

Hyperbaric Oxygen Therapy in Veterinary Medicine

At Carson-Tahoe Veterinary Hospital

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Introduction

Hyperbaric Oxygen Therapy (or HBOT) in veterinary medicine is the same as human medicine. That is, the delivery of 100% oxygen under pressure to the "patient", in this case the patient rather than being human, is an animal. The pressure we use is generally 1.5 to 2.4 atmospheres (a pressure equal to that produced by 16 to 46 feet of seawater). The pressure is provided using a monoplace stainless steel pressure chamber that looks similar to diving decompression chambers used on ships. Clients tell us that it resembles a mini-submarine with two portholes and a "hatch" at one end. It is approximately 3 feet in diameter and 4.5 feet long. Oxygen at high flow is infused into the chamber until the desired pressure is reached. This generally takes 10 minutes to reach the desired pressure in our animal patients. We observe them through the portholes and note any changes in their attitude that might indicate some distress (presumably due to pressure changes in the sinus or middle ear). It has been rare to have to stop the descent but, on occasion we have slowed the descent down because of observed discomfort. In animals that are very excited, we tranquilize with a phenothiazine-based anxiolytic such as acetylpromazine. Most animals become comfortable in the chamber, only requiring a small amount (1/2-1 mg) of the tranquilizer. Occasionally, up to 2-3 mg will be required. The treatment time begins when the desired pressure is reached and the range from 30 minutes to 2 hours, depending on the patient's condition and the indication for which it is being used. Most treatment times average one hour. Decompression, which takes another 10 minutes, is then accomplished and the patient is removed from the chamber. The protocol we use regarding length of dive, depth, and frequency depends on the indication, patient size and type, and the financial obligations to which the owners have committed for the treatment of their animal. Most of the animals treated at our facility are dogs and cats and the costs of the treatments are bore by the owners.

Review of the Physiological Effects of the Hyperbaric Oxygen Treatment on Animals.

At 2 atmospheres of pressure oxygen in the veterinary patient's blood and tissues is 15 times greater than is normally present similar to that in human patients. At that pressure, oxygen diffuses through tissues even when blood supply to the area is significantly compromised. It diffuses into tissues an average distance of 5-7 cm. With compromised or constricted vessels, plasma flows through them better than red blood cells that normally carry the oxygenated blood. When the plasma is under the influence of the hyperbaric oxygen it carries 20 times more oxygen to tissues alone without the red blood cells being involved. Thus, small compromised capillaries can deliver oxygen to the tissues they supply even if they can only allow plasma predominately through them. All mammalian cells depend on oxygen to live and remain functional. Therefore, oxygen delivered by HBOT can make the difference between cell death (apoptosis) or cell recovery, or when global enough, patient death or patient recovery, particularly if normal routes of delivery of oxygen are inadequate. By applying additional pressure to tissues, HBOT also decreases edema and swelling, which also allows better blood flow. This effect continues after the HBOT session is completed and has been found particularly important in the treatment of spinal cord and cerebral edema. Hyperbaric cellular recovery, including its DNA-RNA genetic structure (thus reversing apoptotic events), metabolism, immunity, and overall functions.

Indications for HBOT

There are some 13-15 disease conditions approved by the American College of Hyperbaric Medicine and the Undersea and Hyperbaric Medical Society for which HBOT is known to be of benefit in humans. The use of HBOT in these conditions has been proven to be very effective. Insurance companies for humans generally pay for these HBOT indications. (These indications and references can be found online at www.uhms.org, www.achm.org, or www.hbomedtoday.com.)

Research studies have shown the benefit of HBOT treatment beyond what is approved by the insurance companies. Similar conditions also occur in our animal patients as well. There are over 50 of these "unapproved indications or conditions" where HBOT may have significant benefit as an adjunct to conventional therapy. However with these conditions, HBOT has not yet been proven to be clinically

efficacious in a large double blind study. They have been proven to be beneficial during experimental trials. The ACHM and the UHMS Society have not yet done enough clinical experiments for the condition to reach the "approval" status. At CTVH, these conditions are being treated on an "investigational basis". Some of these conditions being treated include the following:

1. Brain and spinal cord edema and injury or compression
2. Post intervertebral disc herniation especially with "no deep pain" sensation
3. Pancreatitis, particularly when associated with severe edema and hemorrhage
4. Abdominal sepsis, particularly when associated with mixed bacterial infection
5. Pyothorax, particularly when associated with Nocardiosis and Actinomycosis
6. Post traumatic or ischemic shock or following any acute hypoxic episodes
7. Post CPR neurological impairment
8. Very swollen and inflamed limbs following orthopedic surgery
9. Severe sinusitis or septic rhinitis
10. Aortic embolization in both cats and dogs
11. Stroke in the dog and cat
12. Cardiac disease where eschemia is believed present
13. Posttraumatic and reperfusion myocardial injury associated with dysrhythmias

With these investigational conditions, results using HBOT have been mixed. Improvement with adjunctive HBOT has been observed in clinical patients, particularly when HBOT began early in the course of the disease; the best results in our hands have occurred when HBOT was started within 6 hours to the first 24 hours following the diagnosis, depending on the condition. If HBOT is used for any of these conditions owners and referring veterinarians are told that HBOT is primarily adjunctive: and not the primary means of treatment.

How the Hyperbaric Oxygen Therapy is Performed with the Animals Selected

Once a patient is selected for HBOT all metal is removed (collars) and he or she is wrapped in a blanket or towel and placed into the hyperbaric oxygen chamber. For very nervous pets, a sedative is administered and after quieting, he/she is placed into the chamber and the door is closed. During the treatment time most animals simply fall asleep in the chamber. Of course, some look out the porthole at the technician or doctor observing them. A technician or doctor is observing the patient throughout the time the patient is in the chamber. After the desired amount of time, the oxygen is gradually vented over several minutes until normal atmospheric pressure is reached. The door is then opened, thus ending the treatment. HBOT is generally performed at least every 12 to 24 hours, for several days. In some extreme cases, four treatments are performed in the first 24 hours. These conditions include gas gangrene associated with Clostridial infections. Continuous treatments for chronic conditions that are stable are usually conducted on an outpatient basis.

Contraindications

There are very few contraindications to the use of HBOT in our animal patients.

Those encountered include:

1. Untreated pneumothorax (no chest tube in place) or pneumomediastinum (air within the pleural space or mediastinum). Those with a functional Heimlich valve attached to the chest tube can be placed into the chamber without the risk of lung rupture and tension pneumothorax.
2. Coma, unconsciousness, or semi-consciousness, present where aspiration could be a risk, unless intravenous medications are administered through a porthole.
3. Respiratory or cardiac failure in which the patient requires ventilation (except in rare situations where the attending veterinarian or another DVM electively "dives" with the patient in the chamber and is providing ventilation by AMBU bag)
4. Other conditions in which forced isolation, necessary during the HBOT, would be contraindicated; such as near status epilepticus that is not controlled with medications.

Summary of Cases Treated with HBOT

At this center we have given over 700 hyperbaric oxygen treatments per year for the last two years. Dogs and cats were the only veterinary patient species treated. Indications for HBOT include sepsis and peritonitis, pancreatitis, severe wound infections osteomyelitis, osteonecrosis of the nasal turbinates, chronic sinusitis, oronasal fistula, severe gingivitis, encephalitis, seizures of unknown etiology, brain tumor associated edema, spinal cord injury, acute ruptured intervertebral disc herniation with secondary cord edema traumatic shearing and crush wound injured, skin and muscle flap and free grafts, cerebellar syndrome (cause not determined), poisonous snake bite and resultant swelling and necrosis, suspected Brown Recluse spider bite, post bone grafting (cortical, cancellous) post comminuted fracture and fracture repair, post craniotomy for tumor removal, post penetrating abdominal injury, post blunt abdominal trauma, early fasciitis, early skin and subcutaneous wound infection, late and advanced skin, muscle and fat infections following bite wounds, post thyroid tumor resection with resultant edema, post stifle (knee) surgery for ruptured cruciate ligament and meniscus injury, post airway surgery, post open peritoneal drainage for peritonitis, hepatitis (cause undetermined), necrotic cholecystitis and bile duct erosion following gall bladder resection and bile duct repair, post hypovolemic shock, aortic thromboembolism, and post cardiac arrest with persistent neurologic impairment.

In most of the conditions treated, HBOT has been adjunctive. In some cases, due to financial constraints, the therapy has been the primary or main therapy. These conditions included early wound infection, early neurologic deficits secondary to suspected intervertebral disc rupture, suspected very early dissecting fasciitis, and vestibular syndrome that was thought to be cerebral vascular compromise. Results have been extremely positive in the majority of cases. In those cases where HBOT did not seem to be of benefit clinically, it was noted as a prognosticator, i.e., animals that did not respond well to HBOT did not do well with many dying or being euthanized.

The only adverse reactions observed from the use of HBOT have been oxygen-induced seizures which have occurred infrequently. Dogs seem to be prone to them and begin to be seen at 2.4 ATA or even lower in some cases. These have been self-limiting and have not caused any residual effect. If seizures occur, diazepam is administered to prevent any recurring seizures with subsequent HBOT.

Conclusion

In the two and one half years that I have been using HBOT aggressively as an adjunctive therapy in my veterinary patients, I have observed some phenomenal results that I believe would not have occurred without it. There is no question that further studies need to be done to substantiate and further prove that the clinical use of HBOT in veterinary medicine is beneficial. Currently, there are only six veterinary centers in the United States where HBOT is being offered to clients and in most of these centers the chamber is being primarily used for wound related indications. Much has to be done to educate veterinarians and the client, pet owning public on what the benefits are to HBOT. With continued basic and clinical research I feel confident that HBOT will continue to be found beneficial in many disease conditions in which we are barely "scratching the surface".

NOTE: A word about the author

Dr. Crowe is a board certified veterinary specialist in surgery, emergency and critical care medicine with 28 years of practice. He has completed over 500 publications in these fields and was awarded a National Institutes of Health grant related to cardiovascular resuscitation. He has been on the faculty at Kansas State University and the University of Georgia Veterinary Specialists, in Alpharetta, Georgia. Currently, he is Chief of Surgery and Chief of Staff at Carson Tahoe Veterinary Hospital in Carson City, Nevada.