Rescue for Blunt Trauma, Crush & Acute Traumatic Brain Injury

Department of Defense Brain Injury Rescue & Rehabilitation Project (DoD-BIRR)
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Oxygen delivered under pressure, Hyperbaric Oxygen Therapy (HBOT) is one of the most powerful drugs known to man. Simultaneously, HBOT delivers the substrate of life, oxygen, for which there is no substitute. HBOT has profound beneficial effects on injury pathophysiologic processes that are common in military casualties. Moreover, it has been shown to positively impact traumatic brain injury, compartment syndrome, burns, hemorrhage, and reperfusion injury. These injuries and injury processes comprise the bulk of battlefield casualties. With timely intervention of HBOT the morbidity and mortality of injured soldiers should substantially improve as they have in their civilian counterparts. Past foreign military experience strongly suggests this benefit in extremity wounds and it is our conviction that United States soldiers deserve nothing less. This is the goal of the Brain Injury Rescue & Rehabilitation Project (DoD-BIRR).

HBOT has both acute and chronic drug effects. HBOT exerts these effects by obeying the Universal Gas Laws, the most important of which is Henry's Law (2). Henry's Law states that the concentration of a gas in solution is proportional to the pressure of that gas interfacing with the solution.

At the point of three atmospheres absolute of pure oxygen (3 ATA), just slightly more than the amount the U.S. Navy has used for 50 years in the treatment of divers with decompression sickness, we can dissolve enough oxygen in the plasma to render red blood cells useless. Under these conditions as blood passes through the tiniest blood vessels tissue cells will extract all of the dissolved oxygen in the blood without touching the oxygen bound to hemoblogin. This amount of dissolved oxygen alone can exceed the amount necessary for the tissue to sustain life. In other words, you don't need red blood cells for life at 3 ATA of 100% oxygen. This ability to maintain life without blood has obvious potential to battlefield casualties awaiting transfusion.

As a result of Henry's Law HBOT is able to exert a variety of drug effects on acute pathophysiologic processes. These have been well documented over the past 50 years and include reduction of hypoxia (lack of oxygen), inhibition of reperfusion injury (immune response to injury), reduction of edema (swelling), blunting of systemic inflammatory responses, and a multitude of others. In addition, repetitive HBOT in wound models acts as a DNA stimulating drug to effect tissue growth. HBOT has been shown to interact with the DNA of cells in damaged areas to begin the production of repair hormones, proteins, and cell surface receptors that are stimulated by the repair hormones. The resultant repair processes include replication of the cells responsible for tissue strength (fibroblasts), new blood vessel growth, bone healing and strengthening, and new skin growth.

In the past 12 years scientific research has unequivocally shown that the only drug to completely or nearly completely reverse the reperfusion injury process is hyperbaric oxygen. This is a physiological reaction of the body to trauma is a major source of injury that battlefield casualties experience. In multiple experiments with different animal models, different organ systems, different types of blood flow reduction or absence (e.g., heart attack, stroke, cardiac arrest, carbon monoxide, tourniqueting of an

extremity, etc.) timely HBOT within hours of reperfusion injury has been shown to completely or nearly completely reverse reperfusion injury.

Simultaneously, due to HBOT's ability to dissolve large amounts of oxygen in the liquid portion of the blood, oxygen-enriched plasma is able to reach damaged areas of tissue not accessible by normal blood flow and restore oxidative function to these areas. The net result is a dramatic reduction in the secondary injury process, improved viability of tissue that would otherwise die, and salvage of the tissue and patient.

In addition, twenty percent of the wounded in Iraqi experience traumatic brain injury (TBI) a diffuse cerebral insult characterized by primary mechanical disruption of tissue and secondary injury from ischemia, hypoxia, edema, vasospasm, neurochemicals, and reperfusion injury. A review of the medical literature shows that there is substantial data proving a beneficial effect of HBOT on the secondary injury processes of acute TBI. HBOT has been shown indirectly to improve ischemia and hypoxia in acute TBI by its effect on aerobic metabolism and EEG. The neurosurgeon authors of the Rockswold study conclude that "HBOT should be initiated as soon as possible after acute severe traumatic brain injury."

HBOT also has beneficial effects on vasospasm and cellular reperfusion injury. Multiple studies have shown that HBOT reduces cerebral edema and decreases intracranial pressure (ICP). A summary of the HBOT/cerebral edema studies in animals is that HBOT has two different effects: one reducing brain edema (injured brain), and another producing brain edema (normal brain). This toxic effect on normal brain causes a breakdown in the protective vasoconstriction of arterioles, resulting in a rapid rise in brain blood flow and deterioration in EEG.

Rockswold in 1992 reported the most exhaustive, rigorous, and important study to date in acute TBI in an attempt to refute or affirm all of the above animal and human data. Conducted from 1983 to 1989 the study enrolled 168 patients with GCS of 9 or less in a RPCT design and stratified the patients by age and GCS. Patients were treated at 1.5 ATA/60 every 8 hours for a maximum of two weeks immediately post TBI or until awake or deceased during these two weeks. The average patient entered treatment 26 hours post TBI and received 21 treatments. Overall mortality was significantly reduced 50% in the HBOT group and as high as 56% and 60% in the elevated ICP and GCS 4-6 subgroups.

This reduction in mortality has never been equaled by any therapy in the medical armamentarium except possibly the ambulance, or in the case of the military, the helicopter. Adding HBOT to helicopter evacuation of casualties should further decrease morbidity and mortality of injured soldiers. This is the foundation of the DoD-BIRR Project.

References:

Harch, Paul, M.D., "FEB Scientific Background & Overview," 2005 (81 scientific references)

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