk" patients should be treated at _____ ATA unless otherwise determined by the clearing physician.

3.Which patients should have clearance by a cardiologist?

_____

4.A patient with COPD and CHF, that has an Ejection Fraction of 40% can NOT receive HBOT.

True or False

September - Chamber Care

Overview

Maintenance and cleanliness of the hyperbaric chambers are an important part of compliance and safety for patients and staff. Governing and regulatory bodies will ensure these safe practices are being performed according to policy.

Cleaning Precautions

- Hyperbaric staff will only use chamber manufacturer's approved cleaning products on acrylic surfaces.
- Hyperbaric staff will use a soft, damp, cotton cloth or towel to clean the chamber surfaces.
- Hyperbaric staff will use personnel protection equipment (PPE) and follow manufacturer's recommended procedures when handling cleaning chemicals.
- Hyperbaric staff will avoid spraying any liquid on exposed electrical circuits, including patient monitoring and grounding leads.

SerenaGroup Cleaning Policy

- Hyperbaric staff will clean the exterior of the chamber weekly.
- Hyperbaric staff will clean the chamber interior daily or immediately after treatment for exposure to multi-drug resistant bacteria or infestations. The list below is an example of infections and infestations that require cleaning after every treatment. The list is not comprehensive. The decision to clean the chamber after each use can be made by the supervising provider and or safety director.
  - Vancomycin resistant enterococcus
  - Clostridium difficile
  - Methicillin resistant staphylococcus aureus
  - Insects of the genus Cimex (Bed bugs)
  - Fleas
  - Lice
- The stretcher mattress will be cleaned after each treatment. The gurney frame will be cleaned weekly, or after becoming soiled.
- Chamber cleaning will be documented.

Procedure

1. Spray the approved disinfectant cleaning solution covering the chamber interior, beginning at the foot-end and working out through the chamber door. Remove cover plates as needed, to access protected areas. Allow the spray mist to settle for at least 20 seconds.
2. Allow the disinfectant to set according to product labeling recommendations.
3. Wipe the excess disinfectant with a soft, cotton cloth. Repeat as needed to eliminate streaking.
4. Vent the chamber to remove residual odor.
5. The non-acrylic chamber exterior can be cleaned with the detergent solution followed by a clean, warm water wipe down.
6. All other ancillary hyperbaric equipment will be cleaned after each use with the approved cleaner in accordance with manufacture's recommendations.

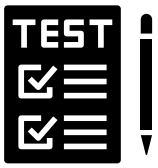
Maintenance

Chamber maintenance checklists are available on the SerenaGroup Member's Portal and in the policies and procedures. Be sure to use the correct checklist as each chamber manufacturer and chamber type has a different checklist.

- Daily (opening and closing)
- Weekly
- Annual

Conclusion

Maintaining clean chambers protects their longevity and the health of your patients. Use a cotton cloth when wiping the acrylic, such as a pillowcase, and do not clean the acrylic in a circular motion. When cleaning the acrylic be sure to check for crazing or scratches, if you notice any acrylic damage, notify your hyperbaric service technician and national safety director right away. The muffler should be removed from the chamber weekly and cleaned with soapy water and a wire brush, if necessary. Make sure that the area surrounding the chamber is always kept clean and free of dust. Approved cleaning products can be found at perrybaromedical.com and sechristusa.com. Hand sanitizers can be utilized in the hyperbaric center, but the hand sanitizer cannot have a high percentage of alcohol as alcohol-based products cannot go in the chamber. Therefore, it is not recommended to have alcohol-based hand sanitizers in the hyperbaric chamber room. Opening and closing checklists will be performed daily and documented in the chamber logs, along with weekly maintenance checklist. Annual preventative maintenance records should also be filed in the chamber logs.



Name: _____

Date: _____

Post-Test: Chamber Care

1. If the first patient of the day has MRSA, it is adequate to clean the chamber at the end of the day.
   True or False

2. Where do you find the list of approved chamber cleaners?

_____

3. How often should the chambers be cleaned?

_____

4. Daily maintenance is to be completed at the completion of patients for that day.
   True or False

5. What cloth is best to be used to wipe the acrylic?
   a. Paper towels
   b. Microfiber towels
   c. Cotton fabric

October - Physiology of HBOT for Each Indication and When to Consider Continuation

How important is it to understand the physiological effects and the 'what' and 'why' in hyperbaric oxygen? Extremely! An informed educated technician/technologist is the best way to assure patient adherence and provider buy-in that you are knowledgeable in the delivery of hyperbaric oxygen. And it makes a significant contribution to the team of care givers.

If the patient is being treated for an approved diagnosis, are you aware of what and why for treatment? Understanding the rationale of hyper-oxygenations, angiogenesis, osteogenesis, and perfusion is key to understanding your responsibilities as a technician/technologist with the patient and the provider and care team. Likewise, it is paramount to compliance.

Sharing your knowledge with patients and providers will reassure them that they are in great hands. That reassurance will increase their compliance to their treatment program. Knowing that you are experienced can also help to ease their anxiety.

Ask yourself, "If the patient asked me how this treatment is beneficial to me and my wound?" How would you answer this question? Professional training, knowledge, and experience are directly linked to helping the patient understand that being compliant is essential to "best care and practice". The more education the patient has, the more apt they are to comply.

Chronic Refractory Osteomyelitis (CROM)

- Decreased oxygen tensions, typically associated with bony infections, can be returned to normal or above normal levels during HBOT.
- Neutrophils require tissue oxygen tensions of 30-40 mmHg to destroy bacteria by oxidative killing mechanisms. Leukocyte mediated killing of aerobic Gram-negative and Gram-positive organisms, including Staphylococcus aureus, is restored when the low oxygen tensions intrinsic to osteomyelitic bone are increased to physiologic or supra-physiologic levels. Additionally, HBOT therapy has been noted to exert a direct suppressive effect on anaerobic infections.

- In addition to enhanced leukocyte activity, HBOT can enhance the transport and augment the efficacy of antibiotic action. (cefazolin and HBOT therapy produced a 100-fold greater reduction in bacterial counts than either antibiotics or HBOT alone.) Comparable effects are also seen with HBOT in mitigating localized soft tissue infections. A research study demonstrated a 46% reduction in infection resolution time from a mean of 13 to only 6 days when HBOT was added to antibiotics in the management of soft tissue infections. As infected soft tissues often act as conduits for initiating and sustaining bone infections, HBOT's benefit in ameliorating soft tissue infections may be critical to its overall efficacy in refractory osteomyelitis.
- There is evidence that HBOT enhances osteogenesis. Remodeling of bone by osteoclasts is an oxygen-dependent function. As previously noted, HBOT can restore physiologic or provide supra-physiologic oxygen tension in hypoxic bone environments, thus osteoclast function in infected bone can be improved.
- CROM is characterized by both acute and chronic sources of ischemia. HBOT has been shown to be effective in reducing tissue edema, lowering intra-compartmental pressures and ameliorating the detrimental effects of inflammatory reactions. Over the longer term, HBOT can be used to promote new collagen formation and capillary angiogenesis in both hypoxic bone and surrounding tissues. By creating a sustained increase in the arterial perfusion of previously hypoxic bone and soft tissues, HBOT can reduce the susceptibility of these tissues to recurrent infection and necrosis.

CROM in Layman's Terms

- Bone infections cause a decrease in oxygen in the bone, HBOT increases the oxygen in the bone to normal or even above normal levels.
- HBOT increases the body's natural ability to fight infections and can suppress infection.
- HBOT can enhance the transport and augment the efficacy of antibiotic. (basically, making the antibiotic work better and get to where we need it to go)
- Osteomyelitis creates ischemia in the bone, causing necrosis. HBOT stimulates osteoclast function, making the bone stronger and rebuilding it after damage caused by osteomyelitis, essentially creating osteogenesis.
- HBOT can be used to promote new collagen formation and capillary angiogenesis in both the bone and surrounding tissues.
- By improving the health of the bone and surrounding soft tissues, the likelihood of Osteomyelitis recurring is reduced. And, as we know, the benefits of hyperbaric are usually lasting.

CROM and HBOT

- Initially, 20-30 treatments may be ordered. Reassessments every 10 treatments.
- We should consider continuation when our documentation supports that the patient is showing signs of improvement and/or their physician can base their judgement on the severity of disease noted on diagnostic imaging.
- HBOT should be stopped if/when we can no longer justify that the patient is improving or needs to improve.
- For a patient WITH a wound, this documentation may look like “exposed bone has started to cover over with soft tissue after 30 treatments of HBOT. Will continue HBOT to promote osteogenesis and bone and ulcer healing, as well as to decrease the likelihood of Osteomyelitis recurrence.”
- For a patient WITHOUT a wound, the documentation may need to reference follow up imaging to be supportive of continuation. “Patient is tolerating HBOT well and is complaining of decreased pain, due to the extent of bone damage, we will continue HBOT for an additional 10 treatments and will consider repeat imaging at that time.”
- ***HBOT does not need to be discontinued for CROM patients just because the wound heals. They’re in hyperbaric for treatment of the bone. Soft tissue is easier and faster to heal than bone.

Diabetic Foot Ulcer

- A basic pathway to non-healing is the interplay between tissue hypoperfusion, resulting hypoxia, and infection. Evidence demonstrates that intermittent oxygenation of hypo-perfused wound beds, mitigates many of these impediments and sets into motion a cascade of events that led to wound healing. Physiologically, this produces a directly proportional increase in the plasma volume fraction of transported oxygen that is readily available for cellular metabolism. Availability of substrate for oxygen dependent enzymatic reactions critical to repair and resistance to infection is even more important than normalizing metabolic rate. Furthermore, oxidants appear to be among the most important signals that control the healing process, and this may be another mechanism for the benefits of HBOT in hypoxic wounds. Oxygen diffusion varies in a direct linear relationship to the increased partial pressure of oxygen present in the circulating plasma caused by HBOT. This significant level of hyperoxygenation allows for the reversal of localized tissue hypoxia, which may be secondary to ischemia or to other local factors within the compromised tissue.

- In the hypoxic wound, HBOT acutely corrects the pathophysiology related to oxygen deficiency and impaired wound healing. A key factor in HBOT's enhancement of the hypoxic wound environment is its ability to establish adequate oxygen availability within the vascularized connective tissue compartment that surrounds the wound. Proper oxygenation of the vascularized connective tissue compartment is crucial to the efficient initiation of the wound repair process and becomes an important rate-limiting factor for the cellular functions associated with several aspects of wound healing.
- Neutrophils, fibroblasts, macrophages, and osteoclasts are all dependent upon an environment in which oxygen is sufficient to carry out their inflammatory or repair functions. Improved leukocyte function of bacterial killing and antibiotic potentiation, have been demonstrated. Suppressing growth of many bacterial toxins occurs when tissue oxygen values are elevated, which occurs during HBOT. Dulling of systemic inflammatory responses and prevention of leukocyte activation and adhesion following ischemic reperfusion are effects that may persist after completion of HBOT.
- Stimulation of tissue growth supporting wound healing has also been demonstrated by a variety of mechanisms: 1) Vascular endothelial growth factor (VEGF) release is stimulated, and platelet derived growth factor (PDGF) receptor appearance is also induced. 2) Persistent increases in nitric oxide in wound fluid of diabetic ulcers is associated with increased granulation tissue formation and wound closure when patients are exposed to HBOT.
- The net result of HBOT is improved local host immune response, clearance of infection, enhanced tissue growth and angiogenesis leading to progressive improvement in local tissue oxygenation and healing of hypoxic wounds.

Diabetic Foot Ulcers in Layman's Terms

- HBOT increases oxygenation in the blood plasma and subsequently the wound, reducing hypoxia.
- All of the following are dependent upon an environment in which oxygen is not deficient in order to carry out their specific inflammatory or repair functions…
- Neutrophils (white blood cells that are your body's first line of defense in an immune response)
- Fibroblasts (the most common cell in connective tissue – collagen),
- Macrophages (white blood cell that surrounds and kills microorganisms, removes dead cells, and stimulates the action of other immune system cells.)
- Osteoclasts (initiate normal bone remodeling and mediate bone loss in pathologic conditions by increasing their resorptive activity)

- White blood cells (increase the body's natural ability to fight infection)
- Stimulation of tissue growth, creating an increase in granulation tissue and wound healing.
- Overall, improved immune response, clearance of infection, enhanced tissue growth, and angiogenesis lead to progressive improvement in wound healing.

DFU and HBOT

- Initially, 20-30 treatments may be ordered. Reassessments every 10 treatments.
- The hyperbaric provider should consider continuation when we can document improvement with HBOT, such as decrease in wound size, increase in granulation tissue or healthy bleeding.
- Based on medical necessity, HBOT should be stopped if/when the wound is no longer showing signs of improvement or is healed.
- ***The goal of HBOT is NOT to treat the wound until closure. The goal is to stimulate healing, reduce the risk of amputation, fight infection.

Delayed Radiation Injury

- Because a consistent cause and manifestation of radiation injury is vascular obliteration and stromal fibrosis, the known impact of hyperbaric oxygen in stimulating angiogenesis is an obvious and important mechanism whereby HBOT is effective in radiation injury. HBOT induces neovascularization in hypoxic tissues. Marx has demonstrated the enhanced vascularity and cellularity in heavily irradiated tissues after hyperbaric oxygen therapy by comparing histologic specimens from patients pre- and post- hyperbaric oxygen.
- The impact of hyperbaric oxygen in terms of its beneficial effects in irradiated tissues:
  - Hyperbaric oxygen stimulates angiogenesis and secondarily improves tissue oxygenation
  - Hyperbaric oxygen reduces fibrosis

Delayed Radiation Injury in Layman's Terms

- Radiation kills everything in its path, good or bad.
- HBOT stimulates angiogenesis, growing new blood vessels. This improves tissue oxygenation.
- HBOT improves vascularity in irradiated bone.
- HBOT reduces fibrosis (fibrosis is thickening or scarring of tissue.)

Marx Protocol for Osteoradionecrosis (ORN)

- Preventative ORN
  - 20 pre-operative treatments
  - 10 post-operative treatments
- Confirmed ORN
  - 30 per-operative treatments
  - 10 post-operative treatments

If there is concern for healing after the initially prescribed protocol, continuation may be considered with appropriate documentation to support further HBO treatments. Such as "mandible is still exposed after extractions and debridement of mandible. Will order an additional 10 HBO treatments to support healing and to prevent further complications of ORN or infection."

Soft Tissue Radionecrosis and When to Consider Continuation

- Initially, 30 treatments may be ordered. Reassessments every 10 days.
- We should consider continuation when we can justify improvements with HBOT but still aren't out of the "danger zone" for backsliding/wound regression.
- HBOT should be stopped if/when wound heals or the wound is not responding to HBOT at any 10 treatment assessment.

Compromised/Failed Flap/Graft

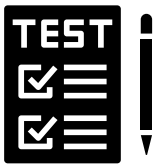
- If a flap is found to have less than adequate oxygen after it has been transferred, hyperbaric oxygen can help maximize the viability of the flap or graft while vascularization takes place which can reduce the need for repeat flap procedures.
- Mechanisms underlying these beneficial effects include increased oxygenation, improved fibroblast function, neovascularization, and amelioration of ischemic reperfusion injury by reducing post-operative edema and limiting venous congestion, while accelerating angiogenesis.

Compromised/Failed Flaps/Grafts

- Flaps and grafts are one of the only indications for hyperbaric in the outpatient setting that are considered to be acute, because flap/graft salvage has to be done quickly. ("Time is tissue"- the more time that passes without adequate perfusion, the more tissue will die)
- When blood flow is reintroduced to an area, cells can swell, burst, and die.

When to Consider Continuation for Flap/Graft

- Initially, 5-10 treatments may be ordered. Reassessments every day. This is different from our normal assessments because we are checking for signs that the graft or flap is perfusing and starting to take.
- We should consider continuing HBOT until we see evidence of revascularization/perfusion.
- HBOT should be stopped if/when the wound is no longer dusky, cold, purple, necrotic and has shown signs of integrating with healthy blood flow or the opposite, if the flap or graft has completely necrosed and needs surgical intervention to repeat the procedure or debride the necrotic tissue. At that time, we may need to consider a new series of HBOT for a new compromised graft/flap.
- ***Again, the goal is not to treat them until complete healing, but to get them on the path to where the graft or flap can survive. More than 20 treatments may be difficult to justify medical necessity.



Name: _____

Date: _____

Post-Test: Physiology of HBOT for Each Indication and When to Consider Continuation

1. How does hyperbaric work for a Wagner Grade 3 Diabetic Foot Ulcer?

_____

2. When should continuation of treatment be discussed?

_____

3. Define "Osteogenesis":

_____

November - Diabetes Management for the Hyperbaric Patient

Diabetic patients need to manage their blood glucose level. The level needs to be at least 110 mg/dL before they go in the hyperbaric chamber, unless otherwise stated by the attending physician. The ideal minimum pre-treatment number is 120 mg/dL. It is also important to make sure blood glucose levels are not too high. Maximum numbers vary but encourage the patient to try to keep blood glucose levels under 180 mg/dL at all times unless otherwise suggested by the patient's healthcare professional. As a hyperbaric technician, always ask diabetic patients if and what they ate prior to coming in. You should also ask if they took their medications. Both can significantly impact the patient's blood glucose levels and can help you to anticipate and prevent hypoglycemic events.

Hyperbaric can lower the patient's blood glucose significantly as a metabolic response, so it is important to make sure levels are high enough to prevent any drop in glucose from becoming a hypoglycemic medical emergency inside the chamber. Also, account for the 2-hour treatment, in which the patient will be without food.

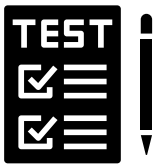
Hypoglycemia symptoms may include:

- Diaphoresis
- Fatigue
- Lightheadedness
- Shakiness
- Nausea/vomiting
- Confusion
- Unresponsiveness
- Anxiety
- Seizures

Procedure:

1. Take patient's blood glucose level upon arrival. If it is 110 mg/dL or higher, but still normal, continue with treatment. If the glucose level is lower (not a critical low = follow hospital policy), consider glucose administration.
2. Follow your hospital protocol for hypoglycemia management. This could be the administration of Glucerna, fruit juice, glucose tablets, etc.
3. Recheck the patient's blood glucose 15+ minutes after administration. If it is lower than the initial level, the attending physician may refuse the patient's treatment for the day for safety concerns of a hypoglycemic event. If the glucose has elevated above 100 (or the number your attending physician is comfortable with) continue with hyperbaric treatment. If the glucose has risen but not as high as it needs to be, with your physician's approval, you may repeat glucose administration and/or another 15+ minute recheck if the schedule allows.

***Always follow hospital protocols and the attending physician's orders!**



Name: _____

Date: _____

Post-Test: Diabetes Management for the Hyperbaric Patient

1. Name 5 symptoms of hypoglycemia:

1.
2.
3.
4.
5.

2. A diabetic patient is on treatment 15 and has never had issues with confinement anxiety but is now 1 hour into treatment and presenting with anxiety symptoms. His blood glucose was 125 mg/dL upon arrival. What should be your first 3 steps?

1.
2.
3.

3. What is your hospital's protocol for hypoglycemia management/prevention?

_____

December - Compliance Checklist and Survey Preparation

Overview

The Joint Commission specifically addresses hyperbaric oxygen chambers under Environment of Care (EC) Standard EC.02.04.03 (which addresses medical equipment inspection, testing, and maintenance), Element of Performance (EP) 10: "All occupancies containing hyperbaric facilities comply with construction, equipment, administration, and maintenance requirements of NFPA 99-2012: Chapter 14." However, aspects of these complex spaces are covered by other standards: fire safety training, in EC.02.03.01; utilities management, in EC.02.05.01; and medical gas management, in EC.02.05.09. The Joint Commission references, includes a detailed chapter (Chapter 14) on safety requirements related to hyperbaric oxygen chambers and are the source reference for this checklist. This checklist, the use of which is not required by The Joint Commission, is divided into two sections: (1) Administrative and Training Requirements and (2) Fire and General Safety and Maintenance Requirements. The checklist is not exhaustive and is not intended to be a substitute for a comprehensive training program. Our goal with providing the checklist is to help our facilities prepare for DNV or Joint Commission surveyors in the hyperbaric center. This checklist can be found on the member's portal.

QUESTION:	Y | N | NA	COMMENTS:
Administrative & Training Requirements		
If the center has one or more hyperbaric oxygen chambers, do they have a designated hyperbaric safety director, who is in charge of all hyperbaric equipment and the operational safety requirements described in Chapter 14?	☐ ☐ ☐	
Does each hyperbaric facility have a designated chamber operator and is the Center in compliance with the SG Staffing Policy?	☐ ☐ ☐	
Before each treatment, does the chamber operator record the following information? • The treatment • The occupant (patient) of the chamber • Types of gas utilized for the treatment	☐ ☐ ☐	
Does the hyperbaric safety director participate with facility management personnel and the hyperbaric physician(s) in developing procedures for operation and maintenance of the hyperbaric equipment?	☐ ☐ ☐	

QUESTION:	Y | N | NA	COMMENTS:
Does the hyperbaric safety director make recommendations for departmental safety policies and procedures? (Note: Often hyperbaric services are contracted out to a third party, and the corporate contractor will implement its own safety policies and procedures. If so, it is critical that your facility's on-site hyperbaric safety director tailor the contractor's P&Ps to the local setting.)		
Does the hyperbaric safety director have the authority to restrict or remove any potentially hazardous supply or equipment items from the chamber? Note: This should be mentioned in the safety director's job description.		
Does the organization's leadership and governing board prioritize rules, regulations, and best practices related to its hyperbaric facilities?		
Are the following issues addressed in your organization's policy? • Qualifications and training of hyperbaric personnel • (Credential Card/ Staff Competencies in current) • Adherence to regulations and other requirements for the inspection, testing, and maintenance of hyperbaric equipment • Controls regarding the conduct of personnel in and around hyperbaric chambers • A description of the apparel and footwear allowed in hyperbaric chambers • Controls pertaining to the periodic inspection of static-dissipating materials		
Are the Center personnel familiar with the content of Chapter 14? • Administrative professionals • Technical staff • Hyperbaric medicine medical director and other clinicians • Staff involved in the operation and maintenance of hyperbaric chambers (Note: The education of these personnel can be the responsibility of the on-site hyperbaric safety director. One good practice is to have a standing hyperbaric safety agenda item for routine staff meetings. Such a standard agenda item keeps the focus on establishing and maintaining a culture of safety.)		
Have the medical director of hyperbaric medicine and the hyperbaric safety director jointly developed minimum staff qualifications based on the following criteria? • Number and type of hyperbaric chambers in use • Maximum treatment capacity • Type of hyperbaric therapy typically provided (Note: SG Policy and UHMS Guidelines for Hyperbaric Facility Operation provides guidelines on staffing and training.)		

QUESTION:	Y | N | NA	COMMENTS:
Have emergency procedures specific to the hyperbaric chambers been established? (Note: These procedures should address mechanical, operational, and medical emergencies.)	☐ ☐ ☐	
Are all hyperbaric staff trained in your organization's emergency procedures? (Note: It is important to do more than conduct periodic fire drills. The hyperbaric safety director should develop a plan to conduct both didactic and performance demonstration drills so that EVERY emergency procedure is addressed at some recurring frequency.)	☐ ☐ ☐	
Have all hyperbaric staff been trained on the purpose, application, operation, and limitations of specific emergency equipment?	☐ ☐ ☐	
Are hyperbaric staff trained to control the chamber(s) and decompress occupants when all powered equipment has been rendered inoperative?	☐ ☐ ☐	
Are emergency and fire training drills specific to hyperbaric chambers held at least annually?	☐ ☐ ☐	
Are these drills worst-case-scenario drills, with all chambers occupied?	☐ ☐ ☐	
Has the Center conducted drills to address the following situations? • A medical emergency in a hyperbaric chamber • A fire in a hyperbaric chamber • Contaminated breathing gas Are the drills documented by the safety director? (Note: Hyperbaric-specific drills can be integrated into the emergency response exercises and fire drills The Joint Commission requires of all accredited health care organizations. The time required to evacuate all persons from a hyperbaric area with a full complement of chamber occupants at treatment pressure must be measured during the drills.)	☐ ☐ ☐	

Fire & General Safety & Maintenance Requirements

Does the organization ensure that any room used for hyperbaric oxygen chambers is not used for any other purpose?	☐ ☐ ☐	
Are signs posted at the entrance to every hyperbaric oxygen chamber that warn not to bring any flammable liquids, gases, or other article prohibited by Chapter 14 into the chamber? (Note: Signage placed on the door of a Class B chamber might not be noticed by the patient because the door would typically be open. It is recommended that hazard signage be posted in additional locations, such as the patient changing area.)	☐ ☐ ☐	

QUESTION:	Y | N | NA	COMMENTS:
Is a fire alarm signaling device located in the room housing the hyperbaric oxygen chamber(s)? (Note: The NFPA technical committee on hyperbaric facilities considers a telephone to be a fire alarm-signaling device. So, in the absence of an alarm pull station, a phone is an acceptable device.)		
Is the room housing the hyperbaric oxygen chambers sprinklered, using sprinkler heads of an approved type with fusible elements?		
In the event that air in the vicinity of chambers is fouled by smoke or other combustion products during a fire, is a source of breathable gas allowing unrestricted mobility available outside each chamber? Are fire and smoke escape hoods not expired?		
In case the hyperbaric oxygen chambers and the rooms housing them need to be evacuated quickly during a fire, are the chambers compliant with the following NFPA 99-2012 standards for depressurization? "Class B chambers must be capable of depressurizing from 3 ATA to ambient pressure in 2 minutes or less."		
In accordance with Chapter 14, are the following ignition sources/activities prohibited in the immediate vicinity of and within the hyperbaric oxygen chamber(s)? • Smoking and vaping • Cigarette lighters, matches, and vaping devices • Open flames • Hot objects • Personal warming devices (such as therapeutic chemical heating pads and hand warmers) • Cell phones and pagers • Personal entertainment devices • Toys that emit sparks • Paper Products • Hearing aids (batteries)		
For Class B (single-person occupancy) hyperbaric chambers, if a chamber contains more than 23.5% oxygen, does the organization ensure electrical grounding of the patient(s) by providing a high-impedance conductive pathway in contact with the patient's skin (usually in the form of a wrist strap)?		

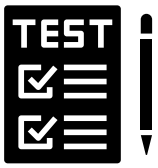
QUESTION:	Y | N | NA	COMMENTS:
Are the following restrictions/recommendations implemented regarding hyperbaric patients' clothing? • Silk, wool, and synthetic textiles or any combination of these materials (except as noted below) must not be worn in hyperbaric chambers. • Garments that are 100% cotton or a blend of cotton and polyester are allowed in Class A chambers equipped with fire protection and in all Class B chambers. (Note: Health care facilities should issue special garments meeting the above criteria for patients to wear in hyperbaric chambers. Although tighter-fitting garments are preferred, hospital gowns are permitted to be worn by patients undergoing procedures.)		
Regarding medical/surgical supplies to be used in a hyperbaric chamber, does the physician or surgeon work with the hyperbaric safety director to determine which of the following normally prohibited materials may be permitted in specific cases? • Suture material • Alloplastic devices • Bacterial barriers • Surgical dressings • Biological interfaces • Synthetic textiles (Note: If any of the above items or other Medical Devices have been placed in the chamber was a SG Risk Assessments performed and Exception to protocol Completed?		
Are flammable hair sprays, hair oils, and skin oils prohibited hyperbaric patients and staff?		
Has your organization developed a policy on safe use of gases in a hyperbaric oxygen chamber?		
Does your hyperbaric safety director ensure that all valves, regulators, meters, and similar equipment used in the hyperbaric chamber(s) are tested as part of the facility's routine maintenance program? (Note: This requirement still applies to Class B chambers. Make sure to keep up-to-date maintenance logs that demonstrate compliance with this requirement.)		
Has your organization developed a policy on safe use of gases in a hyperbaric oxygen chamber?		

QUESTION:	Y | N | NA	COMMENTS:
Are pressure relief valves tested and calibrated as part of the routine maintenance program for your organization's hyperbaric chambers? (Note: Review the annual chamber service (APM) and ensure it is documented in the service report.		
Does your facility make sure that hyperbaric chamber rooms are not used to store hazardous materials?		
Does your organization ensure that any installations, repairs, and modifications of equipment related to hyperbaric chambers meet the following criteria? • Tested under pressure • Approved by the safety director • Evaluated by Corporate Safety Director		
If power to critical electrical equipment associated with hyperbaric chambers is interrupted, can emergency electrical power be restored within 10 seconds?		
Are Class B chambers in your facility certified and stamped in accordance with criteria established by the American Society of Mechanical Engineers (ASME) in ANSI/ASME PVHO-1 Safety Standard for Pressure Vessels for Human Occupancy?		
Do staff know where the medical gas alarms are located?		
Does the organization include in its fire response plan a process for shutting off oxygen to the department and to the hyperbaric chambers?		

Additional Resources

SerenaGroup has several other additional resources that will aid in successfully complying with surveys of this nature. Some examples include:

- Annual hyperbaric competencies
- Staff coverage program
- Technician training program
- Safety director job descriptions
- Policies and procedures
- HBOT safety manual
- Adverse event record



Name: _____

Date: _____

Post-Test: Compliance Checklist and Survey Preparation

1. The HBOT Compliance Checklist is REQUIRED to be completed annually.

   True or False?

2. Name one item on the checklist.

   _____

3. Name one additional resource.

   _____

Department of Hyperbaric Medicine
Adverse Event Record

1. Ear Barotrauma
2. Sinus or Tooth Squeeze
3. Oxygen Toxicity
4. Nausea/Vomiting
5. Pneumothorax
6. Air Embolism
7. Seizure
8. Anxiety/Claustrophia
9. Diabetic Reaction
10. Other - Please Specify

Medical Record #	Adverse Event	Intervention	Comments

Safety Director: _____

Medical Director: _____

SerenaGroup
Building the Nation's Leading Wound Care Team

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