HBOT RESEARCH AND SCIENCE

MOST RECENT RESEARCH

[a] Xavier A. Figueroa, PhD and James K. Wright, MD (Col Ret), *USAF Hyperbaric Oxygen: B-Level Evidence in Mild Traumatic Brain Injury Clinical Trials*. Neurology® 2016;87:1–7 "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."

[b] 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.*

[c] 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."


[Additional commentary on above]: Alexander, Caroline. "Mystery of How Battlefield Blasts Injure the Brain May Be Solved. A landmark study sheds new light on the damage caused by “blast shock”—the
signature injury of wars for more than a century." National Geographic. JUNE 9, 2016

"Compelling evidence suggests the advantage of hyperbaric oxygen therapy (HBOT) in traumatic brain
injury. ...Patients undergoing hyperbaric therapy achieved significant improvement....with a lower
overall mortality, suggesting its utility as a standard intensive care regimen in 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

[b] Shi XY, Tang ZQ, Sun D, He XJ. Evaluation of hyperbaric oxygen treatment of neuropsychiatric

study of the therapeutic potential of hyperbaric oxygen therapy on chronic brain injury. J Neurol

http://www.researchgate.net/publication/51416688_Effect_of_hyperbaric_oxygen_on_patients_wi
th_trumatic_brain_injury_injury

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

[f] Harch PG, Fogarty EF, Staab PK, Van Meter K. Low pressure hyperbaric oxygen therapy and
SPECT brain imaging in the treatment of blast-induced chronic traumatic brain injury (post-


2. Data from NBIRR-01 observational study

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

[b] Hyperbaric Oxygen Induces Late Neuroplasticity in Post Stroke Patients - Randomized, Prospective Trial http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0053716


4. **Animal studies showing positive effects of HBOT on brain injury**


5. **Expert Opinion**

[a] "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/2014/05/01/what-the-bleep-is-going-on-with-hyperbaric-oxygen-therapy/)**  

[b] 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....” [http://www.therapiehyperbare.com/images/hyperbare/2012-06_uhms_editorial.pdf](http://www.therapiehyperbare.com/images/hyperbare/2012-06_uhms_editorial.pdf)

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.


Mac Donald, CL; Ann M. Johnson; Linda Wierzechowski; Elizabeth Kassner, Theresa Stewart, Elliot C. Nelson, Nicole J. Werner, David Zonies, John Oh, Raymond Fang, David L. Brody. Prospectively Assessed Clinical Outcomes in Concussive Blast vs. Nonblast Traumatic Brain


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](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.
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).


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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