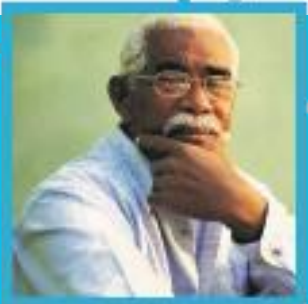


Clinical Applications of Hyperbaric Oxygen Therapy (HBOT) in Wound Care

SEPTEMBER 22, 2016

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Objectives

- To explain the basic science behind hyperbaric oxygen therapy (HBOT)
- Describe the clinical scenarios where HBOT is a useful adjunct
- Current status of HBOT in treating Traumatic Brain Injuries (TBI) and Post-traumatic Stress Disorder (PTSD)

The Basics of Hyperbaric Oxygen

The elevator speech

Hyperbaric Oxygen is a treatment in which a patient breathes 100% oxygen intermittently while inside a treatment chamber at a pressure higher than sea level (i.e. > 1 atmosphere absolute or 1 ATM). In other words, during HBOT the air pressure is raised up to three times higher than normal air pressure. Under these conditions, the patient's lungs can gather up to three times more than would be possible breathing pure oxygen at normal air pressure. The patient's blood then carries this oxygen throughout the body, stimulating the release of growth factors and stem cells.

Administration of 100% oxygen at ambient pressures causes a five-fold increase in the amount of dissolved oxygen in the blood. In HBOT, administration at 2-3 ATM increases the dissolved oxygen in blood and tissues up to 20-fold, a level high enough to sustain life without any contribution from oxygen bound to hemoglobin.

The Basics of HBOT

- Breathe 100% O²
- Chamber pressure higher than sea level and can be raised up to three times sea level
- Breathing 100% O² causes a five-fold increase in dissolved O² in blood
- HBOT at 2-3 ATM increases the O² in blood and tissues 20 fold
- Patient's blood carries O² throughout the body stimulating growth factors and stem cells
- High enough to sustain life without any hemoglobin bound O²

What's the problem?

Chronic wounds fail to proceed through the normal healing process and the result is delayed or poor wound healing.

Contributing Factors:

- Infection
- Ischemia
- Cellular senescence
- Unrelieved pressure or repetitive mechanical injury

Tissue Hypoxia

- Underlying the deterrents to normal healing is tissue hypoxia which is identified in a variety of disease states (i.e. peripheral vascular disease and diabetes mellitus).
- Correction of this local oxygen deficit is vital to successful wound care.
- To address tissue hypoxia HBOT is commonly used adjunct in advanced wound care centers.

How does HBOT work?

HBOT increases the dissolved oxygen content in blood plasma which translates into a systemic increase in reactive oxygen (oxygen free radicals) and reactive nitrogen species.

- Immediate correction of tissue hypoxia in infected, ischemic or irradiated tissue
- Stimulation and support of collagen synthesis and new blood vessel growth (angiogenesis)
- Reduction of local tissue edema by local alteration in blood flow
- Enhancement of immune function by supporting WBC-mediated microbial control and improving antibiotic effectiveness

How is HBOT provided?

Appropriately selected patients are placed in a large, clear acrylic chamber that is pressurized with 100% oxygen, typically at twice the ambient atmospheric pressure.

The patients breathe this medical gas while enjoying a nap or watching television. Ninety minute sessions are most commonly provided 5 days per week, for a total of 30-40 treatments.



Is HBOT safe for my patient?

- HBOT is safe and well-tolerated.
- Occasionally, patients will sense a pressure change or discomfort in their ears (as during a plane flight).
- More serious complications can occur, though very rarely so.
- A trained hyperbaric physician performs a comprehensive patient assessment to ensure potential candidates are screened for the prevention of such issues and also observes the patient during the actual treatment phase.

Risks of HBOT

- Ear and sinus barotrauma
- Confinement anxiety
- Hypoglycemia
- Air gas embolism
- Pneumothorax
- Central nervous system and pulmonary toxicity
- Flash pulmonary edema
- Reversible visual and refractive changes

What specific diseases or conditions benefit from HBOT?

- When combined with appropriate conventional wound care such as debridement, antibiotics, edema control, and pressure relief, many previously non-healing wounds can be managed.
- The FDA approves 14 treatment indications (most are reimbursed by CMS and private payers when the patient meets other medical necessity criteria).

What specific diseases or conditions benefit from HBOT?

1. Air or gas embolism
2. Carbon monoxide poisoning
3. Crush injury , compartment syndrome, and other acute traumatic ischemias
4. Decompression sickness
5. Arterial insufficiencies
6. Central retinal artery occlusions
7. Severe anemia
8. Intracranial abscess
9. 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

HBOT use in Traumatic Brain Injury (TBI) and Post-Traumatic Stress Disorder (PTSD)

The published conclusions of the Department of Defense (DoD) and the Veterans Administration (VA) sponsored studies on the benefits of HBOT for service members diagnosed with post-concussion syndrome have recommended ceasing the development of a promising therapy.

Post-concussion symptoms and categories

- Emotionality
- Somatic symptoms
- Cognitive symptoms
- Sleep disorders

Emotionality

- More emotional
- Sadness
- Nervousness
- Irritability

Somatic symptoms

- Headaches
- Visual problems
- Noise/light sensitivity
- Dizziness
- Nausea

Cognitive symptoms

- Attention problems
- Memory dysfunction
- Cognitive slowing
- “Fogginess”
- Fatigue

Sleep disturbance

- Difficulty falling asleep
- Sleeping less than usual

Clinical Results in Brain Injury Trials Using HBO2 Therapy: Another Perspective

Xavier A. Figueroa, Ph.D., James K. Wright, M.D.

UHM 2015, Volume 42, Number 4, pages 333-351

HBO in TBI/PTSD

Current Issues

- Confusion due to the use of non-validated controls and an unfamiliarity by many practitioners of HBOT with the experimental literature.
- Use of air sham (21% oxygen, 1.14-1.15 atmosphere absolute/atm abs.) in clinical and animal studies, instead of observational or crossover controls, has led to the acceptance of the null hypothesis (declaring that there is no effect when one is present), due to the biological activity of these “sham” controls.

HBO effects on TBI/PTSD

- Stem cell upregulation
- Modulation of inflammatory responses by HBOT
- Cellular repair and protection
- Cellular oxygen utilization: mitochondrial regulation and idling neurons

The Urgency of Now

- Current epidemic of U.S. military suicides (22+ service members a day take their lives, 44 attempt suicide) is possibly due to misdiagnosing the military TBI population with PTSD or failing to appropriately diagnose other mental health conditions.
- DoD/VA has spent at least \$9.2 billion since 2010 treating PTSD but have been unable to stem the epidemic of suicide and mental illness in veterans.

Clinical Reality

- Currently there are no treatments that can improve symptoms or cognitive performance for mild to moderate TBI/PTSD
- HBOT is safe with relatively few side effects
- Durable measurable outcomes
- Available in many centers managed by hospitals and independent clinics

HBOT in TBI/PTSD

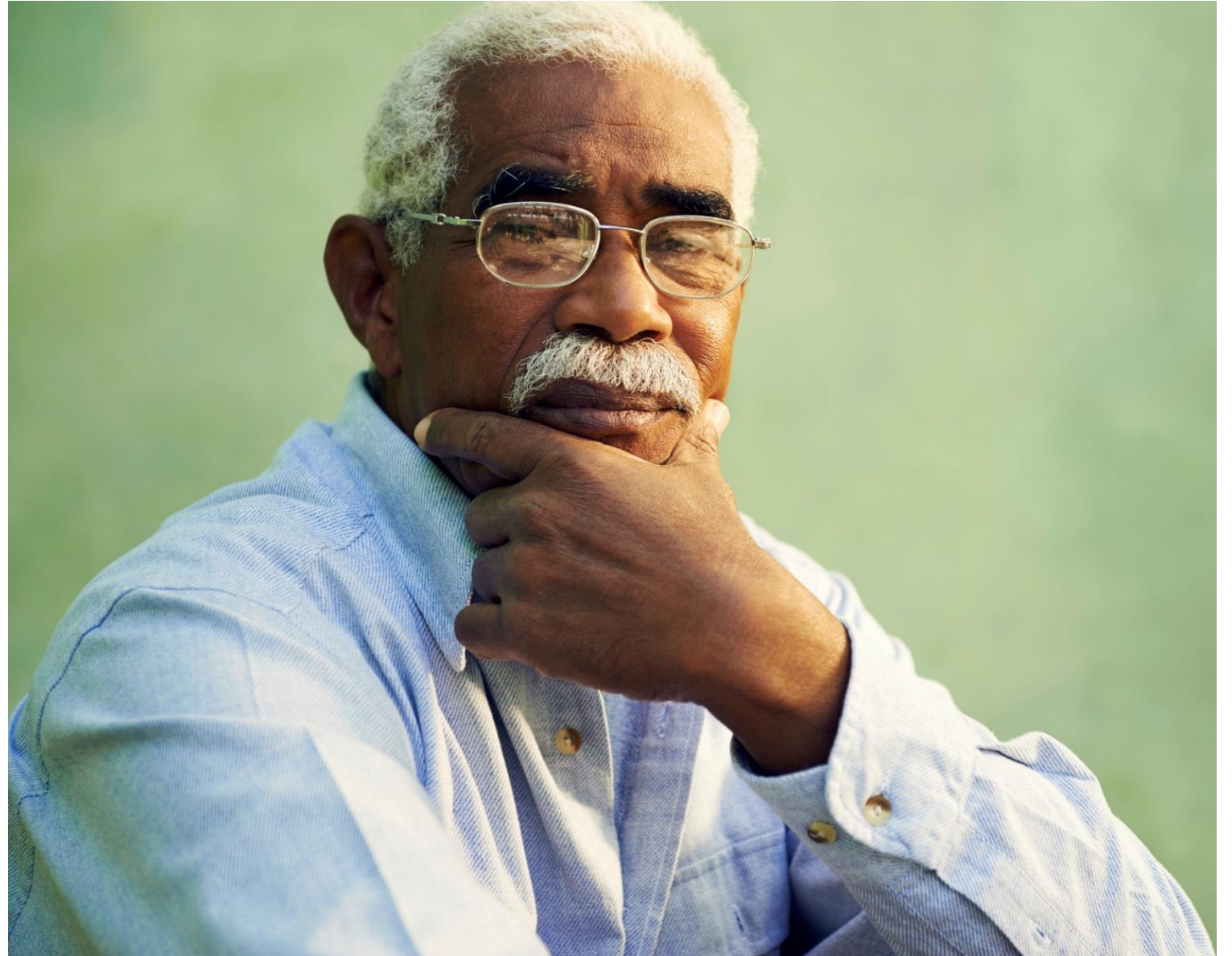
- Average 15 point jump in IQ
- 87% reduction in headaches
- 93% improvement in cognitive difficulties

Effectiveness of HBOT for blast TBI and PTSD

Significant improvements in:

- General anxiety
- Depression
- Suicidal ideation
- Memory
- Working memory
- Attention
- SPECT Brain Blood Flow Imaging
- Reciprocal reduction/elimination of psychoactive and narcotic prescription medication usage in 64%

Case Presentation



HBO for PTSD/TBI

Pros

- Safe
- Non-addictive
- Readily available
- Healing environment

HBO for PTSD/TBI

Cons

- Not validated by scientific studies
- Expensive

Next Steps?

Next Steps

Do something!!!

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Questions?