HBOT RESEARCH AND SCIENCE

MOST RECENT RESEARCH

[a] Amir Hadanny & Shai Efrati (2016): Treatment of persistent post-concussion syndrome due to mild traumatic brain injury: current status and future directions, Expert Review of Neurotherapeutics. DOI: 10.1080/14737175.2016.1205487. Persistent post-concussion syndrome caused by mild traumatic brain injury has become a major cause of morbidity and poor quality of life. Unlike the acute care of concussion, there is no consensus for treatment of chronic symptoms. Moreover, most of the pharmacologic and non-pharmacologic treatments have failed to demonstrate significant efficacy on both the clinical symptoms as well as the pathophysiologic cascade responsible for the permanent brain injury. This article reviews the pathophysiology of PCS, the diagnostic tools and criteria, the current available treatments including pharmacotherapy and different cognitive rehabilitation programs, and promising new treatment directions. A most promising new direction is the use of hyperbaric oxygen therapy, which targets the basic pathological processes responsible for post-concussion symptoms; it is discussed here in depth.

[b] Baughman Shively, S., Iren Horkayne-Szakaly, Robert V Jones, James P Kelly, Regina C Armstrong, Daniel P Perl. Characterisation of interface astroglial scarring in the human brain after blast exposure: a post-mortem case series. The Lancet, Neurology, June 2016. DOI: http://dx.doi.org/10.1016/S1474-4422(16)30057-6. In what is being called a breakthrough study, Dr. Daniel P. Perl and his team at the Uniformed Services University of the Health Sciences in Bethesda, Md., [the medical school run by the Department of Defense], have found evidence of tissue damage caused by blasts alone, not by concussions or other injuries. The New York Times calls it the medical explanation for shell shock: preliminary proof of what medicine has been saying without proof for nearly 100 years -- blasts cause physical damage, and this physical damage leads to psychological problems, i.e., PTSD. The importance of this admission cannot be overstated: this is a DOD discovery with documented evidence that blast injury [IEDs, breeching, whether in training or combat, enemy and/or friendly fire] can lead directly to physical brain damage and the accompanying effects, many of which have been heretofore diagnosed as "only PTSD."


[c] Xavier A. Figueroa, PhD and James K. Wright, MD (Col Ret), USAF Hyperbaric Oxygen: B-Level Evidence in Mild Traumatic Brain Injury Clinical Trials. (IN PRE-PUBLICATION). NEUROLOGY/701565 2016. "There is sufficient evidence for the safety and preliminary efficacy data from clinical studies to support the use of HBOT in mild traumatic brain injury/ persistent post concussive syndrome (mTBI/PPCS). The reported positive outcomes and the durability of those outcomes has been demonstrated at 6 months post HBOT treatment. Given the current policy by Tricare and the VA to allow physicians to prescribe drugs or therapies in an off-label manner for mTBI/PPCS management and reimburse for the treatment, it is past time that HBOT be given the same opportunity. This is now
an issue of policy modification and reimbursement, not an issue of scientific proof or preliminary clinical efficacy."


[e] E.G. Wolf, L.M. Baugh, C.M.S. Kabban, et al. Cognitive function in a traumatic brain injury hyperbaric oxygen randomized trial. UHM 2015, Vol. 42, No. 4, 2015. Dr. Wolf is a principle co-author of the first Army study. This recent USAF paper reanalyzing the data in the cornerstone DOD/VA/Army study concludes: "This pilot study demonstrated no obvious harm [and] both groups showed improvement in scores and thus a benefit. Subgroup analysis of cognitive changes and PCL-M results regarding PTSD demonstrated a relative risk of improvement . . . . There is a potential gain and no potential loss. The VA/Clinical Practice Guidelines define a “B evidence rating” as “a recommendation that clinicians provide (the service) to eligible patients. At least fair evidence was found that the intervention improves health outcomes and concludes that benefits outweigh harm. . . ."[emphasis added] Hyperbaric oxygen therapy for mild traumatic brain injury and PTSD should be considered a legitimate adjunct therapy if future studies demonstrate similar findings or show comparable improvement to standard-of-care or research-related treatment modalities."

[NOTE: subsequent worldwide studies already published and those underway show comparable improvements.]

1. Peer-reviewed published articles


http://www.echa.net/36-6%20UHM-P391-399.pdf


2. **Data from NBIRR-01 observational study**

3. **Peer-reviewed Israeli research on stroke and TBI, neurogenesis and angiogenesis**


4. **Animal studies showing positive effects of HBOT on brain injury**
http://online.liebertpub.com/doi/abs/10.1089/neu.2012.2510


http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0097750

5. Expert Opinion

"What the *Bleep* is going on with Hyperbaric Oxygen Therapy? Brain Health and Healing Foundation. Xavier Figueroa. PhD has been performing neurological clinical research since 1995 in the field of Alzheimer’s research, as well as basic research in neuron biology, cancer research, bioengineering and the biophysics of water in cells. He has a long history of involvement with research using hyperbaric oxygen therapy for brain injury.

**http://brainjury.org/blog/2014/05/01/what-the-bleep-is-going-on-with-hyperbaric-oxygen-therapy/  
**http://brainjury.org/blog/2014/07/03/what-the-bleep-is-wrong-with-the-dodva-hbot-studies/  

UHM 2012, Vol. 39, No. 4 – How many deaths will it take? AN EDITORIAL PERSPECTIVE. Undersea & Hyperbaric Medical Society, Inc. How many deaths will it take till they know? Monkeys, madmen and the standard of evidence. George Mychaskiw II, DO, FAAP, FACOP, Editor-in-Chief Chair, Department of Anesthesiology, Nemours Children’s Hospital, Orlando, Florida USA. The Journal of Hyperbaric Medicine is the most prestigious journal on Hyperbaric Medicine in the world. . . . . .

"Hyperbaric oxygen is a safe, easily used treatment that, in many cases, has resulted in a dramatic improvement in the symptoms of patients with [TBI]. Every day we are.... gathering more data validating its efficacy.... I feel, as do many of my colleagues, that there is sufficient clinical and research evidence to justify the use of [HBOT] as a standard-of-care treatment for [TBI] that should be reimbursed by CMS and Tricare.... I have no doubt that, over the next several years, [HBOT] will be proven beyond a reasonable doubt to be one of the most effective treatments for [TBI].... There is a preponderance of evidence now to justify the use and funding for the treatment....”


6. Data from DoD/Army studies, with responses
Summary of positive findings in Army Studies: Army medicine has run trials investigating the use of Hyperbaric Oxygen to treat and help heal Traumatic Brain Injury. They have shown that HBOT is both safe and effective: "Randomization to the chamber . . . . offered statistical and in some measures clinically significant improvement over local routine TBI care." Also: "... total scores for [both] groups revealed significant improvement over the course of the study for both the sham-control group .... and the HBO2 group....." Expert outside consultants to DOD declared that "[HBOT] is a healing environment."


7. Validating SPECT Scans to diagnose HBOT treatment before-and-after brain states

8. BLAST INJURY BIBLIOGRAPHY


Fox, TM. Reflections on Blast Incident, September 2014. Correspondence.


Blast injury, and the accompanying role of air embolism in invisible wounds to the brain, is still not widely studied and thus seldom treated. Hyperbaric Oxygen Therapy is recognized worldwide as the definitive treatment for air embolism. Air/gas embolism is already an on-label, approved indication for HBOT.

Johns Hopkins reports that the brains of Iraq and Afghanistan combat veterans who survived blasts from improvised explosive devices and died later of other causes show a honeycomb of broken and swollen nerve fibers in critical brain regions, including those that control executive function. The pattern is different from brain damage caused by car crashes, drug overdoses or collision sports, and may be the never-before-reported signature of 'shell shock' suffered by World War I soldiers.

http://www.sciencedaily.com/releases/2015/01/150114140600.htm
This is a page out of the Textbook of Military Medicine, updated in 2006; this same algorithm is in the textbook in the 1980s. The "definitive therapy" then and is HBOT treatment for TBI.

BLAST EXPOSURE

Evaluation for Head Injury and Arterial Air Embolism

Diminished Level of Consciousness or Focal Neurological Deficits

No External Evidence of Head Injury

Open Head Wound

Neurosurgical Evaluation and Treatment

Evidence of Direct Trauma

Evidence of Intracranial Air

Definitive Therapy in Hypobaric Chamber

Fig. 9-10 Algorithm for the evaluation of neurological abnormalities in a blast casualty

Textbook of Military Medicine - Series on Combat Casualty Care Part 1 Volume 6 pg 313 Conventional Warfare: Ballistic Blunt and Burn Injuries: Prewaried by the Office of the Surgeon General Department of the Army, United States Army Medical Research Institute of Biomedical Sciences, Walter Reed Army Institute of Research, Washington DC. Uniformed Services University of the Health Sciences, Bethesda, Maryland, United States Army Institute for Surgical Research, San Antonio, Texas. Printed in the United States 2006
Figure 1: Schematic diagram of the mechanisms of blast-related traumatic brain injury

Figure shows local effects (1–7) and systemic effects (8, 9) of primary blast injury, secondary blast injury (10–12), tertiary blast injury (13), quaternary blast injury (14), and portals for blast wave transmission to the brain (15, 16). (1) Acoustic impedance mismatch causes spallation. (2) Shock-bubble interaction. (3) Shear stress causing diffuse axonal injury. (4) Cavitation. (5) Skull deformation with elastic rebound. (6) Reflection of the blast wave within the skull. (7) Bobblehead effect of acceleration-deceleration. (8) Blood surge from the torso damages the microvasculature. (9) Air embolism from blast lung injury. (10) Penetrating fragments. (11) Compound fractured skull. (12) Intracerebral haemorrhage. (13) Contrecoup contusion. (14) Burns. (15) Blast wave transmitted through the orbits. (16) Blast wave transmitted through the nasal sinuses.

14 on-label indications for HBOT are already approved and insured

1. **Air or Gas Embolism**
2. **Carbon Monoxide Poisoning**
   - Carbon Monoxide Poisoning Complicated By Cyanide Poisoning
3. **Crush Injury, Compartment Syndrome and Other Acute Traumatic Ischemias**
4. **Decompression Sickness**
5. Arterial Insufficiencies:
   - **Central Retinal Artery Occlusion**
     - Enhancement of Healing In Selected Problem Wounds
6. Clostridial Myositis and Myonecrosis (Gas Gangrene)
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 (Approved on October 8, 2011 by the UHMS Board of Directors)

**These indications are similar to conditions found in brain injury**

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