

Diagnosis and Therapy of Chronic Systemic Co-infections in Lyme Disease and Other Tick-Borne Infectious Diseases

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Abstract

Often Lyme Disease (LD) patients are initially diagnosed with other illnesses, such as Chronic Fatigue Syndrome. The diagnosis of LD should be based on clinical and laboratory data as well as the likelihood of exposure to the LD spirochete. Virtually all LD patients have multiple co-infections. In addition to the *Borrelia burgdorferi*, the majority of LD patients are also infected with tick-borne mycoplasma, rickettsia and/or protozoa. There are a number of considerations when undergoing therapy for the multiple infections found in chronic LD, including whether to use traditional antimicrobial as well as integrative nutraceutical approaches. Chronic LD requires long-term therapy, including antibiotic/antiprotozoan therapies and dietary supplements to restore immune and gastrointestinal systems as well as mitochondrial function.

Lyme Disease (LD) is the most common tick-borne disease in North America and has been reported in 48 U.S. states and in Eastern Canada. First described in Old Lyme, Connecticut in 1975, the infection is caused by a tick bite and the entry of the spiral-shaped spirochete *Borrelia burgdorferi* and other co-infections.¹ *Borrelia b.* and its co-infections has been carried into new habitats by a variety of ticks, such as the deer, black-legged, lone-star and bear ticks, and their vectors, such as birds, deer, rodents and other mammals. After incubation for a few days to a month, the LD spirochete and co-infections migrate through the subcutaneous tissues into the lymph and blood where they can travel to near and distant host sites.² Transplacental transmission of *Borrelia b.* and co-infections can occur in pregnant animals, including humans, and blood-borne transmission in humans by blood transfusion is likely but unproven. The tick-borne LD co-infections can and usually do appear clinically at the same time.

Often LD patients are diagnosed with other illnesses, such as Chronic Fatigue Syndrome (CFS) or Rheumatoid Arthritis. Since the signs and symptoms of LD overlap with other chronic conditions, this is not unusual. However, many patients with LD have not received an adequate diagnosis for years, and during this period ineffective treatments may have contributed to the refractory nature of the disease.

CLINICAL AND LABORATORY DIAGNOSIS OF TICK-BORNE *BORRELIA BURGENDORFI* INFECTIONS

About one-third of LD cases start with the appearance of a round, red, bulls-eye skin rash (*erythema migrans*) at the site of the tick bite, usually within 3-30 days.² Within days to weeks mild flu-like symptoms can occur that include shaking chills, intermittent fevers and local lymph node swelling. After this localized phase that can last weeks to months, the infection(s) can spread to other sites (disseminated disease), and patients then show malaise, fatigue, fever and chills, headaches, stiff neck, facial nerve palsies (Bell's palsy) and muscle and joint pain and other signs/symptoms.

LD can eventually become persistent or chronic and involve the central and peripheral nervous systems as well as ophthalmic, cardiac, musculoskeletal and internal organ invasion. At this late chronic stage rheumatoid arthritis, neurological impairment with memory and cognitive loss, cardiac problems (myocarditis, endocarditis causing palpitations, pain, bradycardia, etc.) and severe chronic fatigue are often apparent.²⁻⁴ As mentioned above, the signs/symptoms in the late chronic phase of the disease usually overlap with other chronic conditions, such as CFS, Fibromyalgia Syndrome, Rheumatoid Arthritis, among others,⁵ causing confusion in the diagnosis and treatment of the chronic phase in LD patients. Some contend that this late phase is not even related to LD, resulting in failure to successfully identify and treat the chronic condition. The involvement of co-infections, such as *Mycoplasma* species and other co-infections, in causing chronic signs/symptoms in patients has not been carefully investigated; however, such infections on their own have been shown to produce comparable signs/symptoms.⁶

Similar to many chronic illnesses, diagnostic laboratory testing for LD at various clinical stages is, unfortunately, not full-proof, and experts often stress the need to diagnose LD with a checklist of signs and symptoms and potential exposures, along with multiple laboratory tests.^{2,7} The laboratory tests used for LD diagnosis include: detection of *Borrelia b.* surface antigens by enzyme-linked immunoassay (EIA), immunofluorescent assay (IFA), and Western immunoblot of *Borrelia* proteins. Alternatively, polymerase chain reaction (PCR) for *Borrelia* DNA has been used to detect the DNA of the intact organism in blood.

A true-positive test result usually consists of more than one positive test from the above list, usually EIA followed by Western immunoblot. The problem with these tests is that they are blood tests requiring the presence of antibodies or *Borrelia* proteins in the blood, or they are dependent on the spirochete and thus its DNA being present in the blood (PCR). Some of the tests, such as serology testing for antibodies against *Borrelia b.* antigens, show cross-reactivity with other microorganisms and in some cases are only useful 4-6 weeks after onset of signs/symptoms; thus the quality of the tests can vary. The most sensitive type of test (PCR) requires that the spirochete be released into the blood where its DNA can be detected, and this only occurs occasionally, such as within the first week of antibiotic administration.

Other tests that are offered for LD have been criticized. For example, diagnosis of LD based on culture of *B. burgdorferi* is completely unreliable.⁷ One laboratory offers a one-step Lyme antigen urine test (LUAT), but some researchers have criticized this test for its high rate of false-positive tests.⁸ Similarly, some IFA tests are suspect because they are almost universally positive. Most consider a patient positive if *Borrelia b.* antigens (EIA plus Western Blot analysis) are present in blood serum in more than one test, or the patient is PCR-positive for *Borrelia b.*

DIAGNOSIS OF TICK-BORNE CO-INFECTIONS: *MYCOPLASMA*, *BABESIA*, *EHRlichia* AND OTHERS

Co-infections complicate the diagnosis and signs/symptoms of LD. These infections can also occur in various combinations. For example, another tick-borne infection is caused by the intracellular

protozoan *Babesia* spp., first described in domestic animals in Romania.⁹ There are over 100 species of the genus *Babesia*, but most infections in humans in North America are caused by *Babesia microti* and in Europe by *Babesia divergens* and *Babesia bovis*. About 20-40% of cases of LD show *Babesia* co-infections. When both infections are present, the number of signs/symptoms, their severity and duration of illness can be greater in the early stages of disease,⁹ including high fever, chills, generalized weakness, gastrointestinal symptoms (anorexia, nausea, abdominal pain, vomiting, diarrhea, among others), anemia, muscle and joint pain, respiratory problems and dark urine. This combination of infections can be lethal in some patients (about 7% of patients can have disseminated intravascular coagulation, acute respiratory distress syndrome and heart failure), but the majority of patients with *Babesia* spp. have the chronic form of the infection. In *Babesia* infections patients can show mild to severe hemolytic anemia (probably correlating with the protozoan colonization of erythrocytes, which can be seen by experienced individuals in blood smears) and a normal to slightly depressed leukocyte count.⁹ However, this is usually not seen in patients who have progressed to the chronic phase of the disease.

We and others¹⁰ have found that the most common co-infection with *Borrelia b.* are various species of Mycoplasma. Approximately 60-75% of LD patients also have mycoplasmal co-infections (*Mycoplasma fermentans* > *Mycoplasma hominis* > *Mycoplasma pneumoniae*, *M. genitalium*, *M. penetrans*, other species). In some cases multiple mycoplasmal infections are present in LD patients. The presence of mycoplasmal infections complicates the diagnosis and treatment of LD, and some of the generalized signs/symptoms found in *Borrelia*-positive patients are also found in mycoplasma-positive patients.^{5,6}

Like the *Borrelia b.* spirochete, mycoplasmas are found at intracellular locations in various tissues and are only rarely found free in the blood. This can make detection difficult, and in some patients the appearance of *Borrelia b.* and various mycoplasmas in their white blood cells can be cyclic. We recommend testing for mycoplasmal infections in LD using the most sensitive PCR procedures to detect DNA in white blood cells.^{5,6,11} In addition to LD, mycoplasmal infections have been found at high incidence (40-60%) in CFS, Fibromyalgia Syndrome, Rheumatoid Arthritis, Gulf War Illness and neurodegenerative diseases.^{5,6,11,12} These are emerging infections, and the medical community is just beginning to respect the involvement of this type of co-infection in many clinical conditions.

Another co-infection found in some LD patients is a rickettsial infection caused by *Ehrlichia* species.^{2,3} These small, gram-negative, pleomorphic, obligate intracellular infections are similar to mycoplasmas in their structures, intracellular locations and resulting signs/symptoms. Commonly found species are *E. chaffeensis* and *E. phagocytophila*, and these microorganisms can cause signs/symptoms within 1-3 weeks of exposure, such as fever, shaking chills, headache and muscle pain and tenderness and less commonly nausea, vomiting, abdominal pain, diarrhea, cough and confusion.³ Laboratory features include mild to moderate transient hemolytic anemia, decreases in white blood cell count (leucopenia, thrombocytopenia) and elevated erythrocyte sedimentation rate, and sometimes increases in liver enzymes and less often increases in blood urea nitrogen and creatinine. Serology is usually only positive after 1-2 weeks with the limitations discussed above. Since culturing the microorganism is not practical, antibody and PCR testing have been used for confirmation of the infection.³

LD patients are at risk for a variety of other opportunistic infections, including other bacterial infections as well as viral and fungal infections. These can complicate diagnosis and treatment, but they may be principally a problem in the late, chronic phase of the disease. Late stage patients with neurological manifestations, meningitis, encephalitis, peripheral neuropathy and other signs/symptoms may have complicated co-infections that are not recognized or treated by their physicians.

TREATMENT OF LD *BORRELIA* AND CO-INFECTIONS

Most LD patients do well on combinations of antibiotics plus nutritional and nutraceutical support. Experts agree that LD is much easier to treat in the earlier phases, but some of the co-infections can be difficult to treat, especially if the disease is in the late chronic stage. The most common recommendations for the treatment of LD *Borrelia* and co-infections involve antibiotics that can effectively suppress early localized or early disseminated LD *Borrelia*.²⁻⁴ A variety of antibiotics in 2-week regimens show good activity against early-stage *Borrelia* infections, such as combinations of doxycycline plus amoxicillin, doxycycline plus penicillin V and amoxicillin or penicillin V plus cefuroxime axetil, in that order, in terms of effectiveness and expense,^{2,13} although some reports indicate that the latter antibiotics are just as effective as the doxycycline combinations.^{14,15} Also, doxycycline also shows good activity against most species of *Mycoplasma* and *Ehrlichia*, and it also shows good penetration into the central nervous system (CNS). Doxycycline should not be used in children under the age of 8 years, but some have suggested that short duration treatments (2 weeks) at pediatric doses are very useful.¹³ Alternatives include the use of erythromycin, but most experts do not consider this a first line treatment for LD *Borrelia*.^{2,13}

A major problem in the treatment of LD is finding effective treatments of the late chronic stage, especially when they involve the CNS. The table below (Table 1) shows the antibiotics useful for treating LD based on the clinical situation.¹³⁻¹⁵ Since with time (late stage) *Borrelia b.* infections occur intracellularly as cystic or persistent forms, Plaquenil, Falgyl or Tinidazole should be added along with a macrolide (azithromycin, Biaxin or Dynabac) and/or fluoroquinolones (ciprofloxacin, gatifloxacin, levofloxacin, ofloxacin).¹³⁻¹⁷ With antibiotic treatment, Herxheimer reactions (or ‘die-off’ reactions involving chills, fever, night sweats, muscle aches, joint pain, short term memory loss and fatigue or a general worsening of symptoms) usually occur for days to weeks due to release of bacterial cell wall degradation products and stimulation of interleukins or chemical messengers that cause worsening of some signs/symptoms.^{16,17}

To overcome Herxheimer reactions or other adverse responses i.v. antibiotics have been used for a few weeks—then oral. Oral Benadryl (diphenhydramine, 50 mg) taken at least 30 min before antibiotics, and lemon/olive drink (1 blended whole lemon, 1 cup fruit juice, 1 tbs olive oil—strain and drink liquid) have proved useful.¹⁶ This period usually passes within a few weeks and differs from allergic reactions that can cause immediate rashes, itching, swelling, dizziness, trouble breathing and other problems. For LD the dosing for pediatric use has been worked out.²

ANTIBIOTIC THERAPY FOR CO-INFECTIONS OF *BORRELIA*, *MYCOPLASMA*, *BABESIA* AND OTHERS,

Patients with co-infections of *Borrelia plus Mycoplasma* species the therapy should be the same as in Table 1 (with doxycycline) but the duration of therapy must be increased. The reason for this is that slow-growing mycoplasmal infections are not readily susceptible to antibiotics, and thus the therapy must be more gradual.^{6,16,17} Some patients with mycoplasma co-infections may benefit from combinations of antibiotics other than those listed in the table, such as adding additionally azithromycin or a floxacin, especially if there are limited responses.¹⁶ These can be worked into the regimen slowly over weeks, if necessary. The protocol for infections involving *Borrelia plus Mycoplasma* species should be continued for at least 6 months.¹⁷

When *Babesia* infections are present as co-infections with *Borrelia*, patients can be treated with quinine (Quinamm) and clindamycin (cleocin).⁹ For co-infections with *Mycoplasma* or *Ehrlichia* species doxycycline should be added to the antibiotic regimen.³ Dr. Richard Horowitz has presented a scheme for treating co-infections in LD,¹⁹ and I have added advice on *Mycoplasma/Ehrlichia* co-infections (Table 2). If *Chlamydia pneumoniae* is also present, then two penetrating antibiotics active

against these microorganisms should be considered, such as doxycycline plus a fluoroquinolone (levofloxacin, ofloxacin or gatifloxacin).

GENERAL NUTRITIONAL CONSIDERATIONS WHEN UNDERGOING THERAPY

LD patients are often immunosuppressed and susceptible to opportunistic infections, so proper nutrition is imperative.¹⁷ Patients should not smoke or drink alcohol or caffeinated products. Fresh fluids, lots of juices (such as Juice Plus) or pure water are best. It is important that patients avoid high sugar and fat foods, such as military (MRE) or other fast foods and acid forming, allergen-prone and system stressing foods or high sugar/fat junk foods. Increase intake of fresh vegetables, fruits and grains, and decrease intake of fats and *simple or refined sugars that can be immunosuppressive*. Cruciferous vegetables, soluble fiber foods, fish and whole grains are useful. In some patients exclusive use of 'organic' foods has been beneficial. For heavy metal removal, Garlic Plus (Longevity) has been proposed, and we find the use of Detoxamin suppositories useful. For help with bowel bacteria and bladder infections, many recommend D-mannose (Biotech). This natural sugar inhibits binding of bacteria to biological membranes.

Chronic illness patients are often depleted in vitamins (*especially* B complex, C, E, CoQ-10) and certain minerals.¹⁶ These illnesses often result in poor absorption. Therefore, high doses of some vitamins are useful; others, such as vitamin B complex, cannot be easily absorbed so sublingual *natural* B-complex vitamins should be substituted. General vitamins plus extra C, E, CoQ-10, beta-carotene, folic acid, bioflavoids and biotin appear to be best, and L-cysteine, L-tyrosine, L-glutamine, L-carnitine, malic acid and flaxseed or fish oils have been used as supplements. Certain minerals are depleted in chronic illness patients, such as zinc, magnesium, chromium and selenium. Thus extra vitamins and minerals have been used, especially if patients are removing heavy metals with chelating agents. Vitamins and minerals must not be taken at the same time of day as antibiotics (or oxygen therapy), because they can affect absorption.

YEAST/FUNGAL OVERGROWTH WHILE ON ANTIBIOTICS

Yeast overgrowth can occur, especially in females (especially vaginal infections) during antibiotic therapy. Gynecologists recommend Nizoral, Diflucan, Mycelex, or anti-yeast creams. Metronidazole (Flagyl, Prostat) has been used to prevent fungal or parasite overgrowth or other antifungals (Nystatin, Amphotericin B, Fluconazole, Diflucan or Pau d' arco, 7 capsules/2X/day) have been administered for fungal infections that can occur while on antibiotics. Some patients have as their principal problem systemic fungal infections that can be seen using dark field microscopy of blood smears. For superficial fungal infections, such as fungal nail, a topical mixture of Laminsil in 17% DMSO 2X/day is effective. As mentioned above, *L. acidophilus* mixtures are used to restore gut flora. Bacterial overgrowth can also occur, for example, in between cycles of antibiotics or after antibiotics have been stopped.¹⁶

Nutraceutical approaches to controlling yeast infections include: Pau d' arco, grapefruit extract, olive leaf, caprylic acid, garlic extract and oregano oil. Diet is especially important in controlling yeast overgrowth, and the dietary instructions above should be followed, such as the elimination of most simple sugars from the diet.¹⁶⁻¹⁸

OXIDATIVE THERAPY FOR CHRONIC LYME DISEASE CO-INFECTIONS

Borrelia, *Mycoplasma*, *Ehrlichia* and other infections are mostly intracellular and should be considered

borderline anaerobic infections that grow and survive better in low oxygen environments. Oxidative therapy can be useful in suppressing a variety of anaerobic infections, but this approach should be considered experimental and only palliative. We recommend several weeks to months of Hyperbaric Oxygen (1.5-2.0 ATM, 60 min) treatments, because these are well tolerated by most patients with chronic infections.¹⁶ Alternatively, American Biologics Dioxychlor, i.v. ozone or hydrogen peroxide might be useful but should only be undertaken with experienced physicians. Some patients have used peroxide baths with 2 cups of Epsom salt in a hot bath or Jacuzzi. After 5 min, 2-4 bottles 16 oz. of 3% hydrogen peroxide are added. This is repeated 2-3 times per week; but no vitamins must be taken 4 hr before the bath. The hydrogen peroxide is added after skin pores open. This appears to have some benefit to patients, especially those with skin/muscle problems.

Hydrogen peroxide can also be directly applied to skin after a work-out or hot shower/tub. In this case the hydrogen peroxide is left on for 5 min, and then washed off. For oral irrigation, 1 part 3% hydrogen peroxide with 2 parts water can be used like a mouth wash three times per day.¹⁶ Most chronic illness patients have periodontal problems, and oral infections and bone cavitation infections are common.

REPLACEMENT OF GUT FLORA, IMMUNE MODULATORS AND NATURAL REMEDIES

Patients undergoing treatment with antibiotics and other substances risk destruction of normal gut flora, and this can result in over-growth of less desirable bacteria. To supplement bacteria in the gastrointestinal system live *Lactobacillus acidophilus* in capsules or powder have been strongly recommended. Mixtures of *Lactobacillus acidophilus*, *L. bifidus*, *B. bifidum*, *L. bulgaricus* and fructooligosaccharides to promote growth of these probiotics in the gut have also been used. *L. acidophilus* mixtures (above 2.5-3 billion live organisms) should be taken three-times per day. For irritable bowel, the nutraceutical Calm Colon (Samra) has proven to be very effective in clinical trials. A very good probiotic mixture is Theralac (www.theralac.com). In addition, to improve digestion and especially absorption enzyme mixtures have proved useful. The best known of these is Wobenzym.

A number of natural remedies, such as ginseng root, herbal teas, lemon/olive drink, olive leaf extract with antioxidants are sometimes useful, especially during or after antibiotic therapy. More important examples are immune modulators, such as bioactive whey protein (ImuPlus, www.imuplus.com; Immunocal, ImmunoPro), transfer factor (4-Life Transfer Factor, Immuni-T) or MGN3. Some additional remedies are: olive leaf extract (many sources), NSC-100 and Laktoferrin. These products have been used to boost immune systems. Although they appear to help many patients, their clinical effectiveness in chronic illness patients has not been carefully evaluated. They appear to be useful during therapy to boost the immune system or after antibiotic therapy in a maintenance program to prevent relapse and opportunistic secondary infections.

LIPID REPLACEMENT THERAPY FOR CHRONIC INFECTIONS AND RESTORING MITOCHONDRIAL FUNCTION

Lipid Replacement Therapy is useful in providing membrane lipids in unoxidized forms to repair nerve and mitochondrial membranes that are damaged by heavy metals, chemicals and infections.²⁰ For LD patients we recommend the oral supplement Healthy Aging containing NTFactor (Nutritional Therapeutics). This product comes as tablets that are taken twice per day. For children it should be ground up between two spoons into a course powder that can be added to several spoonfuls of applesauce. The NTFactor is not bitter, but it is slightly sour, and some children actually like the taste. The dose should be 4-6 tablets twice per day. For children 1/2-1 tablet for children up to 2 years-old, 2 tablets for 2-3 years old and 3-4 tablets for 4-5 years-old and 4-5 tablets 5 years-old and older.

Research has demonstrated no adverse responses with NTFactor even many times these doses. Since this formulation is a completely natural membrane lipid mixture, there are no known toxicities and no known toxic dose limits. NTFactor can also be taken in a form with vitamins, minerals and probiotics (Propax). Lipid Replacement Therapy has been shown to improve fatigue scores and mitochondrial function in various chronic illnesses.²⁰

References

1. Burgdorfer WA, Barbour AG, Hayes SF, et al. Lyme disease – a tick-borne spirochetosis? *Science* 1982; 216:1317-1319.
2. Kind A, Schned E, Anderson F, et al. Lyme Disease guidelines for Minnesota clinicians: epidemiology, microbiology, diagnosis, treatment and prevention. Minnesota Department of Public Health, 1999. <http://www.state.mn.us/divs/dpc/adps/lyme/guideline>.
3. Gale A, Ringdahl E. Tick-borne diseases. *Amer Fam Physician* 2001; 64:461-466. <http://www.aafp.org/afp/200110801/461>
4. Burrascano JJ, Jr. Advanced topics in Lyme Disease. Diagnostic hints and treatment guidelines for Lyme and other tick borne illnesses. LymeNet On-Line Library, Burrascano Treatment Guidelines, 2000. <http://www2.lymenet.org/domino/file.nsf/UID/guidelines>
5. Nicolson GL, Nasralla M, Franco AR, et al. Diagnosis and Integrative Treatment of Intracellular Bacterial Infections in Chronic Fatigue and Fibromyalgia Syndromes, Gulf War Illness, Rheumatoid Arthritis and other Chronic Illnesses. *Clin Pract Alt Med* 2000; 1(2):92-102. http://www.immed.org/illness/infectious_disease_research
6. Nicolson GL, Nasralla M, Franco AR, et al. Mycoplasmal infections in fatigue illnesses: Chronic Fatigue and Fibromyalgia Syndromes, Gulf War Illness and Rheumatoid Arthritis. *J Chronic Fatigue Syndr* 2000; 6(3):23-39. http://www.immed.org/illness/infectious_disease_research
7. Verdon ME, Sigal LH. Recognition and management of Lyme Disease. *Amer Fam Physician* 1997; 56:427-436. <http://www.aafp.org/afp/970800ap/lymedis>
8. Klemperer MS, et al. Intralaboratory reliability of serologic and urine testing for Lyme disease. *Amer J Med* 2001; 110:217-219.
9. Mylonakis E. When to suspect and how to monitor Babesiosis. *Amer Family Physician* 2001; 63:1969-1974. <http://www.aafp.org/afp/20010515/1969>
10. Eskow E, Adelson ME, Rao RV, Mordechai E. Evidence for disseminated *Mycoplasma fermentans* in New Jersey residents with antecedent tick attachment and subsequent musculoskeletal symptoms. *J Clin Rheumatol* 2003; 9:77-87.
11. Nicolson GL, Gan R, Haier J. Multiple co-infections (*Mycoplasma*, *Chlamydia*, human herpesvirus-6) in blood of chronic fatigue syndrome patients: association with signs and symptoms. *Acta Pathol Microbiol Immunol Scand* 2003; 111: 557-566.
12. Nicolson GL, Berns P, Nasralla M, Haier J, Pomfret J. High frequency of systemic mycoplasmal infections in Gulf War veterans and civilians with Amyotrophic Lateral Sclerosis (ALS). *J Clin Neurosci* 2002; 9:525-529.
13. Eppes SC. Lyme Disease: current therapies and prevention. *Infect Med* 2001; 18:388-395. <http://www.medscape.com/SPC/IIM/2001/v18.n08/m1808.01eppe/mig-pnt-m1808.01eppe>
14. Dattwyler RJ, Volkman DJ, Conaty SM, et al. Amoxicillin plus probenecid versus doxycycline for treatment of erythema migrans borreliosis. *Lancet* 1990; 336:1404-1406.

15. Luger SW, Paparone P, Wormser GP, et al. Comparison of cefuroxime axetil and doxycycline in treatment of patients with early Lyme disease associated with erythema migrans. *Antimicrob Agents Chemother* 1995; 39:661-667.
16. Nicolson GL: Considerations when undergoing treatment for chronic infections found in Chronic Fatigue Syndrome, Fibromyalgia Syndrome and Gulf War Illnesses. (Part 1). Antibiotics Recommended when indicated for treatment of Gulf War Illness/ CFIDS/FMS (Part 2). *Intern J Med* 1998; 1:115-117, 123-128.
<http://www.immed.org/>
17. Nicolson GL, Nasralla M, Franco AR *et al.* Diagnosis and Integrative Treatment of Intracellular Bacterial Infections in Chronic Fatigue and Fibromyalgia Syndromes, Gulf War Illness, Rheumatoid Arthritis and other Chronic Illnesses. *Clin Pract Alt Med* 2000; 1:92-102.
18. Nicolson GL, Ngwenya R. Dietary considerations for patients with chronic illnesses and multiple chronic infections. A brief outline of eighteen dietary steps to better health. *Townsend Lett* 2001; 219:62-65.
http://www.immed.org/illness/treatment_considerations
19. Horowitz R. Lyme Disease and other tick-borne diseases. ILADS Annual Conference, October 29-30, 2005.
20. Nicolson GL, Ellithrope R. Lipid replacement and antioxidant nutritional therapy for restoring mitochondrial function and reducing fatigue in chronic fatigue syndrome and other fatiguing illnesses. *J Chronic Fatigue Syndr* 2006; 13(1):57-68.

Table 1. Treatment of Lyme Disease During the Different Stages of the Disease^{12,13}

<i>Clinical Stage</i>	<i>Time</i>	<i>Primary Treatment</i>	<i>Alternative Treatment</i>
Early localized	3-30 days	doxycycline	erythromycin,
		amoxicillin	clarithromycin
		cefuroxime axetil	azithromycin
Early disseminated	1-12 wks	doxycycline	erythromycin
		amoxicillin	clarithromycin
		cefuroxime axetil	azithromycin
		with CNS involvement	ceftriaxone (iv)
			doxycycline (iv or po)
Late disseminated	>2 months		
with arthritis		amoxicillin	penicillin G (iv)
		doxycycline	doxycycline (iv or po)
with CNS involvement		ceftriaxone (iv)	penicillin G (iv)
			doxycycline (iv or po)
with cardiac involvement		ceftriaxone (iv)	
		amoxicillin	

Table 2. Combination Treatments for Lyme *Borrelia* Plus Co-Infections¹⁷

<i>Lyme Borrelia</i>	<i>Mycoplasma/Ehrlichia</i>	<i>Bartonella</i>	<i>Babesia</i>
Amox+Probenecid+ Macrolide+Plaquenil ±Flagyl/Tinidazole	+Doxycycline	+Septra	+Mepron +Malarone +Artemesia +Lariam
Bicillin+ Macrolide+ Plaquenil ±Flagyl/Tinidazole	+Doxycycline	+Septra	+Mepron +Malarone +Artemesia +Lariam
Cephalosporin (po/iv)+ Macrolide+Plaquenil ±Flagyl/Tinidazole	+Doxycycline	+Septra	+Mepron +Malarone +Artemesia +Lariam
Doxycycline+ Plaquenil ±Flagyl/Tinidazole	+Ciprofloxacin	+Septra +Rifampin	+Lariam +Malarone +Artemesia
Macrolide+Plaquenil ±Flagyl/Tinidazole	+Doxycycline	+Septra +Quinolone	+Mepron +Malarone +Artemesia +Lariam