Lyme Disease

What is lyme disease?

The public definition of Lyme disease is much broader than the medical definition of Lyme disease. In the medical definition, Lyme disease is caused by the bacterium, Borrelia burgdorferi, which is transmitted to humans by infected deer ticks. A large number of cases are misdiagnosed and quickly develop into a more serious condition known as late disseminated Lyme. The condition may also be complicated by a number of co-infections transmitted from ticks carrying the lyme bacteria. Lyme disease remains a very difficult condition to diagnose and evaluate, and it is important to have an accurate diagnose with all other possible causes of the symptoms being fully investigated.

Who does lyme disease typically affect?

Lyme disease has been reported in all 50 states and is a growing silent epidemic around the world. Lyme-infected ticks have been found in 42 of 58 counties in California. The CDC speculates that because the condition mimics so many other illnesses, the actual number of people with Lyme disease may be 5 to 10 times higher than the estimated 150,000 of reported cases coping with the disease.

What are the most common symptoms of lyme disease?

Early signs of Lyme disease include flu-like symptoms and a Bull?s eye rash appears in about 50% of patients. When Lyme disease goes undiagnosed for months or years following infection, the bacteria can spread to the nervous system, the heart and other organs, tendons and joints. This late-stage infection can result in a wide variety of symptoms including arthritis, fatigue, heart abnormalities, Bell's palsy (paralysis of one or both sides of the face) and severe cognitive and/or mental dysfunction. Lyme disease is considered very difficult to treat by the medical community.

What are the traditional treatments for lyme disease?

Lyme disease is a bacterial infection and like other bacterial infections it is treated with antibiotics. Physicians often prescribe a combination of drugs to take advantage of the diverse ways that individual antibiotics affect the Bb organism. Special attention to nutrition and diet are part of the overall traditional treatment plan and may include herbal supplementation.

May lyme disease be amenable to hyperbaric oxygen therapy?

Protocols for the treatment of Lyme disease using hyperbaric oxygen are in development. We believe that hyperbaric oxygen protocols in wide use at various centers have to be modified when there is active inflammation and in particular, when there is neurological lyme disease. This is because hyperbaric oxygen, as the pressure increases above 2.0 atmospheres, reduces brain blood flow. In patients who have neurological Lyme disease, we believe that the neurological symptoms that may be related to vascular infections and inflammation require a slower, more careful start with lower pressures at 1.5 atmospheres and then gradually, increase as tolerated. We are working to develop these protocols as part of our brain injury research on the benefits of hyperbaric oxygen at low pressure in non-healing wounds of the brain, including traumatic brain injury and vascular brain injury resulting from inflammatory small vessel disease.

We recognize that only with better diagnostic tests for the germs that cause Lyme disease, including Borrellia, Bartonella and Protozoa, can we know for sure if the infection is actually eliminated by the use of hyperbaric oxygen. Therefore, observations that patients improve on HBOT may not be related to the actually killing of the microbe. Hyperbaric oxygen may help a patient's symptoms considerably even without complete eradication of the germs.

Hyperbaric oxygen treatments infuse the body with oxygen, increasing oxygen 10 times normal levels in body tissues through the increased pressure. Lyme bacteria are microaerophilic, meaning they die in high oxygen environments. A study was completed in 1997 by William Fife, Ph. D. at the Texas A & M Hyperbaric Laboratory. The results of the study were significant: improvement in approximately 85 percent of the 66 patients treated with HBOT.

What benefits can I expect from oxygen therapy for lyme disease?

Hyperbaric oxygen has been shown to reduce pain significantly, stimulate the immune system, increase energy, alleviate sleep dysfunction, and reduce cognitive impairment. In most cases, patients are also able to discontinue use of antibiotics or other drugs.
Bethesda Hyperbaric Oxygen Therapy, Maryland

"45 - 70% of Bb patients have mycoplasma fermentens incognitus, 10 - 35% of Bb patients have Erlichia, 25-45% of Bb patients have bartonella, 8-20% of Bb patients have babesia." Professor Garth Nicholson, 2007.

A lot of Lyme www-chat rooms make loud claims about some of the tick bite co-infections to Lyme disease (*Borrelia bugdorferi* "Bb") as *"loving oxygen".* Simply put these claims are based on half-truths (the worst sort) – shallow science at best and the conclusions not only incorrect but would make any Lyme patient hesitant to make use of hyperbaric oxygen therapy as part of their overall treatment and recovery plan.
If you have a Lyme disease positive diagnosis, know that it is probable that you also have co-infections from the same tick that bit you. There never has been a more important moment to concentrate (if you can – Lyme patients are allowed mental cloudiness) or have your primary care-giver drill down into cellular science and understand the diagnosis and defy the prognosis.

This page should be considered a lay-person's primer, since your recovery and return to a normal life is in your own hands. Always remember that the pit of loneliness and depression induced by a chronic illness such as Bb is your pit. There are likely to be other little villains in that pit also, adding to your misery. It will take effort on your part to beat back these invaders in your body and find you way back to health. Understanding the invaders is important to arriving at a strategy to defeat them or better said *"I am* cured." **"Understand the diagnosis, defy the prognosis."**

The pathophysiology (the study of biological manifestations of disease and disturbance of health) of tick-bite co-infections to Bb . . .

Most of these are bacterial infections (*Bartonella, Tulermeia, Erlichia*) while some are a protozoan *(Babesia*) with many variations of each. Most of them are Gram-negative, meaning that their cell walls do not pick up the crystal-violet color during the Gram staining process used to identify them. To throw in a wild-card into this mix is another bacterium that does not have cell walls, the *mycoplasma* family. So we need to give them the basket-name of *gram-negative pathogens*. All of these have many things in common. Apart from overlapping symptoms, is the fact that the cell walls of these pathogens cause a cascade of inflammatory response in the human body. Hold that thought, we will come back to it shortly.

Almost all of these gram-negative pathogens are facultative in that they do find that an abundant supply of oxygen is their preference, but when there is a lack of oxygen, they have other ways of producing energy, usually by a fermentation process. As you will see, it would be easy to believe that *"they love oxygen"* therefore hyperbaric oxygen should be avoided until the gang of invaders are banished one by one with the silver-bullets of modern pharmacology, namely antibiotics.

Pathogens have to "invade"" a human to do their damage. However there are barriers to entry, such a healthy skin, mucosa lining and robust lungs. All with their own specific security forces collectively known as the "immune system" to fight hard when these barriers are breached thus, healthy young adults shrug off pathogens faster than small infants and elderly folk. However, in the instance of an infectious tick bite, young and old are vulnerable. This is because the Lyme spirochete and any other pathogens in the ticks' saliva will mostly start their invasion by entering the different cells that make up our blood. A particular favorite is the red-blood cell (*erythrocyte*) or "RBC." Not because the pathogens "love oxygen" but because red blood cells are such a rapid ride throughout the body – about every 20 seconds.

While in the RBC, many of these pathogens consume the *heme* iron molecules, and excrete toxins known as *exotoxins,* destroying cells and disrupting cellular metabolisms Then, at the end of their life-cycle or when they are being poisoned off with either antibiotics or the free-radicals produced by hyperbaric oxygen therapy (HBOT) they exude *endotoxin*.

Endotoxin . . . a fearsome word. The cause of the *Jarisch-Herxheimer* (Herx) response. Many dead pathogens *lysing* (disintegrating) and much poisonous trash to be disposed of. The kidneys and liver are overwhelmed and fever, chills, and muscle pain can occur. In essence, no matter what approach you have on your road to cure, there will be some discomfort. Hold that thought until you read the bottom portion of this page, because your health professional can add things to the interdisciplinary approach needed to get rid of this tick-borne pathogens . . .

Conventional Western Medicine likes to get the lab' work, identify the pathogens, line them up and pick them off, one by one using the *Silver Bullets* of pharmacology.

Silver Bullets to eradicate Bb pathogenic co-infections:

Most of the gram-negative pathogens can be eradicated with modern pharmaceuticals and also Hyperbaric Oxygen Therapy (HBOT). But there is always a cost to the body – anything toxic has the potential of a wider ranging toxicity on the entire body, not only the pathogen. Some examples:

Babesia (similar to and often confused with and misdiagnosed with Malaria) is treated with the antibiotic (Abx) *Arithromycin* plus *quinine*. **Side effects can include** Rash, itchy skin, mental coldness, being dizzy, painful joints, diarrhea and oral and vaginal fungus. Because this Abx has such side effects, the preferred treatment for this parasite is *atovaquone*, marketed under the trade-name of *Malarone.* Special attention must be given to small adults and children when this drug is administered.

Bartonella (many variations) is an opportunistic infection and is often treated with the broad spectrum tetracycline Abx which has few side effects. Patients with liver or kidney problems should make their

history known to their prescribing physician. However, addition of specific nutrients can counteract detrimental effects of this pathogen.

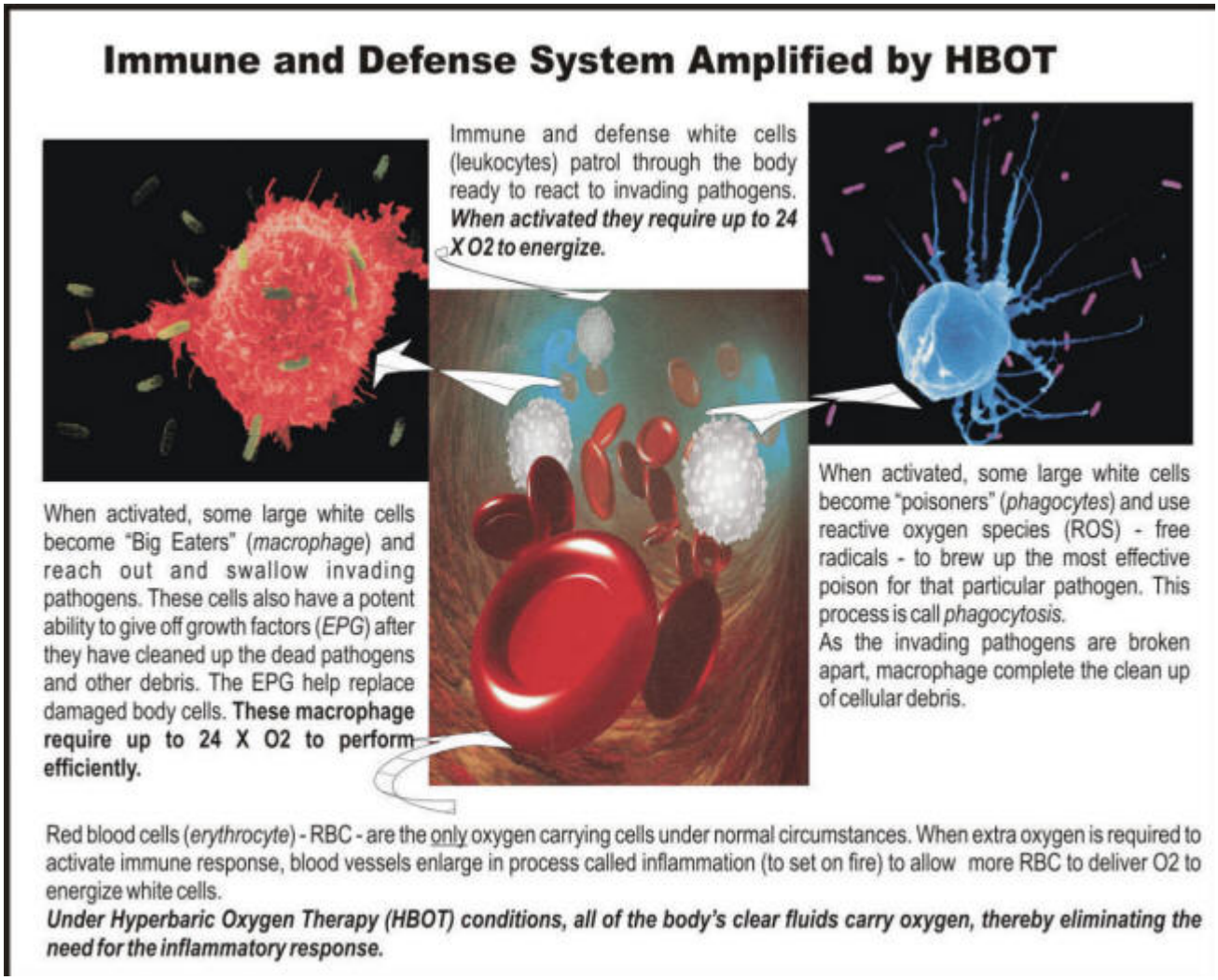
Lyme disease (early stages) is usually treated with *doxycycline*, an Abx that has few negative side effects. Dispensed for oral use, its trade-name is *Vibramycin.* It works well, killing with both gram negative bacteria as well as protozoa, such as malaria and other Lyme co-infections. Since this Abx is usually a 21-day program, physicians will often resort to pacing other cocktails of Abx in an effort to eliminate Bb.

Ciproflaxacin is often prescribed by physicians that claim to be "Lyme literate doctors" (LLD) and many Lyme patients that come to our centers have a central catheter or PICC line to allow for daily injections of this Abx. However, there are often **serious and quality-of-life and even life-threatening adverse effects** in the prolonged use of this Abx. These include irreversible peripheral neuropathy, tendonitis, muscle wasting, liver failure and hepatitis, photosensitivity and corneal perforation, general weakness, bone marrow depression, psychotic reactions and confused states – to name just a few. Currently, a number of lawsuits are underway against the many manufacturers of this family of Abx.

Tigercycline is the Abx. (brand name Tigacil) is the BIG hope for all Bb patients. Originally developed to fight methicillin- resistant Stapholococcus aureus (MRSA), it is bacteriostatic for bot gram-positive and gram-negative bacteria. In 2008 studies at the Division of Infectious Diseases, Department of Medicine at Stony Brook University, New York, researchers found this Abx to be " 16 - to - 1999 fold more active than *doxycycline* at immobilizing Bb isolates." A word of caution is that these were *in vitro* (in a dish) and as yet, no *in vivo* (in an alive body) reports (studies or anecdotal evidence) is yet available. A good example of in vivo results is that it is known that the HIV virus is quickly killed with bleach in the dish but any HIV patient would not do well being injected with bleach. **Side effects:** Patients can expect mild nausea, vomiting and diarrhea, pain at the infusion site, alterations in heartbeat plus the potential of additional infections in the first couple of days of the BID one hour infusion process.

However, Lyme patients need "shotgun" multi-disciplinary (holistic) approach since many of the symptomolgy (side effects) of their Abx actually mimic the real signs and symptoms of Lyme and its tick-borne co-infections. Thus, the overlays of misdiagnosis of specialist after specialist. All Lyme patients should remain under the care of a licensed health professional since life-threatening events have been reported (patients being transported to urgent care) during the "cure" process.

Hyperbaric Oxygen Therapy (HBOT) is often included since it has its own bactericidal effect and acts synergistically with most antibiotics, allowing the prescribing physician to reduce Abx levels while achieving better results. **HBOT *IS* a standard allopathic Western Medicine drug** and it also has Side Effects. ***A "show me the science comment on "toxicity" from consecutive daily treatments comes from Stephen Thom, MD, PhD,*** Professor of Emergency Medicine at the University of Pennsylvania School of Medicine ***"Aural barotrauma occurs in a small number of patients, and rare occurrences of biochemical O2 toxicity to eyes, lungs, and the central nervous system are virtually always reversible."*** Professor Thom is the lead author in "Stem cell mobilization by hyperbaric oxygen" - American Journal of Physiology-Heart and Circulation Physiology, 290:1378-1386, 2006. First published Nov 18, 2005; Research funded by the National Institute of Health.



GOOD NEWS . . . Hyperbaric oxygen therapy (HBOT) produces large amounts of ROS which are used by the body to brew poison to kill invaders. This included aerobic and anaerobic bugs. It works this way . . .

With the additional meltdown of oxygen (Henry's Law) into the body via the lungs, the increase of molecular oxygen energizes the immune system. White cells (leukocytes) are now in a state of arousal and gather around invaders. Some of these white cells change into macrophage ("big-eaters") and some morph into phagocytes. The latter brew poisons specific to the invading pathogen and act like stinging jellyfish. Where do they get their poison – from increased ROS of HBOT.

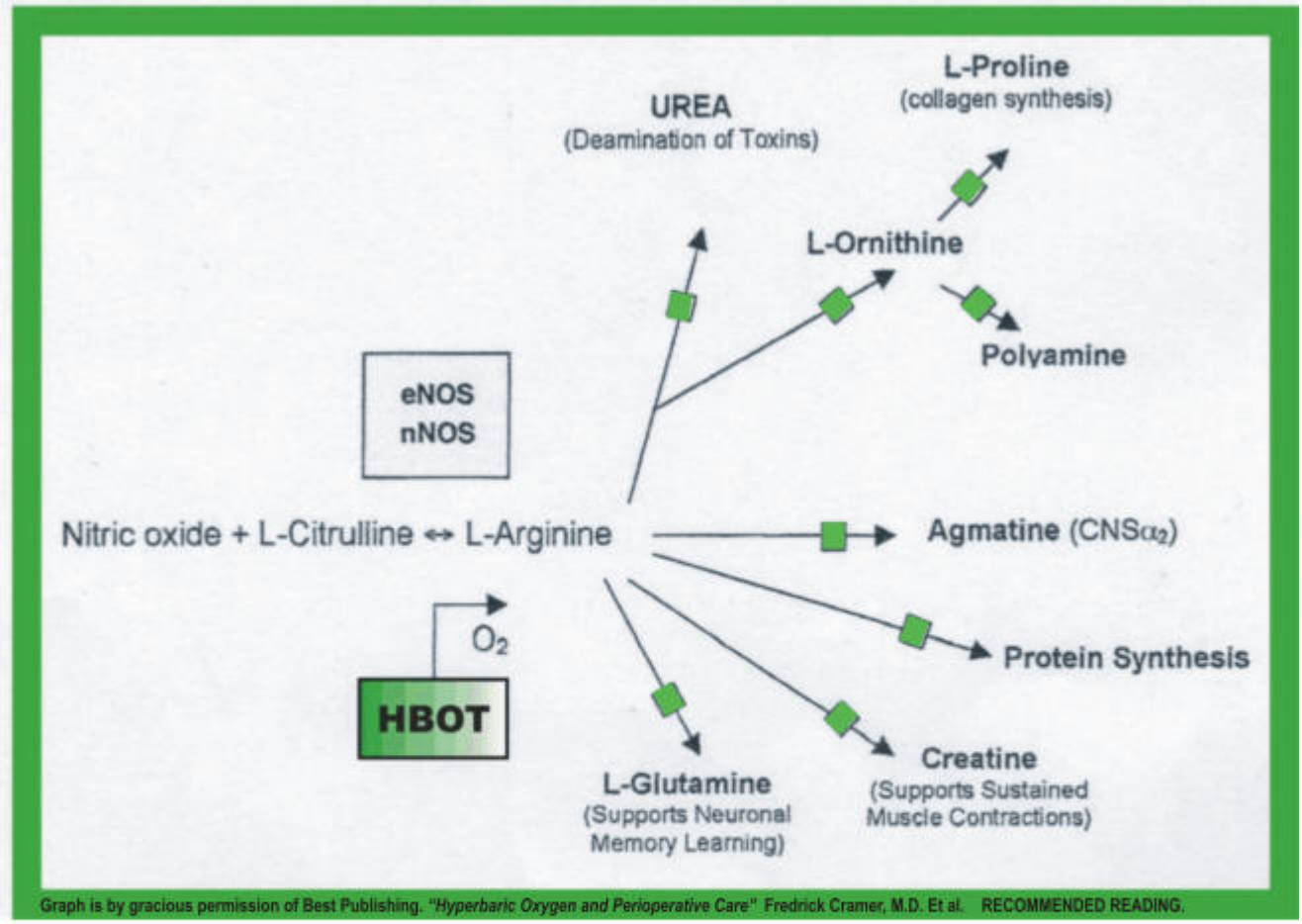
In essence, HBOT induces enough nasty free radicals to poison and then consume the dead bodies of the pathogens. Then, since human cells produce appropriate amounts of SOD, after each treatment, a cascade of SOD happens within all body cells and the excess amounts of free radicals are swept away naturally. *Unlike some of the unhappy side effects of Abx, any side effects of oxygen toxicity are reversible and transient.* In addition, since HBOT is known to make cell walls (both human and pathogen) more permeable, HBOT acts synergistically with Abx and the physician is able to reduce the daily dosing requirements of their Rx. to obtain the same result as Abx alone.

GOOD NEWS . . . Almost all gram-negative protozoa and bacteria do not possess their own supply of superoxide dismutase (SOD). What does this mean? SOD is an enzyme that turns reactive oxygen species (ROS) – also known as free radicals – back into oxygen or its chemical components within the body.

GREAT NEWS . . . the human immune system has the shotgun ability to cope with multiple sub-clinical infections. All that is needed is an exogenous source of energy, best called "God's Gunpowder" – OXYGEN. All of the body's defense and repair systems are oxygen energized and in the case of Lyme and its co-infections, up to 24 times more oxygen is required, dissolved into the body. This can only be done in a hospital-grade hyperbaric oxygen therapy (HBOT) chamber.

Since HBOT increases cellular metabolism, there is a positive requirement to fuel the cells during their increased activity.

Remember, *"Understand the diagnosis, defy the prognosis."* Time to participate in your own survival by looking outside the box. Drilling down into the knowledge of how healthy cells work and what you can add to regain your



Graph is by gracious permission of Best Publishing. *"Hyperbaric Oxygen and Perioperative Care"* Fredrick Cramer, M.D. Et al. RECOMMENDED READING.

In vivo (in the body) effects of adding semi-essential acids (low cost nutrients at the vitamin store) L-Citruline and L-Arginine then increasing cellular metabolism with HBOT. The result is a cascade of activity within the body's organs and cells include *in vivo* production of additional semi-essential amino acids.

Urea: used by the liver and kidneys to eliminate endotoxins.
L-Proline: produces collagen, which makes up app' 1/3 of human body. Skin softens, tendon and muscle repair.
L-Ornithine: central part of the urea cycle and acts as a catalyst in eliminating toxins.
Polyamine: important amino-acid in cell growth and renewal. Exogenous supply (right hand push of equation) dramatically increase cell production.
Argmatine: powerful neurotransmitter especially during stress (nueronal deficits due to endotoxins) or trauma.

Cellular response as shown above cannot be duplicated *in vitro* (in a dish) since none of the body's push-pull switches that act as chaperones and guides to these amino acids are present.

health will assist you. **Consider adding nutrients that act like antibiotics!**

Detrimental effects of Bartonella henslae are counteract by L-arginine and nitric oxide in human endothelial progenitor cells.

"Nutrients have traditionally been viewed as a means to provide basic calories to sustain homeostasis during sedentary style of life and physical exercise However, critically ill, surgical and trauma patients are in a constant dynamic state between systemic inflammatory response and **compensatory anti-inflammatory response. Results from ongoing research support the use of specific nutrients to modulate the immune and/or metabolic response.** ***However, the postulate of using nutrients as a therapeutic substances rather than***

just 'nutritional adjuvant support' requires a shift in current (medical) belief." **(emphasis added) [Ignarro, et al (2007) Nutrition, physical activity and cardiovascular disease: An update. Cardiiovasc Tes 73:326 - 340]**

The authors continued **"Amongst the most common nutrients found in currently available formulas are omega-3 fatty acids, antioxidants, nucleotides, glutamine and L-arginine."** [Detrimental effects of Bartonella henslae are counteract by L-arginine and nitric oxide in human endothelial progenitor cells. Paulo Salvatore, et al, (University of Naples - Italy), Department of Molecuular Pharmacolgy, Geggen School of Medicine, UCLA, U.S.A.]

HBOT actually enhances these easily obtainable (by the patient without the requirement of an M.D. prescription) and low cost nutritional support substances. For example, L-arginine is costs around $15.00 per 300 50 mg capsules at specialist vitamin stores in the United States.

Fife, William P; Freeman, DM (1998). "Treatment of Lyme disease with hyperbaric oxygen therapy". *Undersea and Hyperbaric Medical Society Annual Meeting Abstract*.

The purpose of this study was to determine if hyperbaric oxygen therapy affected Lyme disease caused by the spirochete, Borrelia burgdorferi.

The spirochete B. burgdorferi is a microaerophilic organism carried by the Deer tick (Ixodid) and transferred to humans and other mammals by its bite. Symptoms often begin by a bulls-eye rash and erythema migrans. Symptoms may include pain in joints and muscles, sore throat, fever, swollen glands, and mental " fogginess". If not diagnosed within the first one or two months, the disease may become a chronic infection. At that time it apparently becomes sequestered in fibroblasts and other cells which, in turn appear to protect it against effective treatment by all known antibiotics so far tested. The disease is difficult to diagnose without serological findings and requires the skill of a highly qualified physician, experienced in treating this disease.

Rationale:

It was shown by Austin that the spirochete could not survive if transferred in air to another host, but would survive if transferred in a gas mixture of 4% oxygen. This demonstrated that the spirochete could not survive in an oxygen partial pressure of 160-mm Hg (the partial pressure of oxygen in air), but could survive in a partial pressure of 30-mm Hg (which is the partial pressure of 4% oxygen at 1 atmosphere, absolute (ground level pressure). Therefore, it seems clear that a lethal level of oxygen for the spirochete falls somewhere between 30 mm Hg, and 160 mm Hg.

It also is known that while the inspired partial pressure of oxygen is approximately 160 mm Hg, at the tissue level, the partial pressure of oxygen normally is approximately 30-35 mm Hg. Thus, it would not be expected that breathing air at ground level would cause any damage to the spirochete. However, if the patient were placed in a hyperbaric chamber and the pressure increased to 2. 36 atmospheres, absolute (ata), the total barometric pressure would be 1794 mm Hg. If the patient were then to breathe pure oxygen the inspired partial pressure of oxygen would be 1794 mm Hg. Inspired oxygen is diluted by carbon dioxide and water vapor in the alveoli, so that the arterial blood would be exposed to an oxygen partial pressure of approximately 1700-mm Hg, and the tissue oxygen would be between 200 and 300 mm Hg. This clearly would be above lethal oxygen levels for the spirochete since it is expected that oxygen normally would diffuse throughout all cells of the body.

This partial pressure of oxygen can be safely achieved in a hyperbaric chamber, and the patients can tolerate this level for **90 minutes or longer** quite successfully.

Protocol:

This study was approved by the University Institutional Review Board.

Subjects were selected from those referred by clinical physicians who were experienced in the treatment of Lyme disease. All subjects presented with a positive diagnosis of this disease according to the CDC criteria, including a positive Western blot serology of the proper bands. All had failed intravenous antibiotics, and many were continuing to deteriorate even though still on various antibiotics.

Subjects were given a briefing on the use of the hyperbaric chamber, including the risks, and signed a waiver and release in accordance with the Belmont Report. They were placed in the multiplace chamber and compressed to **2.36 ata**, whereupon a plastic helmet was placed over the head and pure oxygen was administered. The oxygen flow pattern was such that the subject inspired 100% oxygen with each breath. Subjects were able to communicate with the attendant in the chamber as well as with each other.
Treatment duration was 60 minutes on oxygen, and in most instances the treatments were administered bid for 5 days followed by a two-day rest. Several different series were tried, ranging from 10 treatments to 30 treatments. One subject received 145 treatments over the course of 3 months.

Results:

Ninety-one subjects completed a total of 1,995 hyperbaric oxygen treatments, although nine were eliminated later due to the presence of another medical problem not apparent during their treatments. These other medical problems were such things as babesiosis, ehrlichosis, hepatitis C, and previously unidentified neurological problems. Two subjects were eliminated due to the development of septicemia from IV catheters, and one because of recent breast cancer, although all three of them later showed an improvement of Lyme symptoms with hyperbaric oxygen administration.
Subject evaluation was carried out by an abbreviated questionnaire taken from a standard questionnaire used by several Lyme specialists as part of their evaluation. This questionnaire was designed so that zero reflected no symptoms, while ten reflected severe symptoms.
Although additional statistical evaluation still is being carried out, it appears that approximately 84.8% of those treated showed significant improvement by a decrease or elimination of symptoms. Only 12 subjects (13.1%) claimed no apparent benefit.
Before treatment, the subjects had an average score of 114.12 (of a possible 270), and after treatment they averaged 49.27. This reduction of 64.85 points was statistically significant in a paired t-test (p=0.000). The variability of the scores from patient-to-patient declined as well after the treatment series. The standard deviation of the scores was 56.00 before and 44.14 after treatment. The p-value of this reduction is 0.057 in a Fisher's F-test. Further, 58% of the respondents had score reduction of 41.86 points or more.

All except one of the 91 subjects developed severe Jarisch-Herxheimer reaction, usually appearing within the first 5 days of the beginning of hyperbaric oxygen treatment. In most cases, the Jarisch-Herxheimer reaction continued throughout the series of treatments, and in many instances continued for up to a month after the treatments were finished. Most subjects then began to show major improvement that in some instances has continued for 8 months.

Hyperbaric Oxygenation for Lyme Vasculitis

W. P. Fife, Ph. D.
R. A. Neubauer, M. D.

Purpose

It is the purpose of this paper to demonstrate the positive effects of hyperbaric oxygenation on severe encephalopathy occurring in Lyme Disease as a synergistic treatment with antibiotics.

Summary

Lyme disease is a tick-borne disease caused by a Borrelia spirochete, usually Borrelia burgdorferi which was first recognized in late 1975 although a disease resembling Lyme has been recognized in Europe for over 100 years. It is endemic in the northeast United States, but may be found throughout the U.S. The larvae of the tick hatch in the spring and are not infected at birth. However, they become infected from mice or other animal

hosts and hibernate throughout winter. They become active as infected nymphs in the summer and as ticks may be carried by any warm blooded animal. In humans, the disease is especially devastating and may even be fatal. In some instances an entire family may become infected. Since the tick is less than 1 mm in diameter, it often is not seen even when the consequences of the infection appear. The mainstay of therapy for this disease is prompt and efficacious antibiotic therapy. It has been noted that the tick cannot live in a hyperoxic environment and a project was begun by Dr. Fife to utilize hyperbaric oxygenation in conjunction with antibiotics in an attempt to eradicate the spirochete.

Introduction

Lyme disease may be difficult to diagnose because seronegative Lyme Borreliosis is not rare and present tests are not completely reliable. In some instances, even while symptoms are present its antigen may be negative, and it antigens can persist in humans after symptoms disappear, even if antibiotics have been used. For this reason it may not be possible to demonstrate the presence or absence of the spirochete at any particular time. This makes any study of treatments difficult to evaluate and quantify. Further, unless the physician is alert to the possible presence of the disease the test may not be ordered, and the disease may not be included in a differential diagnosis which may include flu like symptoms, fatigue, malaise, arthralgias, myalgias, fever, headache, multiple sclerosis, Alzheimer's disease, motor neuron disease and cardiomyopathies or fatality. Of considerable concern is the fact that tissue cultures show that fibroblasts tend to protect the spirochete against antibiotics, and indeed, several eukaryotic cell types provide the Lyme disease spirochete with a protective environment, contributing to its long-term survival, and possibly explaining the reason for the lack of uniform results from any antibiotic so far tried. Even very toxic drugs such as 5-fluorouacil, trimethoprim and sulfamethoxazole have not inhibited the growth of borreliae.

The seriousness of this disease may be seen by a review of the heroic treatment which often is used. Perhaps the most effective therapy is intravenous antibiotics which when continued for as long as 10 months in some patients still may not destroy the spirochete or relieve the symptoms. (Liegner).

One of the usual initial signs of Lyme infection is painless erythema with a bullseye rash at the site of infection, but the symptoms invariably become exacerbated as the disease develops. There may be abnormalities of the nervous system including cognitive, cardiac myopathies including heart failure, joint and muscle pain, fever, headache, and if not treated may result in inflammatory autoimmune changes of a profoundly crippling nature. Treatment usually is successful if antibiotics are aggressively initiated early in the course of the disease. However, a large number of victims do not respond to any known antibiotic and become permanent invalids. In fact, in advanced stages there does not appear to be any completely effective treatment.

Records show that there were 11,603 new cases of Lyme disease reported nationwide in 1995, and there were 1,703 new cases reported that year in New Jersey alone. The increase in new cases may be seen by the 10-fold increase in reported cases during the past 10 years; with 15,000 new cases being reported in 1999.

The diagnosis and treatment of this disease is often difficult. Present understanding of the human immune response to B. Burgdoferi infection is rudimentary. Firstly, only 2/3 of the patients are seropositive at the initial diagnosis and the serological manifestations are not precise or reliable. For example, the Western Blot, OpsA, or ELISA often are not always positive at the same time. Further, many patients seropositive for several years after all symptoms have disappeared. For this reason, it is not possible at this time to have an objective and reliable way of assessing the effectiveness of any particular treatment. The problem of diagnosis was nicely expressed by Burrascano 12 **who stated,**

"Lyme remains a clinical diagnosis as no currently available test, no matter the source or type, is definitive in confirming whether an infection with Borrelia burgdoferi is present, or if so, whether the infection is active and responsible for the patient's symptoms. The entire clinical picture must be taken into account, including a search for the many subtleties that experienced clinicians have learned to look for. Thus, it is necessary to rely in a major way on the judgment of a physician who has had experience in this disease.

In fact, Liegner has listed "False Teachings" concerning Lyme disease as follows:

1. Patients with late Lyme disease almost invariably are seropositive.

2. 28 days of intravenous antibiotic therapy is virtually always curative: continued symptoms following such treatment means the diagnosis was wrong.

3. Neurological Lyme disease is established by selective intrathecal antibiotic synthesis: In absence one can feel positive that there is no central nervous system infection by B. burgdorferi.

4. It is easy to distinguish neurological Lyme disease from multiple sclerosis.

For these reasons it is difficult to provide an objective diagnosis of Lyme disease based on serology alone.

The use of hyperbaric oxygen therapy for the treatment of Lyme disease was discovered by serendipity in our Laboratory, when hyperbaric oxygenation was used to treat a 14 year-old patient who had developed severe crippling inflammatory arthritis as a result of untreated Lyme disease (personal observation). The result of hyperbaric oxygenation treatment was that all pain disappeared after two weeks of hyperbaric oxygenation therapy and the disease appeared to be halted. Since that time, 17 other Lyme disease patients have been treated for from 10 days to 4 weeks to see if this was a valid observation. Again, the symptoms of Lyme disease disappeared, or nearly so in all patients, and all have continued to improve in the weeks following treatment.

Discussion

The rationale for the use of hyperbaric oxygenation in Lyme disease initially was to suppress the autoimmune effects resulting from B. burgdorferi that had caused the severe arthritic changes and pain, and which had made the patient a permanent invalid.

This was based on previous studies which showed that it was possible to suppress some aspects of the autoimmune system with hyperbaric oxygenation. One indication of this was that if a homogenate of Freunds Adjuvant and bovine brain was injected subcutaneously into the foot pads or nuchal area of adult rats, within several weeks they developed progressive paralysis resembling multiple sclerosis. This disease, called Experimental Allergic Encephalomyelitis or EAE (considered to be an animal model for multiple sclerosis) resulted in an autoimmune response and death. However, if the adjuvant was injected into immature animals and daily hyperbaric oxygenation treatments immediately begun, the onset of the paralysis did not occur and the animals reached adulthood. If the hyperbaric oxygenation treatments then were discontinued, the disease appeared and was quickly fatal. Suppression of the autoimmune system in humans with hyperbaric oxygenation has been known for a number of years.

Since it appears that fibroblasts can protect the spirochete against antibiotics, the question must be raised as to whether hyperbaric oxygenation would penetrate such tissues and have any direct effect on B. burgdorferi. This would appear to be a valid possibility since it is well known that oxygen at an elevated partial pressure effectively saturates all tissues even crossing the blood-brain barrier. The benefit of such penetration would depend upon the sensitivity of the spirochete to elevated levels of oxygen.

The effects of oxygen on this organism was demonstrated by the work of Austin, who showed that in vitro cultures in which the oxygen and carbon dioxide were ambient

(PO 2= 160mm Hg.), there was a loss of infectiveness, while if cultured in 4% 0 2 - 5%CO2,(PO2=30 mm Hg.), the infectiveness remained viable. Since under normal conditions the partial pressure of oxygen at the tissue level is only approximately 30 mm Hg, it would appear doubtful if the organism would be suppressed while the host was breathing air. This study suggest that this organism is sensitive to elevated levels of oxygen which are achieved by hyperbaric oxygenation therapy. If the subject breathes pure oxygen at a barometric pressure of 2.36 atmospheres, absolute (ATA), the inspired P02 will be 1,794 mm Hg, and the tissue oxygen is approximately 300 mm Hg. This may explain why hyperbaric oxygenation appears to be effective in the treatment of this disease.

The possible use of increased oxygen in the treatment of Lyme was also suggested by Dr. Burgdorfer himself, and by Schwan.

Materials and Methods

Because of Dr. Fife's astute observation that hyperbaric oxygenation may be an effective treatment and a possible cure for Lyme disease, 91 patients were begun treatment at Texas A&M. Of these, 75 completed the treatment at anywhere between 40 and 120 exposures of hyperbaric oxygenation at 2.36 ATA, 60-90 minutes per day. These patients were all treated in a multiplace chamber with air and oxygen delivery via mask or hood. At the Ocean Hyperbaric Center twelve patients were treated specifically for their cerebral encephalopathy associated with long-standing Lyme disease. Four such cases will be presented. The protocol used was originated by Dr. Fife, 2.4 ATA, one hour twice a day, five days a week for anywhere from 20 to 200 treatments. Each case had a single photon emission computerized (SPECT) scan prior to treatment and repeat scans were followed sequentially at 20, 40, 80, and at the end of the hyperbaric oxygenation treatments. These scans were performed on an Elscint single headed gamma camera. The isotope used was technetium 99, either Ceretec or Neurolite. The hyperbaric chambers are Vickers monoplace compressed with 100% oxygen. In certain instances after a large number of treatments, early oxygen toxicity was noted in several cases and the pressure was reduced to 2.2 ATA.

Results

In the Fife series, 75% completed the series of pressurized oxygen between 10 and 133 treatments. All except 7 of them experienced significant improvement or cessation of symptoms lasting from three months to six years. In the Fife series, 67% of the patients remained on antibiotics during and after hyperbaric oxygenation. At the Ocean Hyperbaric Center one patient, C.Z., had not been on antibiotics for several years and was not started on them during the treating for his encephalopathy. The other patients all remained on continuous antibiotics and were advised not to stop them for a period of at least three months after which time a SPECT brain scan would be performed to see if there was any deterioration. Of the twelve cases treated at the Ocean Hyperbaric Center, four case reports follow.

Case Reports

1. C.Z.

2. M.K.

Fifty-nine year old white, male professor with Lyme Disease. He remembers being bitten by a tick in 1989, but the diagnosis was not made until 1995. The symptoms have been intermittent and the main problem is that of fatigue, joint aches, and over the past years, short-term memory loss. He also suffers from profuse sweating with the least bit of

energy. He has now had 106 hyperbaric oxygenation treatments and states that his energy level is up, his joint pains are less, and that his memory has improved remarkably. He still has the sweating problems and there is still some degree of fatigue, but is not taking antibiotics.

A fifty-eight year old female who suffered from severe Lyme Disease with marked CNS problems associated with frequent grand mal seizure disorder. She had been tried on virtually all seizure medications but still remained mentally alert and active. Her biggest disappointment was not being able to drive a car. She was seen twelve months after the diagnosis was made at the Ocean Hyperbaric Center. She, however, had been symptomatic and misdiagnosed for 22 years. She was begun on a protocol of 2.4 ATA for 90 minutes, one to two times per day depending upon logistics. Initially the seizure disorder almost virtually disappeared but as the treatments increased in number, it was felt that early oxygen toxicity had ensued and the seizure disorder began to return, but was associated pneumonia requiring hospitalization and different antibiotics. She was followed seriously by neurology. After 25 hyperbaric oxygenation treatments, she was advised by the medical director to discontinue treatment temporarily to see if the seizure disorder could be brought under control with standard drugs. This case illustrates that hyperbaric oxygenation is not a panacea. There was some improvement in the SPECT scan and the actual dose of hyperbaric oxygenation is not really known in Lyme Disease.

3. M.C.:

Forty year old male was diagnosed with Lyme Disease in April of 1997 although symptomatic and undiagnosed for at least twelve months prior. He was a firefighter and became unable to work with severe joint pain, fatigue, and his short-term memory was exceedingly bad. He could read a page or two and not remember anything. He felt "done in and useless". He was begun on a course of hyperbaric oxygenation treatments at 2.4 ATA, for 60-90 minutes, two times per day. He progressed nicely losing the joint aches and pains and fatigue. His memory began to come back to where he was capable of reading an entire volume and remember what was on almost every page. He stated that he had never had an ability to retain things or a memory like this before. Because of continuing improvement clinically and on scans, the patient had a total of 141 hyperbaric oxygenation treatments and felt 100% normal and capable of going back to working as a firefighter full-time. He was advised not to stop the antibiotics abruptly, but to stay in touch with his infectious disease physician and the antibiotics could possibly be discontinued for a period of three months. A repeat SPECT scan should be performed at that time.

4. A. L.

Age 19, remembers that he was bitten by a tick in 1992. Over a period of years when the patient was first treated he developed short-term memory loss, fatigue, headaches, joint pain, depression, and comprehensive problems. On December 22", 1998 a SPECT scan was performed which showed primarily bilateral occipital deficits. After 30 hyperbaric oxygenation treatments his concentration was completely better, his memory was better, his mood was better, and he had considerably less fatigue. The patient did continue the antibiotics while on therapy. The scans showed a substantial filling in of the basic deficits compatible with the clinical improvement.

Conclusion

In the series treated at the Ocean Hyperbaric Center results of SPECT imaging gave documentation that hyperbaric oxygenation was a valid treatment of Lyme Disease. This tended to document the work done by Dr. Fife. **Because of the difficulty in actual**

diagnosis it would be suggested that all patients with possible Lyme Disease should have a SPECT or functional brain imaging. Although these cognitive modes and other anomalies may accompany many other diseases, these changes can also come in Lyme Disease and probably respond to hyperbaric oxygenation irrespective of the cause. The serologic diagnosis is mandatory for Lyme. Although difficult to document the positive effects, the long-term results of Dr. Fife's protocol has established this as a treatment of choice. It was the use of his protocol that resulted in the positive changes in Lyme encephalopathy which paralleled the clinical improvement. Frequently the diagnosis can be made only by an astute physician.

Some subjects discontinued antibiotic therapy during hyperbaric oxygenation treatments while others continued their regular regime of antibiotic therapy, either intravenous or oral. No adverse reactions were anticipated from the administration of pure oxygen at the barometric pressures and exposure times used, except that the Jarisch-Herxheimer reaction was expected to appear in all subjects if destruction of the spirochetes took place. Since the subjects were breathing pure oxygen during most of the time they were in the chamber, no decompression sickness was expected and none did occur with the standard treatment which was used at least 2,000 times each year at Texas A&M. In fact, the body content of nitrogen is decreased during oxygen exposure, thus adding an even greater safety factor against decompression sickness.

At the Ocean Hyperbaric Center it must be noted that pressures of 2.4 ATA for 90 minutes twice a day in certain cases became borderline oxygen toxicity and the pressure was therefore reduced to 2.2 ATA for 90 minutes and then eventually to 2.2 ATA for 60 minutes twice a day. This was represented not by seizure disorder but by periods of fatigue and very transient confusion. This was noted particularly in the cases of M.K. and M.C.

Although further studies are necessary, the possibility exists that since the spirochete is a micro-aerophilic like organism, the use of hyperbaric oxygenation actually may eradicate it, and that with proper treatment duration, and all of the patients may have an ultimate disappearance of positive Lyme symptoms.

Addendum

A question should be raised as to the possibility that Lyme spirochete can be transferred to the fetus if the mother is or becomes infected during pregnancy. Five children so far treated appeared to have been infected in utero. It has been shown that even if the mother is seronegative, the fetus may still present with spirochetes, sometimes with severe consequences. This, in turn raises the possible safety and effectiveness of hyperbaric oxygenation therapy during pregnancy. There are a number of cases in which pregnant patients have required hyperbaric oxygenation for such things as life threatening gas gangrene, or carbon monoxide poisoning. In such cases hyperbaric oxygenation was found not to harm the fetus. It cannot be stated that hyperbaric oxygenation would affect spirochetes in a fetus because of the vasoconstriction of the uterine artery. In **animal studies it has been shown that the fetus does not receive the same partial pressure of oxygen as does the mother. This, of course, raises the question as to whether the fetus can be treated effectively** with hyperbaric **oxygenation. Repeated hyperbaric oxygenation therapy has not been shown to be teratogenic in humans when used in the clinical situation.**

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The inclusion of hyperbaric oxygen therapy (HBOT) in the treatment of Chronic Long Term Lyme Disease ("CLD"), or the preferred term of the Infectious Diseases Society of America ("IDSA") as "Post-Lyme Syndrome" (PLS) --Lyme Disease is controversial, even amongst physicians that have their own HBOT Centers.

Changes are being made constantly in treatment (Tx.) protocols . Therefore this page is updated on a regular basis. Reasons for part-answers to the bullet point questions are given when you scroll to the bottom of this page . . .

Should co-infections such as *erlichia, barbesia*, mycaplasma and *bartonella* be killed with pharmaceuticals before HBOT Tx. commence? . . . **Not sure. Some physicians say "yes" other say "no."** **Lyme co-infections HATE oxygen**

How many HBOT Tx. are needed to get positive results? . . . **Between 26 and 40 if HBOT Tx are on consecutive days. Controversial point amongst HBOT specialist physicians.**

If HBOT Tx. are given on consecutive days with no breaks, will the patient be endangered? . . . **NO. However, transient myopic changes often occur with older patients. Normal vision returns.**

What is the most appropriate HBOT Tx. pressure for the treatment of PLS patients? . . . **The *"Fife Study"* advocates 2.36 - 2.8 ata.**
Will the so called low pressure *mild-hyperbaric* (mHBOT) therapy, as administered in an inflatable bag chamber cure Lyme disease? . . . **NO. Even when pressurized with 100% oxygen, the bag is useless and will not alter the progression of this disease or effect the bacteria causing it.**