Hyperbaric Oxygen Therapy - HBOT

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Soft Sided Hyperbaric Oxygen Chamber with clear viewing “port” holes” on the top

Hyperbaric oxygen therapy (HBOT) involves breathing pure oxygen at high pressure (usually 2–3 atmospheres), which increases oxygen levels in the blood and tissues. Clinical, a treatment involves placing a patient in a pressurized environment and having them breathe 100% pure oxygen for a specific period. The pressure is typically 1.4 times higher than the pressure of the air that we breath. This increase in pressure helps to address low oxygen levels in the body, called hypoxia, and improving oxygen delivery to the tissue by increasing oxygen levels in the blood and tissues.[1] Specific facilities and equipment are required to provide hyperbaric oxygen therapy. A treatment is usually done in either single-person chambers or larger chambers that can accommodate multiple patients at once. Recent innovations have led to lighter and more cost-effective chambers, with clear acrylic chambers becoming more common.[1]

At normal atmospheric pressure, only a small amount of oxygen is dissolved in the of blood. At therapeutic pressures used in HBOT, more oxygen is dissolved into body tissues and fluids, which is crucial for treating a variety of conditions. There are 14 approved conditions that HBOT can be used to treat.[2,3] Conditions such as air embolism, severe anemia, carbon monoxide poisoning are included in the list. HBOT is also used in other conditions.

The length of the treatment varies depending on the condition treated; however, a typical treatment can last from 1.5 to 2 hours and occur several times a day over several weeks.

Research on the use of HBOT in Specific Health Concerns

HBOT and leg ulcers

The impact of hyperbaric oxygen therapy on the healing of chronic ulcers of the lower leg was reviewed by Kranke et al. They collected all the of clinical studies that compared the treatment of chronic ulcers that included HBOT and compared those treatment results that did not include HBOT.[4] The authors concluded that the treatments which included HBOT provided accelerated healing at the 6 week mark; however, these results were not sustained at the 18 week mark. A second meta-analysis on HBOT in diabetic foot ulcers analyzed 20 randomized clinical trials with a total of 1,263 participants. They concluded that HBOT

provided benefits in the healing of diabetic foot ulcers and reduced amputation rate.[5]

HBOT and chronic stroke

A retrospective analysis of 162 patients, age 48 to 72 years, was performed to evaluate the effects of HBOT on overall cognitive function of patients in the chronic stage of stroke. The initial assessment of cognitive function and subsequent participation in hyperbaric oxygen treatments occurred at least three months post stroke. These participants were treated in a multi-place hyperbaric chamber and received between 40 to 60 daily sessions, 5 days of the week and each session was 90 minutes in duration. The results of the analysis suggest that HBOT induced significant improvements in cognitive function in all domains even at late chronic stages regardless of stroke type.[6]

HBOT and severe anemia

A woman with a uterine fibroid, experiencing heavy uterine bleeding for over two weeks. Upon arrival at an urgent care center, she was found to have a hemoglobin of 4.6 g/dL. Upon transfer to the emergency department, her hemoglobin was assessed to be 4.4 g/dL. Symptoms of light-headedness and palpitations began on the following day. She was a Jehovah's Witness and was concerned that there would be intense pressure to receive blood transfusions. The bloodless medicine program at the hospital recommended that she receive IV ferric gluconate and HBOT. She was discharge on day 4 after having received the iron transfusions and 3 HBOT treatments. Her hemoglobin was 5.3 g/dL on discharge. Her hemoglobin after 5 weeks was 13 g/dL.[7]

A woman presented to emergency having developed a sudden onset placental abruption with severe blood loss whose religious beliefs prevented her from receiving any blood products. Her hemoglobin was reported to be 1.9 g/dL and she developed multisystem failure, disseminated intravascular coagulation and deep vein thromboses. She underwent a total of 30 hyperbaric oxygen treatments for 90 minutes up to 2 times per day. The family declined the use of any blood products except for erythropoietin. After 29 days of treatment, the patient was discharged to a rehab facility and had no evidence of any sustained physical or cognitive impairment.[8]

HBOT and Carbon monoxide poisoning

Carbon monoxide binds to hemoglobin 200 times more strongly than oxygen, reducing the blood's oxygen content and leading to very low oxygen levels. HBOT provides oxygen through plasma and helps remove carbon monoxide from hemoglobin and myoglobin. Symptoms of carbon monoxide poisoning include loss of consciousness, neurological issues, heart problems, lung edema, metabolic acidosis, headaches, and potentially permanent neurological damage if not treated early. Treatment involves breathing 100% oxygen at 2–3 ATA for 60–90 minutes.[9]

HBOT and Neurophysiologic performance in brain tumor patient after neurosurgery and radiotherapy

Long term survivors of treatment for brain tumors, neurosurgery and radiotherapy often experience cognitive impairments. In a small study (n=10), HBOT was used with long term brain tumor survivors experiencing cognitive impairment. The most often reported impairments were related to reduced short-term and working memory and attention underperformance. Patient's cognitive performance was assessed prior to HBOT treatments at 6 weeks and 4 months after

treatments. The tests included an EEGs (electroencephalographic examination), tests for memory performance and cognitive assessments. Patients underwent HBOT session 5 times per week for 6 to 8 weeks. The researchers concluded, cautiously, that HBOT generally improved both neurophysiologic functioning and cognition.[10]

HBOT and late radiation tissue injury after breast cancer.

Late radiation tissue injury (LRTI) is a skin reaction that occurs after radiotherapy that either persists for 6 or more months or that occurs six months after radiotherapy, and usually worsens with time. The common symptoms of LRTI include pain, edema, tissue fibrosis in the radiated area and limited range of motion of the arm at the shoulder. HBOT has been shown to improvement symptoms of LRTI [11–13] by stimulating the formation of new blood vessels, improving tissue oxygenation and decreasing fibrosis.[14] This study was a case series study with the aim to assess the durability of the improvements in LRTI at the 12 months post HBOT. The study determined improvements persisted up to 12 months after HBOT; however, if there was a poor score with respect symptoms at the start of HBOT then that was predictive for a poor score 12 months after HBOT.[15]

References

1. Ortega MA, Fraile-Martinez O, García-Montero C, et al. A General Overview on the Hyperbaric Oxygen Therapy: Applications, Mechanisms and Translational Opportunities. *Medicina (Mex)*. 2021;57(9):864. https://dx.doi.org/10.3390/medicina57090864

2. FDA- Consumer Updated. Hyperbaric Oxygen Therapy: Get the Facts. Hyperbaric Oxygen Therapy: Get the Facts. 2021. https://www.fda.gov/consumers/consumer-updates/hyperbaric-oxygen-therapy-get-facts

3. Health Canada. Hyperbaric Oxygen Therapy. October 18, 2019. Accessed May 24, 2024. https://www.canada.ca/en/health-canada/services/healthy-living/your-health/medical-information/hyperbaric-oxygen-therapy.html

4. Kranke P, Bennett MH, Martyn-St James M, Schnabel A, Debus SE, Weibel S. Hyperbaric oxygen therapy for chronic wounds. Cochrane Wounds Group, ed. *Cochrane Database Syst Rev*. Published online June 24, 2015. https://dx.doi.org/10.1002/14651858.CD004123.pub4

5. Zhang Z, Zhang W, Xu Y, Liu D. Efficacy of hyperbaric oxygen therapy for diabetic foot ulcers: An updated systematic review and meta-analysis. *Asian J Surg*. 2022;45(1):68-78. https://dx.doi.org/10.1016/j.asjsur.2021.07.047

6. Hadanny A, Rittblat M, Bitterman M, et al. Hyperbaric oxygen therapy improves neurocognitive functions of post-stroke patients – a retrospective analysis. *Restor Neurol Neurosci*. 2020;38(1):93-107. https://dx.doi.org/10.3233/RNN-190959

7. Johnson-Arbor K, Verstraete R. No Bad Blood—Surviving Severe Anemia Without Transfusion. *JAMA Intern Med*. 2021;181(1):7. https://dx.doi.org/10.1001/jamainternmed.2020.6560

8. Graffeo C, Dishong W. Severe blood loss anemia in a Jehovah's Witness treated with adjunctive hyperbaric oxygen therapy. *Am J Emerg Med*. 2013;31(4):756.e3-756.e4. https://dx.doi.org/10.1016/j.ajem.2012.11.013

9. Sen S, Sen S. Therapeutic effects of hyperbaric oxygen: integrated review. *Med Gas Res*. 2021;11(1):30. https://dx.doi.org/10.4103/2045-9912.310057

10. Schellart NAM, Reits D, Van Der Kleij AJ, Stalpers LJA. Hyperbaric oxygen treatment

improved neurophysiologic performance in brain tumor patients after neurosurgery and radiotherapy: A preliminary report. *Cancer*. 2011;117(15):3434-3444. https://dx.doi.org/10.1002/cncr.25874

11. Lin ZC, Bennett MH, Hawkins GC, et al. Hyperbaric oxygen therapy for late radiation tissue injury. Cochrane Gynaecological, Neuro-oncology and Orphan Cancer Group, ed. *Cochrane Database Syst Rev*. 2023;2023(8). https://dx.doi.org/10.1002/14651858.CD005005.pub5

12. Teguh DN, Bol Raap R, Struikmans H, et al. Hyperbaric oxygen therapy for late radiation-induced tissue toxicity: prospectively patient-reported outcome measures in breast cancer patients. *Radiat Oncol Lond Engl*. 2016;11(1):130. https://dx.doi.org/10.1186/s13014-016-0700-0

13. Gothard L, Stanton A, MacLaren J, et al. Non-randomised phase II trial of hyperbaric oxygen therapy in patients with chronic arm lymphoedema and tissue fibrosis after radiotherapy for early breast cancer. *Radiother Oncol J Eur Soc Ther Radiol Oncol*. 2004;70(3):217-224. https://dx.doi.org/10.1016/S0167-8140(03)00235-4

14. Feldmeier JJ. Hyperbaric oxygen therapy and delayed radiation injuries (soft tissue and bony necrosis): 2012 update. *Undersea Hyperb Med J Undersea Hyperb Med Soc Inc*. 2012;39(6):1121-1139. https://pubmed.ncbi.nlm.nih.gov/23342770/

15. Da Vinci Clinic, Nieuwendijk 49, 5664HB Geldrop, the Netherlands, Spruijt NE, Van Den Berg R, Da Vinci Clinic, Nieuwendijk 49, 5664HB Geldrop, the Netherlands. The effect of hyperbaric oxygen treatment on late radiation tissue injury after breast cancer: A case-series of 67 patients. *Diving Hyperb Med J*. 2020;50(3):206-213. https://dx.doi.org/10.28920/dhm50.3.206-213