

Hyperbaric Oxygen Therapy

for Individuals with Neurological Dysfunction

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for Advance for Physical Therapy

Hyperbaric Oxygen Therapy (HBO) is a medical treatment that uses pure oxygen to alleviate hypoxia, or lack of oxygen, at the cellular level. In North America, HBO is an accepted intervention for wound healing, the bends and carbon monoxide poisoning. ***If everyone accepts that HBO increases oxygen at the cellular level for burns and wounds, why not in the brain too?*** In Europe, China and Russia, HBO is standard treatment for neuromuscular disease (MS, CVA, TBI, etc.). This exciting treatment option has been evaluated and found effective for anoxic brain insults in a handful of randomized clinical studies in Europe. In the past few years, North American peer reviewed journals have begun evaluating the effectiveness of HBO for individuals with MS, CP and other neurological dysfunction. With the physician jury still deliberating, here's an overview for PTs.

The concept behind HBO for the treatment of anoxic brain insults is described as enhancing "idling" neurons. After an injury or infarct, brain matter dies and cannot regenerate. The "dead" area is referred to as gliosis (since the neurons are replaced by glial cells). The area around the gliosis is referred to as the perinfarctional zone. This area looks just like gliosis on scans, but may in fact be viable for years following the initial insult. *HBO delivers high doses of oxygen to these "sleeping" cells surrounding the dead neurons, and may be getting them to "wake up".*

Stroke, traumatic brain injury, near drowning, and other similar neurological events result in oxygen and blood supply being cut off to the brain. If the flow is reduced to less than 10% of normal, cell death will result within a few minutes. After a traumatic event, swelling is caused by damaged blood capillaries leaking fluid around the area of cell death. Increased pressure from this swelling and capillary damage prevents red blood cells from getting through and supplying oxygen to the areas most in need. These dying brain cells begin to dump ions into the interstitial space. As their cell walls continue to break down, they release more ions and finally fluid into the surrounding tissue. This can cause damage to the cells around the primary damaged site through pressure and interruption of homeostasis. The surrounding tissue reacts by swelling in an attempt to maintain intra-cellular sodium-potassium level. This results in a secondary, gradually expanding damaged, hypoxic area around the primary lesion. It is now postulated that these cells around the margin of the

primary lesion have the potential of being restored to normal or near normal function. This visible (SPECT scan) increase in metabolic activity in the tissue around the primary lesion may or may not result in better function outcomes for the individual. HBO is the only known intervention which may be able to "wake-up" these marginal non-functioning neurons.

Holbach et al (1975) used a randomized clinical trial of 99 individuals with acute mid-brain syndrome using conventional intensive measures alone versus conventional intensive measures plus HBO. Holbach found a 40% decrease in mortality in the group that also received HBO. The benefits were increased in the younger (< 30) age group to such an extent that he concluded HBO should be standard equipment for all emergency rooms for individuals with mid-brain syndrome.

Astrup (1981) (reference) used serial CT. It may be that the recovery of this tissue is what changes outcomes in patients receiving HBO scans of patients with CVAs and measured metabolic activity of gray matter up to six months post event. Neubauer (1990) demonstrated that neurons can be re-activated up to 14 years following incident. To demonstrate this, Neubauer used SPECT scans to show metabolic activity before and after a treatment course of HBO. SPECT (single-photon emission-computed tomography) is a new scanning technique. Unlike MRI or CAT scans, which can only depict anatomy, SPECT scans show actual blood flow. These scans taken before and after HBO can demonstrate increased metabolic activity in specific brain areas, thus documenting the effects of HBO. These studies seem to indicate the development of new blood vessels in the marginal areas around the primary lesion.

HBO adheres to all of the gas laws of physics. There is no miracle involved. Henry's law states that if the pressure of a gas is increased (oxygen), it will be dissolved in all acceptable body fluids as directly related to the pressure. During HBO, oxygen is in a free molecular state and ready for immediate metabolic use without energy exchange, *is therefore increased in the plasma by up to 2000 fold. It is also increased in bone, urine, lymph and especially the cerebrospinal fluid.* In the case of complete occlusion of a vessel, whether it be central or peripheral, oxygen may be delivered in a retrograde fashion. Fortunately in most brain insults, especially stroke, there remains a trickle phenomenon that delivers additional oxygen in the cerebrospinal fluid and in the plasma. The significance of changing the hemoglobin from 98% to 100% oxygenated is not a major consideration.

During HBO treatment sessions, patients breathe 100% oxygen under increased pressure (room air is 19-21% oxygen) thus increasing the amount of oxygen dissolved into the blood by up to 2000%. The human brain accounts for only 3% of body weight yet consumes 20-25% of the body's total glucose and oxygen. The human brain unfortunately has little capacity to store these vital elements. **When a person experiences an anoxic event, the brain cells quickly go into**

"shock" and may "hibernate" in an attempt to protect and save themselves. High amounts of oxygen may be the trigger to "unshock" the neurons and trigger them to recover and begin functioning again. HBO provides a six fold increase in the amount of oxygen reaching brain tissue as compared to normal respiration. Patients typically spend one hour 3-4 times a week for 12 weeks.

Possible side effects of HBO include damage to the ears, lung sand myopia. The difference in the pressure between the air inside the eardrum and the air outside can damage the eardrum. This pressure is comparable to descending and ascending in an airplane. Most people can easily clear this by swallowing when they feel the pressure. However, if the child or adult undergoing HBO has swallowing difficulties, they might now be able to equalize the pressure in the ear and damage could result. This same pressure gradient problem can occur in the lungs if the airways are blocked by a large mucous plug. Again, damage could occur. For some unknown reason, this same phenomenon causes short term myopia in the eyes. While these complications are rare, they need to be considered when exploring HBO ads a treatment option.

In conclusion, HBO has been an excepted treatment intervention for decades both in North America and around the world. There is of yet no conclusive scientific evidence that HBO has a positive effect on cerebral palsy or other neurological dysfunction. However, over the next few years HBO may prove to be a valuable adjunct for rehabilitation programs to improve measurable functional outcomes both in children and adults who have experienced anoxic events.

References:

Astrup, J, Sazio, BC and L. Simon. Thershold of Ischemia: The Ischemic Penumbra. Stroke vol 12 p723-5. 1981. Neubauer. Enhancing Idling Neurons. Lancet, March 3, 1990:542.

Neubauer. Stroke Treatment. Lancet, June 29, 1991; 1601.

Hart, GB et al. The Treatment of cerebral Ischemia with Hbo. Stroke. 1971; 2:247-250

Holbach, KH, Wasserman, H and T Kolberg. Reversibility of the Chronic Post-Stroke State. Cerebral Energy 1976; 7(3);296-300

Jain, KK, Effects of HBO on Spasticity in Stroke Patients. J Hyperbaric Med, 1989; 4(2):55-61.

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