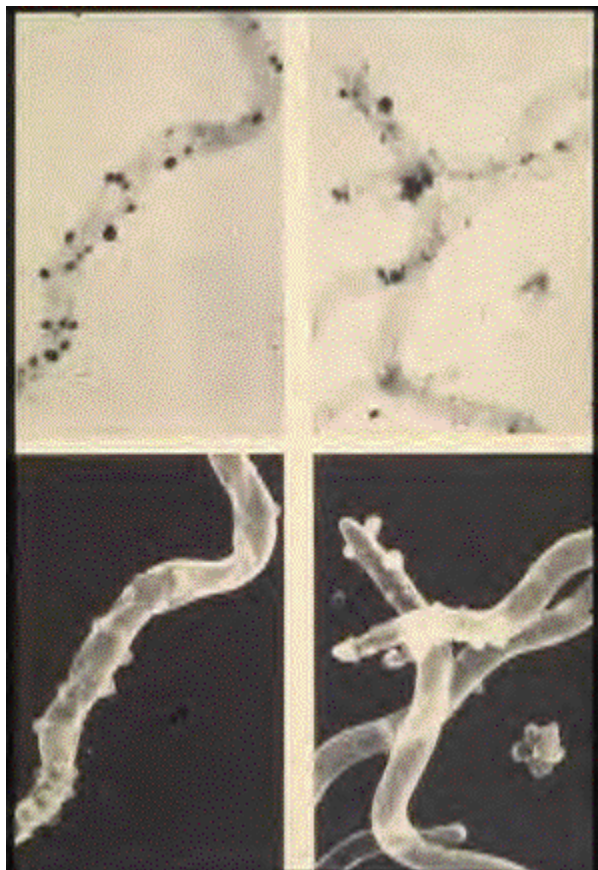


Lyme Disease

Symptoms & Characteristics

A compilation of peer-reviewed literature reports.



Borrelia burgdorferi.

Burgdorfer W. Keynote Address - The Complexity of Vector-borne Spirochetes.
12th International Conference on Lyme Disease and Other Spirochetal
and Tick-Borne Disorders. 1999.

***“Initially thought to be a disorder beginning in the skin and progressing to involve the joints,
Lyme disease is now ranked as one of the great mimickers of other diseases,
in a manner similar to that once ascribed to syphilis.”***

Duray PH. Clinical pathologic correlations of Lyme disease.
Reviews of Infectious Diseases, Vol 11, Suppl. 6: S1487-S1493. 1989.

Contents

I.	<i>Overview of Lyme Disease</i>	1
II.	<i>Symptoms:</i>	
	• General/Constitutional	4
	• Head/Face/Neck	5
	• Ears/Hearing	7
	• Eyes/Vision	8
	• Gastrointestinal System	12
	• Respiratory & Circulatory Systems	15
	• Hepatic System (Liver)	17
	• Musculoskeletal System	18
	• Neurologic System	22
	• Psychological Symptoms	35
	• Cognitive Symptoms	37
	• Reproduction/Sexuality	40
	• Skin/Hair	41
	• Other (including cancer-like presentation)	45
III.	<i>Fatality Reports</i>	46
IV.	<i>Detection of <i>Borrelia burgdorferi</i> in Host Tissues & Fluids</i>	47

Overview & Cause

“Lyme disease, also called Lyme borreliosis, is a widely distributed multi-system disease caused by a tick-transmitted spirochete, *Borrelia burgdorferi*. ...Although other ticks or even flies or other biting insects may transmit the disease in some areas, the usual vectors are small, hard-bodied ticks of the genus *Ixodes*. Within the United States, it is now the most commonly reported tick-transmitted infection.”

Louis Reik, Jr., M.D. *Lyme Disease and the Nervous System*. New York:Thieme Medical Publishers. 1993.

“Although there are regional variations, the basic outlines of this disorder are similar worldwide...”

Steere AC. Lyme disease. *New England Journal of Medicine* 1989;321:586-596.

“Lyme disease... shares many features with the other [human spirochetal] diseases. ...These similarities include a skin or mucous membrane portal of entry...; spirochetemia early in the course of disease, with wide dissemination through tissue and body fluid; and then one or more subsequent stages of disease, often with intervening latent periods. ...chronic arthritis is unique to Lyme disease.”

Schmid GP, Centers for Disease Control. Epidemiology and clinical similarities of human spirochetal diseases. *Rev Infect Dis* 1989;11(Suppl 6):S1460-9.

“Although Lyme disease was initially described as a form of juvenile arthritis following the development of erythema chronicum migrans..., it is now known to be a multisystem disease, with prominent neurologic involvement.”

Halperin JJ; Little BW; Coyle PK; Dattwyler RJ. Lyme disease: Cause of a treatable peripheral neuropathy. *Neurology* 1987;37:1700-6.

Protean Clinical Manifestations

“Clinically, this borrelial infection is most like syphilis in its multisystem involvement, occurrence in stages, and mimicry of other diseases. ...Lyme disease’s great range of presentations can make recognition difficult.”

Steere AC. Lyme disease. *New England Journal of Medicine* 1989;321:586-596.

“...it should be emphasized that marked variation is possible in the clinical expression of the disease. Even without treatment, some patients have very mild disease... At the opposite end of the spectrum, an occasional patient will have severe involvement of the skin, nerves, heart, and joints at the same time.”

Steere AC; Malawista SE; et al. The clinical spectrum and treatment of Lyme disease. *Yale Journal of Biology and Medicine* 1984;57(4):453-64.

“Symptoms can be surprisingly variable, so that days of near normality can alternate with days of profound debility.”

Pachner AR. Early disseminated Lyme disease. *American Journal of Medicine* 1995;98 (suppl):4A-30S-43S.

“As in other spirochetoses, such as syphilis, the symptoms may be fulminant, with a sudden onset, or may develop insidiously over many years. The variable clinical manifestations have led to an awareness of this disorder as a “great imitator” that must be considered in the differential diagnosis of numerous complaints, especially in those geographic areas where the spirochete is endemic.”

Cooke WD; Dattwyler RJ. Complications of Lyme borreliosis. *Annual Review of Medicine* 1992;43:93-103.

“Lyme disease has now been shown to involve nearly every organ and organ system in both sexes.”

Duray PH. Clinical pathologic correlations of Lyme disease. *Rev Infect Dis* 1989;Vol 11(Suppl. 6):S1487-S1493.

Variable Temporal Sequence

“Early infection consists of stage 1 (localized erythema migrans), followed within days or weeks by stage 2 (disseminated infection) and within weeks or months by intermittent symptoms. Late infection, or stage 3 (persistent infection), usually begins a year or more after the onset of the disease. A patient may have one or all of the stages, and the infection may not become symptomatic until stage 2 or 3.”

Steere AC. Lyme disease. *New England Journal of Medicine* 1989;321:586-596.

“In practice, however, infection forms a continuum along which early and late features may overlap.”

Coyle PK; Schutzer SE. Neurologic presentations in Lyme disease. *Hospital Practice* 1991; 6(11):55-66.

“Illness can begin in any one of these organ systems, the systems are not always involved sequentially, other skin lesions can develop in later stages, and neurologic abnormalities can accompany arthritis.”

Louis Reik, Jr., M.D. *Lyme Disease and the Nervous System*. New York:Thieme Medical Publishers. 1993.

“In syphilis, ...staging is particularly useful because it is likely that the pathophysiology of stage 2 and stage 3 disease differs; this is far less clear with neuroborreliosis. Considerable data suggest that the differences between early and late neuroborreliosis are more quantitative than qualitative, with the different syndromes representing different points on a continuum, all with the same pathophysiologic mechanism. Moreover, the clinical phenomena in neuroborreliosis often do not follow an obligatory temporal sequence; any symptoms may develop without an antecedent stage 1 illness. For example, arthritis (generally considered stage 3 disease) may occur early, on occasion even preceding EM; meningitis (nominally stage 2) may develop after arthritis, and so on. All this suggests that dividing neuroborreliosis into early versus late phenomena, while occasionally reassuring to the physician and patient, may lack pathophysiologic validity.”

Halperin JJ. Neuroborreliosis. *Am J Med* 1995;Vol 98(4A):52S-56S.

Waxing & Waning Symptoms / Latent Periods

“This pattern of persistent infection, acute disease, disease remission, and intermittent bouts of exacerbation is typical of untreated human Lyme disease.”

Barthold SW; de Souza MS; Janotka JL; Smith AL; Persing DH. Chronic Lyme borreliosis in the laboratory mouse. *Am J Path* 1993;143(3):959-71.

“Some of the symptoms are present only for a rather short period of time. For instance, palpitations may be noted only for a few minutes, and patients may have only one to five attacks of palpitations.”

Weber K; Neubert U; Büchner SA. Erythema migrans and early signs and symptoms. In *Aspects of Lyme Borreliosis*, ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 105-121. 1993.

“[Lyme disease] is similar to syphilis in that, if left untreated, the disease tends to progress in stages with extended periods where the patient may feel totally asymptomatic.” / “The 20 to 30 year period between primary and tertiary syphilis is the classical statement regarding the chronic condition. In this regard, we already know that certain manifestations of Lyme disease can take up to a decade to develop.”

Benach JL; Coleman JL. Overview of spirochetal infections. In *Lyme Disease*, ed. Coyle PK. St. Louis: Mosby-Year Book Inc., pp.61-68. 1993.

“The syphilis spirochete can live in the CNS for long periods, as evidenced by the fact that patients with general paresis usually do not manifest neurologic symptoms until 15 years after infection. A lengthy latency within the CNS also appears to exist in Lyme disease, with neurologic symptoms not becoming manifest for months or even years.”

Pachner AR. Neurologic manifestations of Lyme disease, the new “Great Imitator.” *Rev Inf Dis* 1989;Vol. 11(Suppl 6):S1482-6.

Geographic Distribution & Spread

“Lyme disease has been reported from five continents—Africa, Asia, Australia, Europe, and North America. ...In North America, Lyme disease occurs in both the United States and Canada. Within the United States, it is now the most commonly reported tick-transmitted infection...The disease is endemic along the East Coast from Maryland to Massachusetts, in the upper Midwest in Minnesota and Wisconsin, and on the Pacific coast in California and Oregon. Increasing numbers of cases have also been reported from mid-Atlantic, southeastern, midwestern, and southcentral states. But the illness remains most common in the states from which it was originally reported...New York, New Jersey, Pennsylvania, Connecticut, Massachusetts, Rhode Island, Wisconsin, and Minnesota. ...Lyme disease is both widespread and common in Europe where thousands of cases are estimated to occur each year. The disease is most common in Austria, Germany, France, Sweden, and Switzerland. But is also occurs in the three other Scandinavian countries, Belgium, Czechoslovakia, Hungary, Italy, the Netherlands, Romania, Spain, the United Kingdom, the USSR, and Yugoslavia.”

Louis Reik, Jr., M.D. *Lyme Disease and the Nervous System*. New York:Thieme Medical Publishers. 1993.

“Patients with the disease have also been found in China, Japan, and Australia.”

Steere AC. Lyme disease. *New England Journal of Medicine* 1989;321:586-596.

“B. burgdorferi-infected ticks may be transported from Lyme-endemic areas into nonendemic areas, which may establish new Lyme-endemic foci. Infected I. ricinus complex ticks (including I. scapularis) and infected I. uriae have been found on migratory birds and along migratory “flyways”; they may be transported into new areas by these birds as they travel between endemic and nonendemic areas, including counties, states, countries, continents, and even hemispheres.”

Gardner T. Lyme disease. In *Infectious Diseases of the Fetus and Newborn Infant*, ed. Remington JS; Klein JO. Philadelphia:W.B. Saunders Co. pp. 519-641. 2001.

Co-Infections & Disease Severity

“In medicine, general emphasis has been to explain most of the manifestations with a single diagnosis; however, in vector borne diseases, multiple infections can occur in the same patient.”

Jacobi C; Schwark C; Kress B; Hug A; et al. Subarachnoid hemorrhage due to *Borrelia burgdorferi*-associated vasculitis. *Eur J Neurol* 2006;13(5):536-8.

“Any disease developing as a result of tick bite should be regarded as a potentially mixed infection. Clinically, tick-borne mixed infections proceed more severely than the corresponding diseases caused by a single agent.”

Korenberg EI. Problems in the study and prophylaxis of mixed infections transmitted by ixodid ticks. *Int J Med Microbiol* 2004;293 Suppl 37:80-5.

“...human coinfections involving various combinations of these pathogens [*Lyme disease, babesiosis, and ehrlichiosis*] are common, and some tend to be particularly severe.”

Thompson C; Spielman A; Krause PJ. Coinfecting deer-associated zoonoses: *Lyme disease, babesiosis, and ehrlichiosis*. *Clinical Infectious Diseases* 2001;33(5):676-85.

“...symptoms and duration of illness in patients with concurrent infections can be greater than in those with either infection alone.”

Sweeney CJ; Ghassemi M; Agger WA; Persing DH. Coinfection with *Babesia microti* and *Borrelia burgdorferi* in a western Wisconsin resident. *Mayo Clinic Proceedings* 1998;73(4):338-341.

“In tick-dominated areas, patients should always be tested for coinfection with *Ehrlichia, Babesia, and Borrelia burgdorferi*.”

Javed MZ; Srivastava M; Zhang S; Kandathil M. Concurrent babesiosis and ehrlichiosis in an elderly host. *Mayo Clinic Proceeding* 2001;76(5):563-5.

“Our data implicate *B henselae* as a potential human tick-borne pathogen. Patients with a history of neuroborreliosis who have incomplete resolution of symptoms should be evaluated for *B henselae* infection.”

Eskow E; Rao RV; Mordechai E. Concurrent infection of the central nervous system by *Borrelia burgdorferi* and *Bartonella henselae*: evidence for a novel tick-borne disease complex. *Archives of Neurology* 2001;58(9):1357-1363.

Infection Rates: I. Scapularis Ticks in Northeastern United States

Connecticut:

Woodbridge, CT: 32.9% of nymphal ticks / 52.6% of adult ticks positive for Lyme disease

Bridgeport, CT: 32.7% of nymphal ticks / 55.0% of adult ticks positive for Lyme disease

Findings reported in: Levin ML; des Vignes F; Fish D. Disparity in the natural cycles of *Borrelia burgdorferi* and the agent of Human Granulocytic Ehrlichiosis. *Emerg Infect Dis* 1999;Vol 5(2):204-8.

New Jersey:

“Using polymerase chain reaction, we analyzed 529 *Ixodes scapularis* Say adults collected from 16 of New Jersey's 21 counties for the presence of *Borrelia burgdorferi*, the etiological agent of Lyme disease.

Overall, 261 (49.3%) were positive.”

Schulze TL; Jordan RA; Hung RW; Puelle RS; Markowski D; Chomsky MS. Prevalence of *Borrelia burgdorferi* in *Ixodes scapularis* adults in New Jersey, 2000-2001. *J Med Entomol* 2003;40(4):555-8.

“PCR analysis of *Ixodes scapularis* ticks collected in New Jersey identified infections with *Borrelia burgdorferi* (33.6%), *Babesia microti* (8.4%), *Anaplasma phagocytophila* [Ehrlichiosis] (1.9%), and *Bartonella* spp. (34.5%).”

Adelson ME; Rao RV; Tilton RC; Cabets K; Eskow E; Fein L; Occi JL; Mordechai E. Prevalence of *Borrelia burgdorferi*, *Bartonella* spp., *Babesia microti*, and *Anaplasma phagocytophila* in *Ixodes scapularis* ticks collected in Northern New Jersey. *J Clin Microbiol* 2004;42(6):2799-2801.

Pennsylvania:

Northwestern PA: 61.6% positive for Lyme disease; 1.9% positive for Ehrlichiosis

Southeastern PA: 13.1% positive for Lyme disease; 39.8% positive for Ehrlichiosis

Findings reported in: Courtney JW; Dryden RL; Montgomery J; et al. Molecular characterization of *Anaplasma phagocytophilum* and *Borrelia burgdorferi* in *Ixodes scapularis* ticks from Pennsylvania. *Journal of Clinical Microbiology* 2003;41(4):1569-1573.

Symptoms	Citations
General/Constitutional	<p><i>“These symptoms are typically intermittent and changing, with the exception of fatigue, which is often persistent and may be debilitating.”</i></p> <p>Clinical manifestations of Lyme disease in the United States. Trock DH; Craft JE; Rahn DW. Connecticut Medicine, 53(6). 1989.</p>
Achiness (generalized)	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
Chills “Chills were common, but not rigors.” (1)	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
Fatigue/Malaise/Lethargy Most common symptom. “some patients felt profoundly weak” (1) “often constant and may be incapacitating” (2) “Fatigue is common in all stages of symptomatic infection.” (3)	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) The clinical spectrum and treatment of Lyme disease. Steere AC; Malawista SE; Bartenhagen NH; Spieler PN; Newman JH; Rahn DW; et al. Yale Journal of Biology and Medicine, 57(4):453-64. 1984.</p> <p>(3) Neurologic presentations in Lyme disease. Coyle PK; Schutzer SE. Hospital Practice, 26(11):55-66; discussion 66, 69-70. 1991.</p>
Fever “Fever is usually absent.” (1) [In early stage disease:] “Fever was reported in 30% of patients but was documented at office evaluation in only 6%.” (2) [In early stage disease:] “typically low-grade and intermittent. However, children in particular sometimes had high (up to 40°C) or persistent temperature elevations.” (3)	<p>(1) Clinical manifestations of Lyme disease. Sigal L. New Jersey Medicine, 87(7):549-555. 1990.</p> <p>(2) Clinical characteristics and treatment outcome of early Lyme disease in patients with microbiologically confirmed erythema migrans Smith RP; Schoen RT; Rahn D; Sikand VK; Nowakowski J; Parenti DL; Holman M; Persing, DH; Steere AC. Annals of Internal Medicine, 136(6):421-428. 2002.</p> <p>(3) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
Swollen glands (lymphadenopathy) “Lymph node swelling of the neck and groin” (2) “Regional (and occasionally systemic) lymphadenopathy may occur.” (3)	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(3) Clinical manifestations of Lyme disease. Sigal L. New Jersey Medicine, 87(7):549-555. 1990.</p>
Stiffness generalized or hand (1)	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
Sweating profuse sweating (1)	<p>(1) Clinical features of early erythema migrans disease and related disorders. Weber K; Neubert U. Zentralbl Bakteriol Mikrobiol Hyg (A), 263:209-228. 1986.</p>
Thirst “increased thirst”	<p>(1) Lyme meningoencephalitis -- report of a severe, penicillin resistant case. Diringer MN; Halperin JJ; Dattwyler RJ. Arthritis & Rheumatism, 30:705-708. 1987.</p>

Symptoms	Citations
<p>Head/Face/Neck</p>	<p><i>“We review our institutional experience with 266 patients with Lyme disease, 75% of whom experienced head and neck symptoms.”</i> Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. Laryngoscope, 101(6 Pt 1):592-5. 1991.</p>
<p>Bell’s palsy (uni or bilateral) “Bell’s palsy—is among those telltale diagnostic signs, particularly when it is bilateral. It is associated with the early disseminated phase of the infection. ...About a third of the time, the palsy in Lyme disease is bilateral, but both sides of the face may not be equally affected and involvement can be subtle.” (2)</p> <p>“Bilateral Bell’s palsy...almost constitutes a firm clinical sign that a given patient in an endemic area with bi-lateral Bell’s palsy has Lyme disease until proven otherwise.” (3)</p> <p>“Lyme disease has been implicated as the cause of over 50% of the FNPs [facial nerve palsies] in children.” (4)</p>	<p>(1) Lyme borreliosis in Bell’s palsy. Long Island neuroborreliosis collaborative study group. Halperin JJ; Golightly M. Neurology, 42(7):1268-70. 1992.</p> <p>(2) Neurologic presentations in Lyme disease. Coyle PK; Schutzer SE. Hospital Practice, 26(11):55-66; discussion 66, 69-70. 1991.</p> <p>(3) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(4) Acute onset of facial nerve palsy associated with Lyme disease in a 6 year-old child. Siwula JM; Mathieu G. Pediatr Dent, 24(6):572-4. 2002.</p>
<p>Facial/Oralfacial/Dental pain “clinical manifestations may include facial and dental pain, facial nerve palsy, headache, temporomandibular joint pain, and masticatory muscle pain.” (1)</p>	<p>(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. Laryngoscope, 101(6 Pt 1):592-5. 1991.</p> <p>(2) Lyme disease: considerations for dentistry. Heir GM; Fein LA. J Orofacial Pain, 10:74-86. 1996.</p>
<p>Headache “typically intermittent (hours)... but could be generalized or persistent.” [some] “had excruciating headache” (1)</p> <p>“Our patients show that headache can be the first, and for a long time the only, prominent sign of Lyme neuroborreliosis” (2)</p> <p>“headaches resembling migraine,... tension-type headache... we conclude that recent-onset headaches are common in patients hospitalized with Lyme disease.” (3)</p>	<p>(1) The triad of neurologic manifestations of Lyme disease: meningitis, cranial neuritis, and radiculoneuritis. Pachner AR; Steere AC. Neurology, 35(1):47-53. 1985.</p> <p>(2) Headache resembling tension-type headache as the single manifestation of Lyme neuroborreliosis. Brinck T; Hansen K; Olesen J. Cephalalgia, 13(3):207-9. 1993.</p> <p>(3) Headache characteristics in hospitalized patients with Lyme disease. Scelsa SN; Lipton RB; Sander H; Herskovitz S. Headache, 35(3):125-30. 1995.</p>
<p>Hoarseness</p> <p>[Hoarseness was reported in 4.9% of 266 patients studied.] (1)</p>	<p>(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. Laryngoscope, 101(6 Pt 1):592-5. 1991.</p> <p>(2) Clinical features of early erythema migrans disease and related disorders. Weber K; Neubert U. Zentralbl Bakteriol Mikrobiol Hyg (A), 263:209-228. 1986.</p>
<p>Jaw pain, stiffness, or temporomandibular joint disorder (TMJ) “Fourteen patients demonstrated temporomandibular joint pain. Of these, 10 patients exhibited other coexisting arthralgias.” (1)</p>	<p>(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. Laryngoscope, 101(6 Pt 1):592-5. 1991.</p> <p>(2) Lyme disease misdiagnosed as a temporomandibular joint disorder. Lader E. J Prosthet Dent, 63(1):82-5. 1990.</p>

Symptoms	Citations
Muscle spasm - facial	(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. <i>Laryngoscope</i> , 101(6 Pt 1):592-5. 1991.
Neck pain, stiffness, or pressure “sometimes marked” (1) “The most common associated symptoms [in early Lyme disease] were low-grade fever, headache, <i>neck stiffness</i> , arthralgia, myalgia, or fatigue.” (2) [italics added] “Headache and mild neck stiffness, which fluctuated in intensity... were the common findings.” (3)	(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. <i>Annals of Internal Medicine</i> , 99(1):76-82. 1983. (2) Clinical characteristics and treatment outcome of early Lyme disease in patients with microbiologically confirmed erythema migrans. Smith RP; Schoen RT; Rahn DW; Sikand VK; Nowakowski J; Parenti DL; Holman MS; Persing DH; Steere AC. <i>Ann Intern Med</i> , 136(6):421-8. 2002. (3) Neurological findings of Lyme disease. Pachner AR; Steere AC. <i>Yale Journal of Biology & Medicine</i> , 57(4):481-3. 1984.
Numbness/tingling – facial “facial paresthesia” ”facial hypesthesia” (1) “he developed paresthesia in his tongue” (2)	(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. <i>Laryngoscope</i> , 101(6 Pt 1):592-5. 1991. (2) [A patient with neuroborreliosis presenting gadolinium-enhanced MRI lesions in bilateral facial nerves.] Tokunaga H; Ohyagi Y; Furuya H; Araki T; Yamada T; Isogai E; Kira J. <i>Rinsho Shinkeigaku</i> , 41(9):632-4. 2001.
Sore throat “nonexudative” (1) “pharyngitis” (2) “These [neurological] symptoms were preceded by an uncharacteristic syndrome with fever, myalgia and <i>pharyngitis</i> in two cases.” (3) [italics added]	(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. <i>Annals of Internal Medicine</i> , 99(1):76-82. 1983. (2) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. <i>Annals NY Academy of Sciences</i> , 539:65-79. 1988. (3) Chronic progressive neurological involvement in <i>Borrelia burgdorferi</i> infection. Weder B; Wiedersheim P; Matter L; Steck A; Otto F. <i>Journal of Neurology</i> , 234(1):40-3. 1987.
Swelling – facial	(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. <i>Laryngoscope</i> , 101(6 Pt 1):592-5. 1991.
Swallowing difficulty “Dysphagia” (1)	(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. <i>Laryngoscope</i> , 101(6 Pt 1):592-5. 1991. (2) Dermatomyositis associated with Lyme disease: case report and review of Lyme myositis. Horowitz HW; Sanghera K; Goldberg N; Pechman D; Kamer R; Duray P; Weinstein A. <i>Clin Infect Dis</i> , 18(2):166-71. 1994.
Twitching of facial or other muscles “the other [patient] has had intermittent facial twitches for eight months. [post treatment]” (1)	(1) Isolation of <i>Borrelia burgdorferi</i> from the blood of seven patients with Lyme disease. Nadelman RB; Pavia CS; Magnarelli LA; Wormser GP. <i>American Journal of Medicine</i> , 88:21-6. 1990.
Vocal paralysis “We have seen a case where serologically confirmed <i>B burgdorferi</i> infection was associated with paralysis of the recurrent laryngeal nerve.” (1)	(1) Paralysis of recurrent laryngeal nerve in Lyme disease. Schroeter V; Belz GG; Blenk H. <i>Lancet</i> , 2(8622):1245. 1988.

Symptoms	Citations
<p>Ears/Hearing</p>	<p><i>“Otolaryngologic manifestations have been reported in all stages of the disease.”</i></p> <p>Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. Laryngoscope, 101(6 Pt 1):592-5. 1991.</p>
<p>Deafness/Hearing loss “Bilateral hearing loss was noted in 4 patients” (1)</p> <p>“bilateral deafness and multiple other neurological complaints some six months after developing a ‘target’ lesion on the lower leg” (2)</p> <p>“[Lyme disease] has been shown to cause asymmetrical sensorineural hearing loss” (3)</p> <p>“Among the 27 patients, associated symptoms included fatigue (74 percent), headache (48 percent), arthritis (37 percent), and hearing loss (15 percent).” (4)</p>	<p>(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. Laryngoscope, 101(6 Pt 1):592-5. 1991.</p> <p>(2) Reversible sensorineural hearing loss in Lyme disease. Quinn SJ; Boucher BJ; Booth JB. J Laryngol Otol, 111(6):562-4. 1997.</p> <p>(3) Should we routinely screen for Lyme disease in patients with asymmetrical hearing loss? Richardson H; Birchall JP; Hill J; McMaster T. Br J Audiol, 28(2):59-61. 1994.</p> <p>(4) Chronic neurologic manifestations of Lyme disease. Logigian EL; Kaplan RF; Steere AC. New England Journal of Medicine, 323(21):1438-44. 1990.</p>
<p>Hypersensitivity to sound, hyperacusis “increased sensitivity to noise” (1)</p> <p>“Lyme disease-induced hyperacusis can be an intensely disabling, chronic condition that is accompanied by posttraumatic stress disorder-like psychobehavioral sequelae.” (2)</p>	<p>(1) Neurologic presentations in Lyme disease. Coyle PK; Schutzer SE. Hospital Practice, 26(11):55-66; discussion 66, 69-70. 1991.</p> <p>(2) Carbamazepine in the treatment of Lyme disease-induced hyperacusis. Niels JA; Fallon BA; Jastreboff PJ. J Neuropsychiatry Clin Neurosci, 11(1):97-9. 1999.</p>
<p>Meniere's disease “Lyme disease can manifest itself as Meniere's disease both clinically and electrophysiologically” (1)</p>	<p>(1) Use of electrocochleography for assessing endolymphatic hydrops in patients with Lyme disease and Meniere's disease. Selmani Z; Pyykko I; Ishizaki H; Ashammakhi N. Acta Otolaryngol, 122(2):173-8. 2002.</p>
<p>Pain in ears “Otalgia” (2)</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. Laryngoscope, 101(6 Pt 1):592-5. 1991.</p>
<p>Ringing in ears (tinnitus) “Six patients had sensorineural hearing loss and five had concomitant tinnitus, two bilateral and three unilateral.” (3)</p>	<p>(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. Laryngoscope, 101(6 Pt 1):592-5. 1991.</p> <p>(2) Latent Lyme neuroborreliosis: presence of <i>Borrelia burgdorferi</i> in the cerebrospinal fluid without concurrent inflammatory signs. Pfister HW; Preac-Mursic V; Wilske B; Einhüpl KM; Weinberger K. Neurology, 39(8):1118-20. 1989.</p> <p>(3) Lyme borreliosis -- an unusual cause of vertigo. Peltomaa M; Pyykkö I; Seppälä I; Viljanen M. Auris Nasus Larynx, 25:233-242. 1998.</p>

Symptoms	Citations
<p>Eyes/Vision</p>	<p>“Ophthalmologic manifestations of Lyme borreliosis may occur alone or in combination with other manifestations of Lyme borreliosis.” Lyme disease. Gardner T. In <i>Infectious Diseases of the Fetus and Newborn Infant</i>, Ed. Remington JS; Klein JO. Philadelphia:W.B. Saunders Company. pp. 519-641. 2001.</p> <p>“Erlchiosis, babesiosis, and Lyme disease may occur together and affect the eye or orbit.” The ticking time bomb. Pendse S; Bilyk JR; Lee MS. Survey of Ophthalmology, 51(3):274-9. 2006.</p> <p>“Late-phase ocular Lyme borreliosis is probably underdiagnosed because of weak seropositivity or seronegativity in ELISA assays. Ocular borrelial manifestations show characteristics resembling those seen in syphilis.” Diagnosis and clinical characteristics of ocular Lyme borreliosis. Karma A; Seppala I; Mikkila H; Kaakkola S; Viljanen M; Tarkkanen A. Am J Ophthalmol, 119(2):127-35. 1995.</p> <p>“...as in other spirochetal infections, high-dose systemic antibiotics are required when B. burgdorferi causes ocular symptoms.” Clinical manifestations of Lyme disease in the United States. Troek DH; Craft JE; Rahn DW. Connecticut Medicine, 53(6):327-330. 1989.</p>
<p>Blindness</p> <p>“The fourth child had headache and visual loss attributable to increased intracranial pressure and perhaps also to optic neuritis. Despite treatment with ceftriaxone and steroids, he had persistent increased intracranial pressure leading to permanent bilateral blindness.” (3)</p> <p>“Long-standing intraocular inflammation results in loss of vision.” (4)</p>	<p>(1) Unilateral blindness caused by infection with the Lyme disease spirochete, <i>Borrelia burgdorferi</i>. Steere AC; Duray PH; Kauffmann DJ; Wormser GP. Annals of Internal Medicine, 103(3):382-4. 1985.</p> <p>(2) Ocular Lyme disease: case report and review of the literature. Kauffmann DJ; Wormser GP. British Journal of Ophthalmology, 74(6):325-7. 1990.</p> <p>(3) Optic neuropathy in children with Lyme disease. Rothermel H; Hedges TR 3rd; Steere AC. Pediatrics, 108(2):477-81. 2001.</p> <p>(4) Schönherr U; Strle F. In <i>Aspects of Lyme Borreliosis</i>, Ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 248-258. 1993.</p>
<p>Choroiditis</p> <p>“Choroiditis was the first recognized manifestation of Lyme disease in this patient. ... Ophthalmoscopy demonstrated multifocal choroiditis, with 1 focus involving the macula lutea.” (1)</p>	<p>(1) Persistence of <i>Borrelia burgdorferi</i> in ligamentous tissue from a patient with chronic Lyme borreliosis. Haupt T; Hahn G; Rittig M; Krause A; Schoerner C; Schonherr U; et al. Arthritis Rheum, 36(11):1621-6. 1993.</p>

Symptoms	Citations
<p>Conjunctivitis “Conjunctivitis, probably the most common ocular borrelial manifestation, usually occurs within the first weeks of infection. ...However, the DNA of <i>B. burgdorferi</i> in the conjunctiva of one of our patients with prolonged follicular conjunctivitis indicates that conjunctival involvement is occasionally a late and long-standing manifestation and that it may be the result of an ongoing infection.” (1)</p> <p>“Conjunctivitis has been reported in 10% to 20% of patients.” (3)</p> <p>“Conjunctivitis and episcleritis are the most frequent manifestations of the early stage.” (4)</p> <p>“A 35-year-old woman presented with a bilateral palpebral follicular conjunctivitis. Subsequently, she developed a bilateral keratitis and, on a separate occasion, an episcleritis”(5)</p>	<p>(1) The expanding clinical spectrum of ocular Lyme borreliosis. Mikkila HO; Seppala IJ; Viljanen MK; Peltomaa MP; Karma A. <i>Ophthalmology</i>, 107(3):581-7. 2000.</p> <p>(2) The clinical spectrum of early Lyme borreliosis in patients with culture-confirmed erythema migrans. Nadelman RB; Nowakowski J; Forseter G; Goldberg NS; Bittker S; Cooper D; Aguero-Rosenfeld M; Wormser GP. <i>American Journal of Medicine</i>, 100(5):502-8. 1996.</p> <p>(3) Cognitive functioning in late Lyme borreliosis. Krupp LB; Masur D; Schwartz J; Coyle PK; Langenbach LJ; Fernquist SK; Jandorf L; Halperin JJ. <i>Arch Neurol</i>, 48(11):1125-9. 1991.</p> <p>(4) [Ophthalmic manifestations in Lyme borreliosis] Zagorski Z; Biziorek B; Haszcz D. <i>Przegl Epidemiol</i>, 56 Suppl 1:85-90. 2002.</p> <p>(5) Episcleritis, conjunctivitis, and keratitis as ocular manifestations of Lyme disease. Flach AJ; Lavoie PE. <i>Ophthalmology</i>, 97(8):973-5. 1990.</p>
<p>Drooping eyelid “transient left eyelid lag” (1)</p>	<p>(1) Fatal pancarditis in a patient with coexistent Lyme disease and babesiosis. Demonstration of spirochetes in the myocardium. Marcus LC; Steere AC; Duray PH; Anderson AE; Mahoney EB. <i>Annals of Internal Medicine</i>, 103(3):374-6. 1985.</p>
<p>Double vision (diplopia) or blurry vision “We report a case of Lyme disease with diplopia as the first manifestation, without systemic symptoms in contrast with other cases of this disease. The serodiagnosis was confirmed by ELISA analysis and evaluation of cerebrospinal fluid (CSF) antibodies.” (1)</p>	<p>(1) [Diplopia as the first manifestation of Lyme disease] Asensio Sanchez VM; Corral Azor A; Bartolome Aragon A; De Paz Garcia M. <i>Arch Soc Esp Oftalmol</i>, 78(1):51-4. 2003.</p> <p>(2) <i>Borrelia burgdorferi</i> detected by culture and PCR in clinical relapse of disseminated Lyme Borreliosis. Oksi J; Marjamaki M; Nikoskelainen J; Viljanen MK. <i>Annals of Medicine</i>, 31(3):225-32. 1999.</p> <p>(3) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. <i>Medicine</i>, 58(4):281-94. 1979.</p>
<p>Endophthalmitis “We have seen a 45-year-old woman who developed unilateral endophthalmitis leading to blindness during the course of this disease.” (1)</p>	<p>(1) Ocular Lyme disease: case report and review of the literature. Kauffmann DJ; Wormser GP. <i>British Journal of Ophthalmology</i>, 74(6):325-7. 1990.</p>
<p>Floaters “The main reported symptom of the 10 patients with uveitis was blurred vision or <i>floaters</i>.” (1) [italics added]</p>	<p>(1) The expanding clinical spectrum of ocular Lyme borreliosis. Mikkila HO; Seppala IJ; Viljanen MK; Peltomaa MP; Karma A. <i>Ophthalmology</i>, 107(3):581-7. 2000.</p>
<p>Foreign body sensation (keratitis)</p>	<p>(1) Lyme disease associated with unilateral interstitial keratitis. Miyashiro MJ, Yee RW, Patel G, Ruiz RS. <i>Cornea</i>, 18(1):115-6. 1999.</p> <p>(2) Bilateral keratitis in Lyme disease. Kornmehl EW; Lesser RL; Jaros P; Rocco E; Steere AC. <i>Ophthalmology</i>, 96(8):1194-7. 1989.</p>

Symptoms	Citations
<p>Holmes-Adie syndrome (tonic pupil and areflexia) "In a referral practice of about 140 patients with Lyme disease, we have seen three patients with predominant neurological symptoms who presented with Holmes-Adie syndrome." (1)</p>	<p>(1) Holmes-Adie syndrome and Lyme disease. Stricker RB; Winger EE. Lancet, 357(9258). 2001.</p>
<p>Horner's syndrome "We document a case of Borrelia infection of the nervous system manifesting as a reversible Horner's syndrome." (1)</p>	<p>(1) Reversible Horner's syndrome and Lyme disease. Glauser TA; Brennan PJ; Galetta SL. J Clin Neuroophthalmol, 9(4):225-8. 1989.</p>
<p>Nystagmus "Findings on neurologic examination included long tract signs, optic neuritis, and nystagmus." (1)</p> <p>"one complained of diplopia, vertigo, and nystagmus" (2)</p> <p>"Neurological problems occurred 15 years after the tick bite with headache, nystagmus, intentional tremor and spastic paraparesis with sphincter disturbances." (3)</p>	<p>(1) Neurologic involvement in the third stage of Lyme disease: CNS manifestations can mimic multiple sclerosis and psychiatric illness. [poster presentation] Pachner AR; Steere AC. Neurology, 36(suppl 1):286. 1986.</p> <p>(2) Invasion of the central nervous system by Borrelia burgdorferi in acute disseminated infection. Luft BJ; Dattwyler RJ. JAMA, 267:1364-67. 1992.</p> <p>(3) Chronic encephalomyelitis caused by Borrelia burgdorferi. Case report. Pavlovic D; Levic Z; Dmitrovic R; Ocic G. Glas Srp Akad Nauka [Med];(43):225-8. 1993.</p>
<p>Oculomotor weakness</p>	<p>(1) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. Medicine, 58(4):281-94. 1979.</p>
<p>Optic neuritis "Findings on neurologic examination included long tract signs, optic neuritis, and nystagmus." (1)</p> <p>"This case of intracranial demyelinating lesions associated with bilateral optic neuritis in a serologically determined Borrelia burgdorferi infection is the first of its kind described in the literature." (2)</p> <p>"2 [children] had decreased vision months after disease onset attributable to optic neuritis" (3)</p>	<p>(1) Neurologic involvement in the third stage of Lyme disease: CNS manifestations can mimic multiple sclerosis and psychiatric illness. [poster presentation] Pachner AR; Steere AC. Neurology, 36(suppl 1):286. 1986.</p> <p>(2) Borrelia burgdorferi infection with bilateral optic neuritis and intracerebral demyelination lesions. Bialasiewicz AA; Huk W; Druschky KF; Naumann GO. Klinische Monatsblätter für Augenheilkunde, 195(2):91-4. 1989.</p> <p>(3) Optic neuropathy in children with Lyme disease. Rothermel H; Hedges TR 3rd; Steere AC. Pediatrics, 108(2):477-81. 2001.</p>
<p>Optic neuropathy "Neuroborreliosis may cause various neuro-ophthalmological complications. We describe a case with a bilateral optic neuropathy." (2)</p>	<p>(1) Lyme disease associated with optic neuropathy. Schechter SL. American Journal of Medicine, 81(1):143-5. 1986.</p> <p>(2) Optic nerve lesion following neuroborreliosis: a case report. Burkhard C; Gleichmann M; Wilhelm H. Eur J Ophthalmol, 11(2):203-6. 2001.</p>
<p>Pain in eyes "pain on eye motion, a feeling of pressure behind the eyes" (1)</p> <p>"severe periodic ocular pain can be characteristic symptoms of Lyme borreliosis." (2)</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) The expanding clinical spectrum of ocular Lyme borreliosis. Mikkila HO; Seppala IJ; Viljanen MK; Peltomaa MP; Karma A. Ophthalmology, 107(3):581-7. 2000.</p>

Symptoms	Citations
<p>Photophobia (oversensitivity to light)</p> <p>“photophobia, nuchal pain, and mild confusion indicate central nervous system involvement.” (2)</p> <p>“severe photophobia” (3)</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. <i>Annals of Internal Medicine</i>, 99(1):76-82. 1983.</p> <p>(2) Complications of Lyme borreliosis. Cooke WD; Dattwyler RJ. <i>Annual Review of Medicine</i>, 43:93-103. 1992.</p> <p>(3) The expanding clinical spectrum of ocular Lyme borreliosis. Mikkila HO; Seppala IJ; Viljanen MK; Peltomaa MP; Karma A. <i>Ophthalmology</i>, 107(3):581-7. 2000.</p>
<p>Retinal vasculitis</p> <p>“Retinal vasculitis developed in seven patients with uveitis.” (1)</p>	<p>(1) The expanding clinical spectrum of ocular Lyme borreliosis. Mikkila HO; Seppala IJ; Viljanen MK; Peltomaa MP; Karma A. <i>Ophthalmology</i>, 107(3):581-7. 2000.</p>
<p>Scleritis (posterior)</p> <p>“CONCLUSIONS: Posterior scleritis should be added to the list of ocular manifestations associated with Lyme disease.” (1)</p>	<p>(1) Posterior scleritis associated with <i>Borrelia burgdorferi</i> (Lyme disease) infection. Krist D; Wenkel H. <i>Ophthalmology</i>, 109(1):143-5. 2002.</p>
<p>Swelling around the eyes (periobital edema)</p> <p>“He soon developed a clinical syndrome suggestive of dermatomyositis: periobital edema, dysphagia, proximal muscle weakness, and a markedly elevated level of creatine phosphokinase.” (1)</p>	<p>(1) Dermatomyositis associated with Lyme disease: case report and review of Lyme myositis. Horowitz HW; Sanghera K; Goldberg N; Pechman D; Kamer R; Duray P; Weinstein A. <i>Clin Infect Dis</i>, 18(2):166-71. 1994.</p>
<p>Uveitis</p> <p>“All patients with Lyme uveitis had manifestations of the posterior segment of the eye, such as vitritis, retinal vasculitis, neuroretinitis, chorioretinitis, or optic neuropathy.” (2)</p> <p>“Four patients presented with a neuro-ophthalmologic disorder, five had external ocular inflammation, 10 patients had uveitis, and one had branch retinal vein occlusion.” (3)</p>	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. <i>Annals NY Academy of Sciences</i>, 539:65-79. 1988.</p> <p>(2) The etiology of uveitis: the role of infections with special reference to Lyme borreliosis. Mikkila H; Seppala I; Leirisalo-Repo M; Immonen I; Karma A. <i>Acta Ophthalmol Scand</i>, 75(6):716-9. 1997.</p> <p>(3) The expanding clinical spectrum of ocular Lyme borreliosis. Mikkila HO; Seppala IJ; Viljanen MK; Peltomaa MP; Karma A. <i>Ophthalmology</i>, 107(3):581-7. 2000.</p>
<p>Visual acuity – decreased</p>	<p>(1) The expanding clinical spectrum of ocular Lyme borreliosis. Mikkila HO; Seppala IJ; Viljanen MK; Peltomaa MP; Karma A. <i>Ophthalmology</i>, 107(3):581-7. 2000.</p>

Symptoms	Citations
<p>Gastrointestinal System</p>	<p><i>“Recently, PCR was used on biopsies from the gastrointestinal (GI) tract to detect B. burgdorferi infection in the gut of patients with erythema migrans and gastrointestinal pain. New insights into the life history of the bacterium show that the GI tract must be considered a sanctuary for this bacterium...”</i></p> <p>Susceptibility of motile and cystic forms of Borrelia burgdorferi to ranitidine bismuth citrate. Brorson O; Brorson SH. Int Microbiol, 4(4):209-15. 2001.</p>
<p>Abdominal pain</p> <p>“All three patients had low back and abdominal pain and two had marked abdominal wall paresis.” (1)</p>	<p>(1) Abdominal wall weakness and lumboabdominal pain revealing neuroborreliosis: a report of three cases. Mormont E; Esselinckx W; De Ronde T; Hanson P; Deltombe T; Laloux P. Clin Rheumatol, 20(6):447-50. 2001.</p> <p>(2) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
<p>Abdominal distention, wall weakness</p> <p>“Expanding abdominal girth can be an unusual manifestation of the polyradiculoneuropathy associated with Lyme disease.” (1)</p> <p>“bifacial paresis and right lower abdominal wall weakness developed” (2)</p>	<p>(1) Lyme polyradiculoneuropathy presenting as increasing abdominal girth. Daffner KR; Saver JL; Biber MP. Neurology, 40:373-5. 1990.</p> <p>(2) Acute Lyme neuropathy presenting with polyradicular pain, abdominal protrusion, and cranial neuropathy. Krishnamurthy KB; Liu GT; Logigian EL. Muscle Nerve, 16(11):1261-4. 1993.</p> <p>(3) Abdominal wall weakness and lumboabdominal pain revealing neuroborreliosis: a report of three cases. Mormont E; Esselinckx W; De Ronde T; Hanson P; Deltombe T; Laloux P. Clin Rheumatol, 20(6):447-50. 2001.</p>
<p>Abdominal paralysis</p> <p>“two had marked abdominal wall paresis. EMG confirmed a motor involvement of the lower thoracic roots” (1)</p> <p>“Abdominal wall paralysis was mostly bilateral (91%) and involved always the lower half of the abdominal wall. It was very severe in 18%.” (3)</p>	<p>(1) Abdominal wall weakness and lumboabdominal pain revealing neuroborreliosis: a report of three cases. Mormont E; Esselinckx W; De Ronde T; Hanson P; Deltombe T; Laloux P. Clin Rheumatol, 20(6):447-50. 2001.</p> <p>(2) [Paralysis of abdominal muscles caused by Lyme disease.] Vial C; Petiot P; Latombe D; Ruel JH; Confavreux C; Trillet M; Bady B. Rev Neurol (Paris), 149(12):810-2, 1993.</p> <p>(3) [Thoraco-abdominal manifestation of stage II Lyme neuroborreliosis] Pfadenhauer K; Schonsteiner T; Stohr M. Nervenarzt, 69(4):296-9. 1998.</p>
<p>Anorexia</p> <p>“The most common of these [systemic symptoms in patients with early Lyme borreliosis] were fatigue (54 percent), arthralgia (44 percent), myalgia (44 percent), headache (42 percent), fever and/or chills (39 percent), stiff neck (35 percent), and anorexia (26 percent).” (2)</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) The clinical spectrum of early Lyme borreliosis in patients with culture-confirmed erythema migrans. Nadelman RB; Nowakowski J; Forseter G; Goldberg NS; Bittker S; Cooper D; Aguero-Rosenfeld M; Wormser GP. American Journal of Medicine, 100(5):502-8. 1996.</p>

Symptoms	Citations
<p>Constipation “This is a report of 2 patients with Lyme disease who initially presented with severe constipation, which progressed to ascending muscular weakness resembling acute idiopathic polyneuritis, with neuropsychiatric symptoms, severe urinary retention, and hyponatremia. These symptoms resolved following proper antibiotic therapy.” (1)</p>	<p>(1) Constipation heralding neuroborreliosis: an atypical tale of 2 patients. Shamim EA; Shamim SA; Liss G; Nylen E; Pincus JH; Yepes M. Arch Neurol, 62(4):671-3. 2005.</p>
<p>Diarrhea</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
<p>Kidney failure / renal failure “Infection caused by <i>B burgdorferi</i> is known to induce glomerulonephritis in animals. We report a patient with acute postinfection membranoproliferative glomerulonephritis after the clinical multisystem manifestation of Lyme disease, which was confirmed serologically. Although the patient was dialysis dependent for a protracted period of 5 months, the final outcome was excellent.” (1)</p>	<p>(1) MPGN secondary to Lyme disease. [MPGN = Mesangiocapillary Glomerulonephritis] Kirmizis D; Efstratiadis G; Economidou D; Diza-Mataftsi E; Leontini M; Memmos D. Am J Kidney Dis, 43:544-551. 2004.</p> <p>(2) Lyme disease and glomerulonephritis. Kelly B; Finnegan P; Cormican M; Callaghan J. Irish Med J, 92(5):372-373. 1999.</p> <p>(3) Rhabdomyolysis with acute renal failure due to <i>Borrelia burgdorferi</i>. Jeandel C; Perret C; Blain H; Jouanny P; Penin F; Laurain MC. J Intern Med, 235(2):191-2. 1994.</p>
<p>Nausea “Associated symptoms [associated with ECM rash] ranged from none to malaise, fatigue, chills and fever, headache, stiff neck, backache, myalgias, <i>nausea</i>, vomiting, and sore throat.” (3) [italics added]</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) Early dissemination of <i>Borrelia burgdorferi</i> without generalized symptoms in patients with erythema migrans. Oksi J; Marttila H; Soini H; Aho H; Uksila J; Viljanen MK. APMIS, 109(9):581-8. 2001.</p> <p>(3) Erythema chronicum migrans and Lyme arthritis. The enlarging clinical spectrum. Steere AC; Malawista SE; Hardin JA; Ruddy S; Askenase W; Andiman WA. Annals of Internal Medicine, 86(6):685-98. 1977.</p>
<p>Splenitis “severe left upper quadrant pain... A splenectomy was performed. Histologic examination of the tissue sections revealed extensive necrosis and inflammation” (1)</p>	<p>(1) Human necrotizing splenitis caused by <i>Borrelia burgdorferi</i>. Rank EL, Dias SM; Hasson J; Duray PH; Johnson RC; Magnarelli LA; Fister RD. Am J Clin Pathol, 91(4):493-8. 1989.</p>
<p>Urinary problems Irritable bladder; trouble starting/stopping; frequent urination; voiding dysfunction. (1) “We report a case of Lyme disease that presented with urinary retention. The individual then experienced lower extremity paralysis. ...To our knowledge this is the first report of a urological manifestation as the initial clinical presentation of Lyme disease.” (2)</p>	<p>(1) Urinary dysfunction in Lyme disease. Chancellor MB; McGinnis DE; Shenot PJ; Kiilholma P; Hirsch IH. Journal of Urology, 149(1):26-30. 1993.</p> <p>(2) Lyme disease presenting as urinary retention. Chancellor MB; Dato VM; Yang JY. Journal of Urology, 143(6):1223-4. 1990.</p> <p>(3) Lyme disease presenting as isolated acute urinary retention caused by transverse myelitis: an electrophysiological and urodynamical study. Olivares JP; Pallas F; Ceccaldi M; Viton JM; Raoult D; Planche D; Delarque A. Arch Phys Med Rehabil, 76(12):1171-2. 1995.</p>

Symptoms	Citations
<p>Vomiting “Associated symptoms [associated with ECM rash] ranged from none to malaise, fatigue, chills and fever, headache, stiff neck, backache, myalgias, nausea, <i>vomiting</i>, and sore throat.” (2) [italics added]</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. <i>Annals of Internal Medicine</i>, 99(1):76-82. 1983.</p> <p>(2) Erythema chronicum migrans and Lyme arthritis. The enlarging clinical spectrum. Steere AC; Malawista SE; Hardin JA; Ruddy S; Arskense W; Andiman WA. <i>Annals of Internal Medicine</i>, 86(6):685-98. 1977.</p>
<p>Weight loss/gain</p>	<p>(1) Chronic meningitis and Lyme disease in Sweden. Stiernstedt GT; Skoldenberg BR; et al. <i>Yale J Biol Med</i>, 57(4):491-7. 1984.</p>

Symptoms	Citations
Respiratory & Circulatory Systems	<p><i>“Lyme carditis may occur at any age and in either sex... The time interval between the tick bite and the occurrence of cardiac manifestations may be as short as 10 days...The diagnosis of Lyme carditis can be difficult, since the clinical pattern can be very heterogeneous...”</i></p> <p>Lyme carditis. Van der Linde MR; Ballmer PE. In <i>Aspects of Lyme Borreliosis</i>, Ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 131-151. 1993.</p>
<p>Chest pain “short stabbing pains lasting only seconds” (1)</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. <i>Annals of Internal Medicine</i>, 99(1):76-82. 1983.</p>
<p>Cough “dry cough” (1) “nonproductive” (2)</p>	<p>(1) Fatal adult respiratory distress syndrome in a patient with Lyme disease. Kirsch M; Ruben FL; Steere AC; Duray PH; Norden CW; Winkelstein A. <i>Journal of the American Medical Association</i>, 259(18):2737-9. 1988.</p> <p>(2) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. <i>Annals of Internal Medicine</i>, 99(1):76-82. 1983.</p>
<p>Heart</p> <p>“Lyme carditis is becoming a more frequent complication of Lyme disease, primarily due to the increasing incidence of this disease in the United States. Cardiovascular manifestations of Lyme disease often occur within 21 days of exposure and include fluctuating degrees of atrioventricular (AV) block, acute myopericarditis or mild left ventricular dysfunction and rarely cardiomegaly or fatal pericarditis. AV block can vary from first-, second-, third-degree heart block, to junctional rhythm and asystolic pauses.” (1)</p> <p>“Heart involvement was... sometimes accompanied by meningoencephalitis, facial palsy, arthritis” (3)</p> <p>acute coronary syndrome (8) acute myopericarditis (2) (3) atrial flutter/fibrillation (6) block (2) (3) cardiomegaly (2) (3) congestive heart failure (9) myocardial conduction abnormalities (5) pancarditis (2) pericardial effusion (4) tachycardia (7) ventricular dysfunction (3)</p>	<p>(1) Complete heart block due to Lyme carditis. Lo R; Menzies DJ; Archer H; Cohen TJ. <i>Journal of Invasive Cardiology</i>, 15(6):367-9. 2003.</p> <p>(2) Clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Pachner AR; Rahn DW; Sigal LH; Taylor E; Malawista SE. <i>Zentralblatt für Bakteriologie, Mikrobiologie, und Hygiene - Series A, Medical Microbiology, Infectious Diseases, Virology, Parasitology</i>. 263(1-2):201-5. 1986.</p> <p>(3) Lyme carditis: cardiac abnormalities of Lyme disease. Steere AC; Batsford WP; Weinberg M; Alexander J; Berger HJ; Wolfson S; Malawista SE. <i>Annals of Internal Medicine</i>, 93(1):8-16. 1980.</p> <p>(4) First description of recurrent pericardial effusion associated with borrelia burgdorferi infection. Gasser R; Horn S; Reisinger E; Fischer L; Pokan R; et al. <i>International Journal of Cardiology</i>, 64(3):309-310. 1998.</p> <p>(5) Erythema chronicum migrans and Lyme arthritis. The enlarging clinical spectrum. Steere AC; Malawista SE; Hardin JA; Ruddy S; Arskense W; Andiman WA. <i>Annals of Internal Medicine</i>, 86(6):685-98. 1977.</p> <p>(6) Borrelia burgdorferi infection in patients with suspected acute myocardial infarction. Oksi J; Voipio-Pulkki L-M; Uksila J; Pulkki K; Laippala P; Viljanen MK. <i>Lancet</i>, 350(9089):1447-8. 1997.</p> <p>(7) Treatment of the early manifestations of Lyme disease. Steere AC; Hutchinson GJ; Rahn DW; Sigal LH; Craft JE; DeSanna ET; Malawista SE. <i>Annals of Internal Medicine</i>, 99(1):22-6. 1983.</p> <p>(8) [Lyme disease presenting as infarction pain. A case report]. Meimoun P, Sayah S, Benali T, Bore AL, Bailly J, Beausoleil J, Jeleff C, Maitre B. <i>Arch Mal Coeur Vaiss</i>, 94(12):1419-22. 2001.</p> <p>(9) Cardiac manifestations of Lyme disease: a review. Nagi KS; Joshi R; Thakur RK. <i>Can J Cardiol.</i>, 12(5):503-6. 1996.</p>

Symptoms	Citations
<p>Shortness of breath, respiratory failure</p> <p>“fatal adult respiratory distress syndrome developed; this was believed to be secondary to Lyme disease” (3)</p> <p>“This patient, presenting with respiratory failure, had bilateral diaphragm palsy requiring long-term mechanical ventilation. ...The diagnosis of neuroborreliosis was established by the evidence of CSF production of borrelia burgdorferi antibodies.” (5)</p> <p>“Peri- and myocarditis can mimic all degrees of right-sided and left-sided heart failure, but most often the patient complains of shortness of breath.” (6)</p>	<p>(1) Diaphragmatic paralysis due to Lyme disease. Faul JL; Ruoss S; Doyle RL; Kao PN. Eur Respir J, 13(3):700-2. 1999.</p> <p>(2) Neuroborreliosis as a cause of respiratory failure. Silva MT; Sophar M; Howard RS; Spencer GT. J Neurol, 242(9):604-7. 1995.</p> <p>(3) Fatal adult respiratory distress syndrome in a patient with Lyme disease. Kirsch M; Ruben FL; Steere AC; Duray PH; Norden CW; Winkelstein A. Journal of the American Medical Association, 259(18):2737-9. 1988.</p> <p>(4) Tick bite induced respiratory failure. Diaphragm palsy in Lyme disease. Winterholler M; Erbguth FJ. Intensive Care Med, 27(6):1095. 2001.</p> <p>(5) Respiratory failure due to Lyme meningopolyradiculitis. Sigler S; Kershaw P; Scheuch R; Sklarek H; Halperin J. American Journal of Medicine, 103:544-547. 1997.</p> <p>(6) Lyme carditis. Van der Linde MR; Ballmer PE. In <i>Aspects of Lyme Borreliosis</i>, ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 131-151. 1993.</p>
<p>Vasculitis (inflammation/swelling of blood vessels)</p> <p>“We conclude that cerebral lymphocytic vasculitis and multifocal encephalitis may be associated with B. burgdorferi infection. The presence of B. burgdorferi DNA in tissue samples from areas with inflammatory changes indicates that direct invasion of B. burgdorferi may be the pathogenetic mechanism for focal encephalitis in LNB [Lyme neuroborreliosis].” (2)</p> <p>“Imaging techniques showed either MS-like lesions or evidence of vascular involvement, as in other spirochetal infections, especially in meningovascular syphilis.” (5)</p>	<p>(1) Borrelia burgdorferi detected by culture and PCR in clinical relapse of disseminated Lyme borreliosis. Oksi J; Marjamaki M; Nikoskelainen J; Viljanen MK. Annals of Medicine, 31(3):225-32. 1999.</p> <p>(2) Inflammatory brain changes in Lyme borreliosis. A report on three patients and review of literature. Oksi J, Kalimo H, Marttila RJ, Marjamaki M, Sonninen P, Nikoskelainen J, Viljanen MK. Brain, 119 (Pt 6):2143-54. 1996.</p> <p>(3) The enlarging clinical spectrum of Lyme disease: Lyme cerebral vasculitis, a new disease entity. Brogan GX; Homan CS; Viccellio P. Annals of Emergency Medicine, 19(5):572-6. 1990.</p> <p>(4) Cerebral vasculitis as the only manifestation of Borrelia burgdorferi infection in a 17-year-old patient with basal ganglia infarction. Heinrich A; Khaw AV; Ahrens N; Kirsch M; Dressel A. Eur Neurol, 50(2):109-112. 2003.</p> <p>(5) Chronic central nervous system involvement in Lyme borreliosis. Kohler J; Kern U; Kasper J; Rhese-Kupper B; Thoden U. Neurology, 38(6):863-7. 1988.</p> <p>(6) Retinal vasculitis in Lyme borreliosis. Smith JL, Winward KE, Nicholson DF, Albert DW. J Clin Neuroophthalmol, 11(1):7-15. 1991.</p>

Symptoms	Citations
<p>Hepatic System (Liver)</p>	<p>“Subclinical hepatitis is a common finding in early Lyme disease.” The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983</p>
<p>Hepatitis “Liver involvement can vary from a mild lymphocytic portal triaditis all the way to liver cell derangement that simulates acute hepatitis” (1)</p> <p>“Complete blood counts and sedimentation rates are generally normal in patients with early Lyme disease. However, liver function assays are mildly abnormal in more than one third of patients with culture-confirmed EM.” (2)</p> <p>“Forty-six (40%) patients had at least one liver test abnormality, and 31 (27%) had more than 1 abnormality... Patients with early disseminated Lyme disease were more likely to have elevated liver function studies (66%) compared with patients with localized disease (34%) (P = .002).” (3)</p> <p>“We report two cases of Lyme disease, revealed by hepatic damage in a 71- and a 59-year old man. In the first case, the disease was revealed by febrile jaundice whereas, in the second case, results of liver tests showed cytolytic and cholestatic abnormalities with fever.” (4)</p> <p>“Patients with this lesion [erythema migrans] may also have headache, meningeal irritation, mild encephalopathy, multiple annular secondary lesions, malar or urticarial rash, generalized lymphadenopathy and splenomegaly, migratory musculo-skeletal pain, <i>hepatitis</i>, sore throat, non-productive cough, conjunctivitis, periorbital edema, or testicular swelling.” (5) [<i>italics added</i>]</p>	<p>(1) Histopathology of human Lyme borreliosis. De Koning J; Duray PH. In <i>Aspects of Lyme Borreliosis</i>, ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 93-104. 1993.</p> <p>(2) Erythema migrans and early Lyme disease. Nadelman RB; Wormser GP. Am J Med, 98(4A):15S-23S; discussion 23S-24S. 1995.</p> <p>(3) Liver function test abnormalities in early Lyme disease. Kazakoff MA; Sinusas K; Macchia C. Arch Fam Med, 2(4):409-13. 1993.</p> <p>(4) Hepatic injuries related to Lyme disease. Study of 2 cases and a review of the literature. Dadamessi I; Brazier F; Smail A; Delcenserie R; Dupas JL; Capron JP. Gastroenterol Clin Biol, 25(2):193-196. 2001.</p> <p>(5) Clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Pachner AR; Rahn DW; Sigal LH; Taylor E; Malawista SE. Zentralblatt fur Bakteriologie, Mikrobiologie, und Hygiene - Series A, Medical Microbiology, Infectious Diseases, Virology, Parasitology. 263(1-2):201-5. 1986.</p> <p>(6) Hepatitis due to recurrent Lyme disease. Goellner MH; Agger WA; Burgess JH; Duray PH. Annals of Internal Medicine, 108:707-8. 1988.</p> <p>(7) Relapsing or reinfectious Lyme hepatitis. Schoen RT Hepatology, 9(2):335-6. 1989.</p> <p>(8) Lyme disease presenting as hepatitis and jaundice in a child. Edwards KS; Kanengiser S; Li KI Glassman M. Pediatr Infect Dis J, 9(8):592-3. 1990.</p> <p>(9) Lyme borreliosis hepatitis. Nicolas X; Granier H; Zagnoli F; Bellard S. Presse Med, 23;31(7):319. 2002.</p>

Symptoms	Citations
<p>Musculoskeletal System</p>	<p><i>“The musculoskeletal pain of Lyme disease is generally migratory in joints, bursae, tendons, muscle, and bone, lasting only hours or days in a given location. ...Although the pattern varies, episodes of arthritis often become longer during the second and third years of the illness, lasting months rather than weeks, and chronic arthritis... characteristically begins in this period.”</i></p> <p>Lyme disease. Steere AC. New England Journal of Medicine, 321:586-596. 1989.</p> <p><i>“Essentially, the spectrum of articular manifestations can be classified in three categories:</i></p> <ol style="list-style-type: none"> <i>1. Arthralgias (musculoskeletal pain) without objective findings,</i> <i>2. Arthritis (intermittent or chronic) with objective physical findings of synovial thickening or joint effusion, and</i> <i>3. Chronic joint and bone involvement under affected skin in ACA.”</i> <p>Joint manifestations. Herzer P. In <i>Aspects of Lyme Borreliosis</i>, ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 168-184. 1993.</p> <p><i>“Our results identified three MRI features, specifically, myositis, adenopathy, and lack of subcutaneous edema, that strongly suggest the diagnosis of Lyme arthritis rather than septic arthritis in children with acute inflammation of the knee.”</i></p> <p>MRI features of Lyme arthritis in children. Ecklund K; Vargas S; Zurakowki D; Sundel RP. Am J Roentgenol, 184(6):1904-9. 2005.</p> <p><i>“All physicians must now realize that Lyme disease is not rare and requires serological evaluation in a wide variety of clinical settings, including patients thought to have septic arthritis or osteomyelitis and children with arthritis and uveitis.”</i></p> <p>Lyme disease simulating septic arthritis. Jacobs JC; Stevens M; Duray PH. JAMA, 256(9)-letters. 1986.</p>
<p>Backache, back pain, sciatica</p> <p>“We report four cases of sciatica in patients with same-level disk herniation confirmed by computed tomography and a final diagnosis of acute radiculitis caused by <i>Borrelia burgdorferi</i>, with a favorable response to ceftriaxone therapy.” (3)</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) Meningoradiculitis due to borreliosis presenting as low back pain only. Demaerel P; Crevits I; Casteels-Van Daele M; Baert AL. Neuroradiology, 40(2):126-7. 1998.</p> <p>(3) Sciatica, disk herniation, and neuroborreliosis: A report of four cases. Dupeyron A; Lecocq J; Jaulhac B; Isner-Horobeti ME; Vautravets P; et al. Joint Bone Spine, 71(5):433-7. 2004.</p>
<p>Bannwarth’s Syndrome</p> <p>“Limb symptoms may be severe and acute (dysesthetic pain, numbness, weakness--the syndrome described by Garin, Bujadoux, and Bannwarth) or milder and more indolent (more slowly progressive, less dysesthetic, less localized, less profound weakness).” (1)</p>	<p>(1) Neuroborreliosis. Halperin JJ. American Journal of Medicine, 98 (4A):4A-52S to 4A-56S. 1995.</p> <p>(2) Neuropathy of vasculitic origin in a case of Garin-Boujadoux-Bannwarth syndrome with positive borrelia antibody response. Camponovo F; Meier C. Journal of Neurology, 233:69-72.</p>

Symptoms	Citations
<p>Bone pain/erosion/osteomyelitis “Spirochetes can be demonstrated in the lymph nodes, spleen and bone marrow and liver.” (1)</p> <p>“The bone marrow involvement of late disease is characterized by plasmocytosis.” (3)</p> <p>“In severe cases, chronic Lyme arthritis may lead to the erosion of cartilage and bone” (5)</p> <p>“Later in the illness, the joints of some patients showed typical changes of an inflammatory arthritis, including juxta-articular osteoporosis, cartilage loss, and cortical or marginal bone erosions.” (4)</p> <p>“the presence of spirochetes in a bone lesion was documented both by culture and by the polymerase chain reaction” (6)</p>	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. <i>Annals NY Academy of Sciences</i>, 539:65-79. 1988.</p> <p>(2) Elevated levels of collagenase and prostaglandin E2 from synovium associated with erosion of cartilage and bone in a patient with chronic Lyme arthritis. Steere AC; Brinckerhoff CE; Miller DJ; Drinker H; Harris ED Jr; Malawista SE. <i>Arthritis & Rheumatism</i>, 23(5):591-9. 1980.</p> <p>(3) Histopathology of human Lyme borreliosis. De Koning J; Duray P. In <i>Aspects of Lyme Borreliosis</i>, ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag;pp 70-92. 1993.</p> <p>(4) Lyme arthritis: radiologic findings. Lawson JP; Steere AC. <i>Radiology</i>, 154(1):37-43 1985.</p> <p>(5) Lyme disease. Steere AC. <i>New England Journal of Medicine</i>, 321(9):586-96. 1989.</p> <p>(6) Subacute multiple-site osteomyelitis caused by <i>Borrelia burgdorferi</i>. Oksi J; Mertsola J; Reunanen M; Marjamaki M; Viljanen MK. <i>Clin Infect Dis</i>, 19(5):891-6. 1994.</p>
<p>Carpal tunnel syndrome “We conclude that a significant proportion of patients with late Lyme borreliosis develop carpal tunnel syndrome.” (1)</p> <p>“Carpal tunnel syndrome (CTS) also is present in about 25% of patients with late disease, typically developing several years after illness onset. Those affected have acral paresthesias in the distribution of the median nerve that are exacerbated during sleep or by using the hands. The CTS is bilateral in two thirds of cases.” (3)</p>	<p>(1) Carpal tunnel syndrome in Lyme borreliosis. Halperin JJ; Volkman DJ; Luft BJ; Dattwyler RJ. <i>Muscle Nerve</i>, 12(5):397-400. 1989.</p> <p>(2) Lyme neuroborreliosis. Peripheral nervous system manifestations. Halperin J, Luft BJ, Volkman DJ, Dattwyler RJ. <i>Brain</i>, 113 (Pt 4):1207-21. 1990.</p> <p>(3) Neurologic aspects of North American Lyme disease. Reik L Jr. In <i>Lyme Disease</i>, ed. Patricia K. Coyle, M.D. St. Louis: Mosby-Year Book Inc., pp.101-112. 1993.</p>
<p>Cartilage erosion “many patients develop intermittent attacks of arthritis (stage 3), which may become chronic, with erosion of cartilage and bone.” (1)</p>	<p>(1) The clinical spectrum and treatment of Lyme disease. Steere AC; Malawista SE; Bartenhagen NH; Spieler PN; Newman JH; Rahn DW; et al. <i>Yale Journal of Biology and Medicine</i>, 57(4):453-64. 1984.</p> <p>(2) Chronic Lyme arthritis. clinical and immunogenetic differentiation from rheumatoid arthritis. Steere AC; Gibofsky A; Patarroyo ME; Winchester RJ; Hardin JA; Malawista SE. <i>Annals of Internal Medicine</i>, 90(6):896-901. 1979.</p>
<p>Cervical pain “Cervical pain is common among patients with neuroborreliosis” (1)</p>	<p>(1) Clinical manifestations and diagnosis of neuroborreliosis. Stiernstedt G; Gustafsson R; Karlsson M; Svenungsson B; Skoldenberg B. <i>Annals NY Academy of Sciences</i>, 539:46-53. 1988.</p>
<p>Foot pain “posterior tibial tendinitis”, “ankle swelling”, “dorsal foot swelling”, “Achilles tendonitis”, “heel pain”, “subtalar joint pain”, “plantar fasciitis”, “first metatarsophalangeal pain” (1)</p>	<p>(1) Foot and ankle disorders resulting from Lyme disease. Faller J; Thompson F; Hamilton W. <i>Foot & Ankle</i>, (11)4:236-238 1991.</p> <p>----- <i>Aditonal Quotation</i> “We have diagnosed a number of cases of Lyme disease in which the sole or presenting symptoms involved the ankle and foot. ...Musculoskeletal syndromes due to this infectious agent can present and masquerade for long periods of time as a structural derangement.” (1)</p>

Symptoms	Citations
<p>Gout “Particularly when attacks of Lyme arthritis affect the first metatarsophalangeal joint alone, it may be confused with gout” (1)</p>	<p>(1) Joint manifestations. Herzer P. In <i>Aspects of Lyme Borreliosis</i>, ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 168-184. 1993.</p>
<p>Hand stiffness</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
<p>Herniated disc “We report on 3 patients with meningeradiculoneuritis (MRN) due to Lyme-borreliosis (LB), which presented clinically as vertebral disc herniation. In 2 cases the underlying infection was discovered only after unsuccessful neurosurgical treatment.” (2)</p>	<p>(1) Sciatica, disk herniation, and neuroborreliosis: A report of four cases. Dupeyron A; Lecocq J; Jaulhac B; Isner-Horobeti ME; Vautravers P; et al. Joint Bone Spine, 71(5):433-7. 2004.</p> <p>(2) Meningoradiculoneuritis mimicking vertebral disc herniation. A “neurosurgical” complication of Lyme-borreliosis. Meier C; Reulen HJ; Huber P; Mumenthaler M. Acta Neurochir (Wien), 98(1-2):42-6. 1989.</p> <p>(3) Neuro-borreliosis or intervertebral disk prolapse? Dieterle L; Kubina FG; Staudacher T; Budinggen HJ. Dtsch Med Wochenschr, 114(42):1602-6. 1989.</p>
<p>Joint pain (arthralgia) “either generalized arthralgia (10%) or migratory arthralgia, characterized by a localized intermittent musculoskeletal pain without joint swelling (90%)” (2)</p> <p>“these [joint] symptoms range from arthralgias, to intermittent attacks of arthritis, to chronic erosive disease.” (3)</p> <p>“10 of the patients (18%) began to have brief episodes of joint, periarticular, or musculoskeletal pain for as long as 6 years, but they never developed objective joint abnormalities.” (4)</p> <p>“Arthritis, the third stage, occurs in 60% of cases and typically begins when other symptoms are present. The arthritis is initially intermittent, migrating, and without joint swelling” (5)</p> <p>“Almost half the patients with the skin lesion who developed arthritis had <i>only</i> pain on motion of affected joints and have not as yet had swelling... It was uncommon for any joint to swell other than the knee” (6)</p> <p>Tender joints on pressure. (7)</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) Lyme disease: an infectious and postinfectious syndrome. Asch ES; Bujak DI; Weiss M; Peterson MG; Weinstein A. Journal of Rheumatology, 21(3):454-61. 1994.</p> <p>(3) Pathogenesis of Lyme arthritis. Steere AC. Annals NY Academy of Sciences, 539:87-92. 1988.</p> <p>(4) The clinical evolution of Lyme arthritis. Steere AC; Schoen RT; Taylor E. Annals of Internal Medicine, 107(5):725-31. 1987.</p> <p>(5) Epidemiology and clinical similarities of human spirochetal diseases. Schmid GP, Centers for Disease Control. Rev Infect Dis, Sep-Oct;11 Suppl 6:S1460-9. 1989.</p> <p>(6) Erythema chronicum migrans and Lyme arthritis. The enlarging clinical spectrum. Steere AC; Malawista SE; Hardin JA; Ruddy S; Arskense W; Andiman WA. Annals of Internal Medicine, 86(6):685-98. 1977.</p> <p>(7) Clinical features of early erythema migrans disease and related disorders. Weber K; Neubert U. Zentralbl Bakteriell Mikrobiol Hyg (A), 263:209-228. 1986.</p>

Symptoms	Citations
<p>Joint swelling (arthritis) “The joints involved were the knees (70%), ankles (17%), shoulders (16%), elbows (13%), small joints of hands or feet (8%), wrists (9%), temporomandibular joints (4%) and hips (severe pain without swelling) in 3%. The duration of joint swelling varied from 3 days to 11 months.” (1)</p> <p>“10 children with acute arthritis consistent with septic arthritis... ultimately were diagnosed with Lyme disease.” (3)</p>	<p>(1) Lyme disease: an infectious and postinfectious syndrome. Asch ES; Bujak DI; Weiss M; Peterson MG; Weinstein A. <i>Journal of Rheumatology</i>, 21(3):454-61. 1994.</p> <p>(2) Pathogenesis of Lyme arthritis. Steere AC. <i>Annals NY Academy of Sciences</i>, 539:87-92. 1988.</p> <p>(3) Lyme arthritis presenting as acute septic arthritis in children. Willis AA; Widmann RF; Flynn JM; Green DW; Onel KB. <i>J Pediatr Orthop</i>, 23(1):114-8. 2003.</p>
<p>Luxation/Subluxation (dislocation/partial dislocation)</p> <p>“Thirteen of the patients with ACA had luxations/subluxations of small joints in the hands or feet and/or arthritis in large joints.” (1)</p>	<p>(1) Joint and bone involvement in Swedish patients with Ixodes ricinus-borne Borrelia infection. Hovmark A; Asbrink E; Olsson I. <i>Zentralbl Bakteriol Mikrobiol Hyg [A]</i>. 263(1-2):275-84. 1986</p> <p>(2) Joint and bone involvement in Dutch patients with Lyme borreliosis presenting with acrodermatitis chronica atrophicans. Houtman PM; Tazelaar DJ. <i>Netherlands Journal of Medicine</i>, 54(1):5-9. 1999</p>
<p>Muscle pain (myalgia; fibromyalgia)</p> <p>“Conclusions: Lyme disease may trigger fibromyalgia” (2)</p> <p>“B. burgdorferi may occasionally trigger fibromyalgia” (3)</p>	<p>(1) Detection of Borrelia burgdorferi DNA in muscle of patients with chronic myalgia related to Lyme disease. Frey M; Jaulhac B; Piemont Y; Marcellin L; et al. <i>American Journal of Medicine</i>, 104(6):591-594. 1998.</p> <p>(2) Lyme disease associated with fibromyalgia. Dinerman H; Steere AC. <i>Annals of Internal Medicine</i>, 117:281-5. 1992.</p> <p>(3) Musculoskeletal manifestations of Lyme disease. Steere AC. <i>American Journal of Medicine</i>, 98(4A) Supplement:4A-44S to 4A-48S. 1995.</p>
<p>Muscle tissue inflammation (myositis)</p>	<p>(1) Borrelia burgdorferi myositis: report of eight patients. Reimers CD; de Koning J; Neubert U; Preac-Mursic V; Koster JG; Muller-Felber W; Pongratz DE; Duray PH. <i>Journal of Neurology</i>, 240(5):278-83. 1993.</p> <p>(2) Lyme myositis: muscle invasion by Borrelia burgdorferi. Atlas E; Novak SN; Duray PH; Steere AC. <i>Annals of Internal Medicine</i>, 109:245-246. 1988.</p>
<p>Osteoporosis</p> <p>“Later in the illness, the joints of some patients showed typical changes of an inflammatory arthritis, including juxta-articular osteoporosis, cartilage loss, and cortical or marginal bone erosions.” (1)</p>	<p>(1) Lyme arthritis: radiologic findings. Lawson JP; Steere AC. <i>Radiology</i>, 154(1):37-43. 1985</p> <p>(2) Lyme arthritis: clinical features, serological, and radiographic findings of cases in Germany. Herzer P; Wilske B; Preac-Mursic V; Schierz G; Schattenkirchner M; Zollner N. <i>Klin Wochenschr</i>, 64(5):206-15. 1986.</p>
<p>Tendonitis</p> <p>“posterior tibial tendinitis”, “Achilles tendonitis” (2)</p>	<p>(1) Persistence of Borrelia burgdorferi in ligamentous tissue from a patient with chronic Lyme borreliosis. Haupt T; Hahn G; Rittig M; Krause A; Schoerner C; Schonherr U; et al. <i>Arthritis Rheum</i>, 36(11):1621-6. 1993.</p> <p>(2) Foot and ankle disorders resulting from Lyme disease. Faller J; Thompson F; Hamilton W. <i>Foot & Ankle</i>, (11)4:236-238. 1991</p>

Symptoms	Citations
Neurologic System	<p><i>“Neurologic involvement can be seen at all stages, and involves both central and peripheral nervous system syndromes.”</i> Lyme disease. Coyle PK. Curr Neurol Neurosci Rep, 2(6):479-87. 2002.</p> <p><i>“Chronic CNS involvement of LNB [Lyme neuroborreliosis] may mimic diseases such as neurosyphilis, meningoencephalitis of viral, fungal or mycobacterial origin, multiple sclerosis, brain tumor, autoimmune disease, stroke or Alzheimer's disease.”</i> Inflammatory brain changes in Lyme borreliosis: A report on three patients and review of literature. Oksi J; Kalimo H; Marttila RJ; Marjamaki M; et al. Brain, 119 (Pt 6):2143-54. 1996.</p> <p><i>“We believe the triad of neurologic manifestations of Lyme disease -- meningitis, cranial neuritis, and radiculoneuritis -- presents a unique clinical picture. In patients who express the complete triad, little else may be confused with it...Furthermore, arthritis is sometimes present, and few other diseases cause both arthritis and lymphocytic meningitis...However, patients may have incomplete pictures. Some lack ECM, and each of the neurologic abnormalities may appear alone...”</i> The triad of neurologic manifestations of Lyme disease: meningitis, cranial neuritis, and radiculoneuritis. Pachner AR; Steere AC. Neurology, 35(1):47-53. 1985.</p> <p><i>“Neurologic Lyme disease frequently presents without a history of a previous skin rash...”</i> Neurologic manifestations of Lyme disease, the new “Great Imitator.” Pachner AR. Rev Inf Dis, Vol. 11(Suppl 6):S1482-6. 1989.</p> <p><i>“The data in our study indicate that considerable infection with B. burgdorferi in the CNS can be present without overt clinical signs.”</i> [Note: This study was performed on adult rhesus monkeys.] Neuroborreliosis in the nonhuman primate: Borrelia burgdorferi persists in the central nervous system. Pachner AR; Delaney E; O’Neill T. Annals of Neurology, 38:667-9. 1995.</p> <p><i>“In some cases... in patients with stage 2 neurologic involvement... the ESR is often elevated, serum IgM may be increased, and serum may contain cryoimmunoglobulins... but routine laboratory tests are usually otherwise normal. In late cases, even these few abnormalities are typically absent.”</i> Louis Reik, Jr., M.D. Lyme Disease and the Nervous System. New York: Thieme Medical Publishers, Inc. 1991.</p>

Symptoms	Citations
<p>Aneurysm “CONCLUSIONS: Cerebral lymphocytic vasculitis and intracranial aneurysms may be associated with B burgdorferi infection. It is suggested that inflammatory changes caused by B burgdorferi in vessel walls may be a pathogenetic mechanism for the formation of aneurysms.” (1)</p>	<p>(1) Intracranial aneurysms in three patients with disseminated Lyme borreliosis: cause or chance association? Oksi J; Kalimo H; Marttila RJ; Marjamaki M; Sonninen P; Nikoskelainen J; Viljanen MK. J Neurol Neurosurg Psychiatry, 64(5):636-42. 1998.</p> <p>(2) Coronary artery aneurysm in two patients with long-standing Lyme borreliosis. Gasser R; Watzinger N; Eber B; Luha O; Reisinger E; Seinost G; Klein W. Lancet, 344(8932):1300-1. 1994.</p>
<p>Ataxia -- cerebellar “A 7-year-old boy.. presented with cerebellar ataxia and headaches... Lyme disease was diagnosed 10 weeks later after arthritis developed. (1)</p>	<p>(1) Cerebellar ataxia as the presenting manifestation of Lyme disease. Arav-Boger R; Crawford T; Steere AC; Halsey NA. Pediatr Infect Dis J, 21(4):353-6. 2002.</p>
<p>Brain hemorrhage “we report a case of Lyme disease in which subarachnoid hemorrhage was the presenting feature of a patient with polyradiculoneuropathy and encephalopathy.” (1)</p> <p>“[the patient] suffered a subarachnoid hemorrhage in association with early Lyme neuroborreliosis.” (2)</p> <p>“It is suspected that cause of the hemorrhage was parenchymatous Lyme-associated vascular damage and/or microaneurysmatic rupture.” (3)</p>	<p>(1) Subarachnoid hemorrhage in a patient with Lyme disease. Chehrenama M; Zagardo MT; Koski CL. Neurology, 48(2):520-3. 1997.</p> <p>(2) Subarachnoid hemorrhage due to Borrelia burgdorferi-associated vasculitis. Jacobi C; Schwark C; Kress B; Hug A; Storch-Hagenlocher B; Schwaninger M. Eur J Neurol, 13(5):536-8. 2006.</p> <p>(3) Spontaneous brain hemorrhage associated with Lyme neuroborreliosis. Seijo MM; Grandes IJ; Sanchez HJ; Garcia-Monco JC. Neurologia, 16(1):43-5. 2001.</p> <p>(4) Intracerebral haemorrhage as a manifestation of Lyme neuroborreliosis? Scheid R; Hund-Georgiadis M; von Cramon DY. Eur J Neurol, 10(1):99-101. 2003.</p>
<p>Cerebral atrophy “In 14 patients with clinical symptoms of neuroborreliosis CT and MR were performed to evaluate CNS changes. MR examinations were abnormal in 36%. Most patients (60%) presented cerebral atrophy.” (1)</p>	<p>(1) [Neuroborreliosis: CT and MRI findings in 14 cases.] Tarasow E; Ustymowicz A; Zajkowska J; Hermanowska-Szpakowicz T. Neurol Neurochir Pol, 35(5):803-13. 2001.</p>
<p>Chorea “We report the spectrum of neurologic involvement in 18 patients, a spectrum that includes meningitis, encephalitis, chorea, cerebellar ataxia... Three of the five children developed chorea” (1)</p>	<p>(1) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. Medicine, 58(4):281-94. 1979.</p> <p>(2) Chorea as a symptom of neuroborreliosis: a case study. Piccolo I; Thiella G; Sterzi R; Colombo N; Defanti CA. Ital J Neurol Sci, 19(4):235-9. 1998.</p>
<p>Clumsiness or coordination difficulties Clumsiness (1) Coordination difficulties (2)</p>	<p>(1) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. Medicine, 58(4):281-94. 1979.</p> <p>(2) The long-term clinical outcomes of Lyme disease. Shadick NA; Phillips CB; Logigian EL; Steere AC; Kaplan RF; Berardi VP; Duray PH et al. Annals of Internal Medicine, 121:560-567. 1994.</p>
<p>Coma “severe encephalopathy including stupor and coma” (1)</p>	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p>

Symptoms	Citations
<p>Cranial nerve abnormalities</p> <p>“Abnormalities of virtually all cranial nerves have been described, with clinical manifestations of diplopia (III, IV, VI); facial numbness, pain, or paresthesias (V), or weakness (VIII); hoarseness (IX, X); or weakness of the neck (XI) or tongue (XII).” (1)</p>	<p>(1) Neuroborreliosis. Halperin JJ. American Journal of Medicine, 98(4A):52S-56S. 1995.</p>
<p>Dementia or Alzheimer’s-like presentation</p> <p>“The occurrence of severe encephalitis resulting in dementia in two of these patients... enlarges the known spectrum of neurologic abnormalities due to infection with B. burgdorferi.” (1)</p> <p>“The data indicate that Borrelia burgdorferi may persist in the brain and be associated with amyloid plaques in AD [Alzheimer’s disease]. They suggest that these spirochetes, perhaps in an analogous fashion to Treponema pallidum, may contribute to dementia, cortical atrophy and amyloid deposition. Further in vitro and in vivo studies may bring more insight into the potential role of spirochetes in AD.” (3)</p> <p>“Morphological changes analogous to the amyloid deposits of AD brain were observed following 2-8 weeks of exposure to the [Borrelia burgdorferi] spirochetes.” (4)</p> <p>“In an additional case with concurrent AD and Lyme disease, using a specific antibody against Borrelia burgdorferi, spirochetes were found in senile plaques, in the leptomeningeal and cortical vessel walls, in neurones, and in microglial cells.” (5)</p> <p>“The following hypothesis is offered based on these observations. Borrelia spirochetes have a complex life cycle which includes corkscrew-shaped forms, uncoiled filamentous forms, L-forms lacking a cell wall, cystic and ameboid forms, and granular forms. ...the granular form of Borrelia may explain granulovacuolar degeneration of nerve cells in the hippocampal formation in Alzheimer’s disease.” (6)</p>	<p>(1) Neurologic abnormalities in Lyme disease without erythema chronicum migrans. Reik L; Burgdorfer W; Donaldson JO. American Journal of Medicine, 81:73. 1986.</p> <p>(2) Rapidly progressive frontal-type dementia associated with Lyme disease. Waniek C; Prohovnik I; Kaufman MA; Dwork AJ. Journal of Neuropsychiatry Clin Neurosci, 7(3):345-7. 1995.</p> <p>(3) Borrelia burgdorferi persists in the brain in chronic Lyme neuroborreliosis and may be associated with Alzheimer’s disease. Miklossy J; Khalili K; Gern L; Ericson RL; Darekar P; Bolle L; Hurlimann J; Paster BJ. J Alzheimers Dis. 6(6):639-649. 2004.</p> <p>(4) Beta-amyloid deposition and Alzheimer's type changes induced by Borrelia spirochetes. Miklossy J; Kis A; Radenovic A; Miller L; Forro L; Martins R; Reiss K; Darbinian N; Darekar P; Mihaly L; Khalili K. Neurobiol Aging. May, 2005.</p> <p>(5) Alzheimer's disease--a spirochetosis? Miklossy J. Neuroreport, 4(7):841-8. 1993.</p> <p>(6) Concurrent neocortical borreliosis and Alzheimer's disease: Demonstration of a spirochetal cyst form. MacDonald AB. Annals NY Academy of Sciences, 539:468-470. 1988.</p> <p>(7) Borrelia burgdorferi in the nervous system: the new “great imitator”. Pachner AR. Annals NY Academy of Sciences, 539:56-64. 1988.</p> <p>(8) Borrelia in the brains of patients dying with dementia. MacDonald A. Journal of the American Medical Association, 256(16):2195-6. 1986.</p> <p>(9) Lyme disease associated with Alzheimer’s disease. Meer-Scherrer L; Chang Loa C; Adelson ME; Mordechai E; Lobrinus JA; Fallon BA; Tilton RC. Current Microbiology, 52(4):330-2. 2006.</p>

Symptoms	Citations
<p>Demyelinating lesions or multiple sclerosis-like presentation</p> <p>“In four patients, focal CNS lesions, remitting and exacerbating over years, were mistakenly diagnosed as multiple sclerosis. ...The index of suspicion of third-stage Lyme neurologic involvement must be high, especially in endemic areas, because it is potentially treatable with antibiotics.” (1)</p> <p>“Large areas of demyelination in periventricular white matter were detected histologically and by MRI in one patient.” (4)</p> <p>“Six patients had relapsing-remitting episodes of focal CNS disease, sometimes mimicking multiple sclerosis” (5)</p> <p>“We describe four patients with marked chronic meningoencephalomyelitis caused by tick-transmitted <i>Borrelia burgdorferi</i> infection. Imaging techniques showed either MS-like lesions or evidence of vascular involvement, as in other spirochetal infections, especially in meningovascular syphilis.” (6)</p> <p>“Later neurologic sequelae, such as demyelinating conditions... occur less commonly and may not become evident until several years after acute infection. ...MRI scanning of the brain may reveal demyelinating lesions...” (7)</p> <p>“Fibers within the nerve eventually lose myelin, a finding that has been demonstrated in both human patients and experimental animals.” (8)</p>	<p>(1) Neurologic involvement in the third stage of Lyme disease: CNS manifestations can mimic multiple sclerosis and psychiatric illness. [poster presentation] Pachner AR; Steere AC. <i>Neurology</i>, 36(suppl 1):286. 1986.</p> <p>(2) Demyelinating encephalopathy in Lyme disease. Reik L Jr; Smith L; Khan A; Nelson W. <i>Neurology</i>, 35(2):267-9. 1985.</p> <p>(3) <i>Borrelia burgdorferi</i> detected by culture and PCR in clinical relapse of disseminated Lyme Borreliosis. Oksi J; Marjamaki M; Nikoskelainen J; Viljanen MK. <i>Annals of Medicine</i>, 31(3):225-32. 1999.</p> <p>(4) Inflammatory brain changes in Lyme borreliosis: A report on three patients and review of literature. Oksi J; Kalimo H; Marttila RJ; Marjamaki M; Sonninen P; et al. <i>Brain</i>, 119 (Pt 6):2143-54. 1996.</p> <p>(5) <i>Borrelia burgdorferi</i> in the nervous system: the new "great imitator". Pachner AR. <i>Annals of the New York Academy of Sciences</i>, 539:56-64. 1988.</p> <p>(6) Chronic central nervous system involvement in Lyme borreliosis. Kohler J; Kern U; Kasper J; Rhese-Kupper B; Thoden U. <i>Neurology</i>, 38(6):863-7. 1988.</p> <p>(7) Clinical manifestations of Lyme disease in the United States. Trock DH; Craft JE; Rahn DW. <i>Connecticut Medicine</i>, 53(6). 1989.</p> <p>(8) Clinical pathologic correlations of Lyme disease. Duray PH. <i>Reviews of Infectious Diseases</i>, 11(Suppl. 6): S1487-S1493. 1989.</p>
<p>Dizziness</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. <i>Annals of Internal Medicine</i>, 99(1):76-82. 1983.</p> <p>(2) <i>Borrelia burgdorferi</i> detected by culture and PCR in clinical relapse of disseminated Lyme Borreliosis. Oksi J; Marjamaki M; Nikoskelainen J; Viljanen MK. <i>Annals of Medicine</i>, 31(3):225-32. 1999.</p> <p>(3) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. <i>Laryngoscope</i>, 101(6 Pt 1):592-5. 1991.</p>

Symptoms	Citations
<p>Encephalitis/ Encephalopathy “Lyme encephalopathy [LE]... is a common late neurologic manifestation of Lyme disease... Although there have been reports of cases with severe cognitive impairment including psychosis and dementia and vasculitic lesions, Lyme encephalopathy usually causes a subtle syndrome of memory impairment, difficulty concentrating, sleep disturbance, irritability, fatigue, or emotional lability.” (1)</p> <p>“Other associated symptoms... may include mild depression ...and excessive daytime sleepiness.” (5)</p> <p>“In our experience, encephalitis is nearly as common as meningitis and reflects the diffuse nature of neurologic involvement.” (3)</p> <p><i>[Testing:]</i> “brain MRI, even with gadolinium enhancement, is usually normal, although in some patients, white matter lesions are seen.” (5)</p> <p>“Quantitative SPECT demonstrates multifocal, partially reversible reduction in cerebral perfusion, mainly of frontal white matter, basal ganglia, and medial cortex, in patients with LE...” (5)</p>	<p>(1) Memory impairment and depression in patients with Lyme encephalopathy: Comparison with fibromyalgia and nonpsychotically depressed patients. Kaplan RF; Meadows ME; Vincent LC; Logigian EL; Steere AC. <i>Neurology</i>, 42:1263-1267. 1992.</p> <p>(2) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. <i>Annals of Internal Medicine</i>, 99(1):76-82. 1983.</p> <p>(3) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. <i>Medicine</i>, 58(4):281-94. 1979.</p> <p>(4) Demyelinating encephalopathy in Lyme disease. Reik L Jr; Smith L; Khan A; Nelson W. <i>Neurology</i>, 35(2):267-9. 1985.</p> <p>(5) Reversible cerebral hypoperfusion in Lyme encephalopathy. Logigian EL; Johnson KA; Kijewski MF; Kaplan RF; Becker JA; Jones KJ; Garada BM; Holman BL; Steere AC. <i>Neurology</i>, 49(6):1661-1670. 1997.</p> <p><i>[Active Infection:]</i> “we believe that LE usually results from active infection of the brain with <i>B. burgdorferi</i>.” (5)</p> <p>“These data support the hypothesis that Lyme encephalopathy is caused by CNS dysfunction and cannot be explained as a psychological response to chronic illness.” (1)</p> <p>“The general paresis form of neurosyphilis may begin with impairment of memory and concentration, irritability, depression, sleep disorder, and fatigue. By analogy, we believe that Lyme encephalopathy may also result from chronic infection of the CNS with <i>B. burgdorferi</i>.” (1)</p>
<p>Encephomyelitis/ Encephomyelopathy “Progressive <i>Borrelia</i> encephalomyelitis: ...Symptoms can begin either gradually or acutely. Once started, they do not resolve spontaneously but worsen progressively, either steadily or step-by-step with sudden worsening followed by only partial improvement before the next attack. ...The most common neurologic symptoms are limb weakness, gait difficulties, ataxia, bladder disturbance, speech abnormalities, visual and hearing loss, and poor memory and concentration.” (1)</p>	<p>(1) Neurologic aspects of North American Lyme disease. Reik L Jr. In <i>Lyme Disease</i>, ed. Patricia K. Coyle, M.D. St. Louis: Mosby-Year Book Inc., pp.101-112. 1993.</p> <p>(2) <i>Borrelia burgdorferi</i>-seropositive chronic encephalomyelopathy: Lyme neuroborreliosis? An autopsy report. Kobayashi K; Mizukoshi C; Aoki T; Muramori F; Hayashi M; et al. <i>Dement Geriatr Cogn Disord</i>, 8(6):384-90. 1997.</p> <p>(3) Chronic encephalomyelitis caused by <i>Borrelia burgdorferi</i>. Case report. Pavlovic D; Levic Z; Dmitrovic R; Ocic G. <i>Glas Srp Akad Nauka [Med]</i>, (43):225-8. 1993.</p>

Symptoms	Citations
<p>Guillain-Barré syndrome “A 4.5 year-old child suffered from rapidly evolving motor weakness with paresthesia and radicular pain in both legs... The diagnosis of Guillain-Barré syndrome was confirmed by electrophysiological studies. [High antibody titres and PCR evidence of B. burgdorferi DNA were found], “thus providing the borrelial aetiology and indicating B. burgdorferi infection.” (1)</p> <p>"One patient died from cardiac arrest caused by myocarditis and Guillain-Barré syndrome." (2)</p> <p>“The third neurologic syndrome that is characteristic of Lyme disease is a radiculoneuropathy that may mimic Guillain-Barré syndrome.” (3)</p>	<p>(1) Demonstration of <i>Borrelia burgdorferi</i> infection in a child with Guillain-Barré syndrome. Horneff G, Huppertz HI, Müller K, Voit T, Karch H. <i>Eur J Pediatr</i>, 152(10):810-2. 1993.</p> <p>(2) <i>Borrelia burgdorferi</i> myositis: report of eight patients. Reimers C; de Koning J; Neubert U; Preac-Mursic V; Koster JG; Mueller-Felber W; Pongratz DE; Duray PH. <i>Journal of Neurology</i>, 240(5):278-83. 1993.</p> <p>(3) Neurologic presentations in Lyme disease. Coyle PK; Schutzer SE. <i>Hospital Practice</i>, 26(11):55-66; discussion 66, 69-70. 1991.</p>
<p>Hemiparesis/Paraparesis “We report on a 12-year-old, previously healthy girl with an acute hemiparesis as the predominant clinical manifestation of Lyme neuroborreliosis (LNB). ...We conclude that LNB should be considered in every stroke-like episode of unknown origin in children, even in the absence of a history of a tick bite or typical skin lesions.” (1)</p> <p>“We describe the case of a 27 - year old man - presenting with a left-sided hemiparesis when waking up. ...The Lyme serodiagnosis in the blood and in the spinal fluid was positive, and we demonstrated an intrathecal <i>Borrelia burgdorferi</i> specific antibody synthesis.” (2)</p> <p>“Central nervous system manifestations that appear to be most common are paraparesis and ataxia.” (4)</p>	<p>(1) Large cerebral vessel occlusive disease in Lyme neuroborreliosis. Klingebiel R; Benndorf G; Schmitt M; von Moers A; Lehmann R. <i>Neuropediatrics</i>, 33(1):37-40. 2002.</p> <p>(2) Left sided sudden hemiparesis linked to a central form of Lyme disease. Deloizy M; Devos P; Stekelorum T; Testard D; Belhadia A. <i>Rev Neurol (Paris)</i>, 156(12):1154-6. 2000.</p> <p>(3) Lyme neuroborreliosis mimics stroke: a case report. Zhang Y; Lafontant G; Bonner FJ. <i>Arch Phys Med Rehabil</i>, 81(4):519-21. 2000.</p> <p>(4) Clinical manifestations and diagnosis of neuroborreliosis. Stiernstedt G; Gustafsson R; Karlsson M; Svenungsson B; Skoldenberg B. <i>Annals NY Academy of Sciences</i>, pp 46-53. 1988.</p>
<p>Intracranial hypertension</p>	<p>Intracranial hypertension in neuroborreliosis. Hartel C; Schilling S; Neppert B; Tiemer B; Sperner J. <i>Dev Med Child Neurol</i>, 44(9):641-2. 2002.</p>

Symptoms	Citations
<p>Meningitis “Meningitis is the single most common abnormality in patients with neurologic involvement in early disseminated disease... The most common symptom is headache, usually either frontal or occipital and varying in intensity from mild to disabling. ...meningitis can occur alone and be the presenting feature of the illness.” (2)</p> <p>“we describe thirty-eight patients who had meningitis sometimes accompanied by cranial neuropathy and/or peripheral radiculo-neuropathy... We believe that this constellation of symptoms is unique among neurological diseases. ...The usual time between the first stage and subsequent meningitis was one month. ... The first sign of illness in one of our early patients was meningitis which recurred three times. The diagnosis became clear only when he developed arthritis.” (3)</p>	<p>(1) The triad of neurologic manifestations of Lyme disease: meningitis, cranial neuritis, and radiculoneuritis. Pachner AR; Steere AC. Neurology, 35(1):47-53. 1985.</p> <p>(2) Neurologic aspects of North American Lyme disease. Reik L Jr. In Lyme Disease, ed. Patricia K. Coyle, M.D. St. Louis: Mosby-Year Book Inc., pp.101-112. 1993.</p> <p>(3) Neurological findings of Lyme disease. Pachner AR; Steere AC. Yale Journal of Biology & Medicine, 57(4):481-3. 1984.</p>

Symptoms	Citations
<p>Motor neuron disease or amyotrophic lateral sclerosis-like presentation</p> <p>“It does appear that Lyme disease can mimic ALS... but how often it does so is not clear.” (1)</p> <p>“CSF investigation in a 61-year old female patient with clinical picture of motorneuron disease gave evidence for chronic infection with <i>Borrelia burgdorferi</i>.” (1)</p> <p>“Cerebrospinal fluid was examined in 24 ALS patients--3 (all with severe bulbar involvement) appeared to have intrathecal synthesis of anti-<i>B burgdorferi</i> antibody.” (2)</p>	<p>Lyme Disease and the Nervous System. Louis Reik, Jr., M.D. New York: Thieme Medical Publishers, Inc. 1991.</p> <p>(1) ALS-like sequelae in chronic neuroborreliosis. Hansel Y; Ackerl M; Stanek G. Wien Med Wochenschr, 145(7-8):186-8. 1995.</p> <p>(2) Immunologic reactivity against <i>Borrelia burgdorferi</i> in patients with motor neuron disease. Halperin JJ; Kaplan GP; Brazinsky S; Tsai TF; Cheng T; Ironside A; Wu P; Delfiner J; Golightly M; et al. Arch Neurol, 47(5):586-94. 1990.</p> <p>(3) CNS-borreliosis selectively affecting central motor neurons. Fredrikson S; Link H. Acta Neurol Scand, 78(3):181-4. 1988.</p>
<p>Neurogenic pain, Neuritis – cranial or radiculoneuritis</p> <p>“Neurogenic pain with radiculitis is often the starting symptom in adult patients with tick-borne Lyme neuroborreliosis and in some cases the only clinical manifestation. ... The present paper describes four patients who had severe pain as the main presenting symptom of Lyme neuroborreliosis.” (1)</p> <p>“Pain due to radiculoneuritis is a frequent symptom in early Lyme borreliosis. It has been described as severe, burning, tearing, migrating pain with characteristic exacerbations at night.” (3)</p> <p>“Chronic neuropathic pain occurs in 10-15% of patients with neuroborreliosis” (4)</p>	<p>(1) Pain as presenting symptom in Lyme neuroborreliosis. Dotevall L; Eliasson T; Hagberg L; Mannheimer C. Eur J Pain, 7(3):235-9. 2003.</p> <p>(2) The triad of neurologic manifestations of Lyme disease: meningitis, cranial neuritis, and radiculoneuritis. Pachner AR; Steere AC. Neurology, 35(1):47-53. 1985.</p> <p>(3) Early neurological involvement (Bannwarth’s syndrome). Pfister HW; Kristoferitsch W; Meier C. In <i>Aspects of Lyme Borreliosis</i>, ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 152-167. 1993.</p> <p>(4) Gabapentin for the symptomatic treatment of chronic neuropathic pain in patients with late-stage lyme borreliosis: a pilot study. Weissenbacher S; Ring J; Hofmann H. Dermatology, 211(2):123-7. 2005.</p>
<p>Numbness, tingling or burning</p> <p>facial numbness (1)</p> <p>“almost one half of the patients we have seen with late Lyme disease have had neurologic difficulties, the most common of which has been the presence of intermittent paresthesias” (2)</p> <p>“Numbness, tingling, or burning pain in an extremity” (3)</p>	<p>(1) Central nervous system manifestations of Lyme disease. Pachner AR; Duray P; Steere AC. Archives of Neurology, 46(7):790-5. 1989.</p> <p>(2) Lyme disease: cause of a treatable peripheral neuropathy. Halperin JJ; Little BW; Coyle PK; Dattwyler RJ. Neurology, 37(11):1700-6. 1987.</p> <p>(3) The long-term clinical outcomes of Lyme disease. Shadick NA; Phillips CB; Logigian EL; Steere AC; Kaplan RF; Berardi VP; Duray PH et al. Annals of Internal Medicine, 121:560-567. 1994.</p>

Symptoms	Citations
<p>Parkinsonism “We present a case of striatonigral degeneration, a form of multiple system atrophy, in Lyme-associated parkinsonism. A 63-year-old man presented with erythema migrans rash, joint pains, and tremors. Serum and cerebrospinal fluid antibodies and polymerase chain reaction for <i>Borrelia burgdorferi</i> were positive... To our knowledge, this is the first report of striatonigral degeneration in a patient with <i>B burgdorferi</i> infection of the central nervous system and clinical Lyme-associated parkinsonism.” (1)</p> <p>“Parkinson’s syndrome can also develop during stage 2. The physical findings, which are sometimes asymmetric, include global rigidity, akinesia, hypomimia, tremor, cog-wheeling, and postural instability.” (2)</p> <p>“the last [patient] developed parkinsonism and communicating hydrocephalus after an otherwise classical meningoradiculitis” (3)</p>	<p>(1) Lyme-associated parkinsonism: a neuropathologic case study and review of the literature. Cassarino DS; Quezado MM; Ghatak NR; Duray PH. Arch Pathol Lab Med, 127(9):1204-6. 2003.</p> <p>(2) Lyme Disease and the Nervous System. Louis Reik, Jr., M.D. New York:Thieme Medical Publishers. 1993.</p> <p>(3) Neurologic forms of Lyme disease. 12 cases. Viader F ; Poncelet AM ; Chapon F ; Thenint JP ; et al. Rev Neurol (Paris), 145(5):362-8 1989.</p> <p>(4) Meningoradiculitis and encephalomyelitis due to <i>Borrelia burgdorferi</i>: A follow-up study of 72 patients over 27 years. Krüger H; Reuss K; Pulz M; et al. J Neurol, 236:322-328. 1989.</p>

Symptoms	Citations
<p>Pseudotumor cerebri, pressure in head “We conclude that acute neuroborreliosis can present with pseudotumor cerebri as an initial manifestation.” (1)</p> <p>“These 4 children with Lyme-associated pseudotumor cerebri all responded to a combination of intravenous ceftriaxone and oral acetazolamide” (2)</p> <p>“To our knowledge, pseudotumor cerebri as a complication of Lyme disease has been described only in children. We report the first case of an adult with pseudotumor cerebri due to Lyme disease...” (4)</p> <p>“intracranial pressure associated with Lyme meningitis” (5)</p>	<p>(1) Pseudotumor cerebri in Lyme disease: a case report and literature review. Kan L; Sood SK; Maytal J. <i>Pediatric Neurology</i>, 18(5):439-41. 1998.</p> <p>(2) Lyme disease and pseudotumor. Zemel L. <i>Mayo Clinic Proceedings</i>, 75(3):315. 2000.</p> <p>(3) Pseudotumor cerebri and Lyme disease: a new association. Raucher HS; Kaufman DM; Goldfarb J; Jacobson RI; Roseman B; Wolff RR. <i>Journal of Pediatrics</i>, 107:931-933. 1985.</p> <p>(4) Lyme disease complicated with pseudotumor cerebri. Nord JA; Karter D. <i>Clinical Infectious Diseases</i>, 37(2):E25-6. 2003.</p> <p>(5) Optic neuropathy in children with lyme disease. Rothermel H; Hedges TR 3rd; Steere AC. <i>Pediatrics</i>, Aug;108(2):477-81. 2001.</p>
<p>Seizures “Along with or months after erythema migrans, cranial neuropathy or Lyme arthritis, the five children developed behavioral changes, forgetfulness, declining school performance, headache or fatigue and in two cases a partial complex seizure disorder.” (1)</p> <p>“Coma has been reported in at least five patients, and seizures of a variety of types, in at least nine: Partial complex, focal motor, and both primary and secondary generalized convulsive seizures have all been reported.” (4)</p> <p>“We describe a child whose first manifestation of Lyme disease was an acute, focal meningoencephalitis with signs and symptoms such as fever, headache, slurred speech, hemiparesis, seizure, and CSF pleocytosis.” (5)</p> <p>“Another was a 40-year-old man presenting with epileptic seizures and MRI-detected multifocal lesions, which disappeared after repeated courses of antibiotics.” (6)</p>	<p>(1) Neurocognitive abnormalities in children after classic manifestations of Lyme disease. Bloom BJ; Wyckoff PM; Meissner HC; Steere AC. <i>Pediatric Infectious Disease Journal</i>, 17(3):189-96. 1998.</p> <p>(2) <i>Borrelia burgdorferi</i> detected by culture and PCR in clinical relapse of disseminated Lyme Borreliosis. Oksi J; Marjamaki M; Nikoskelainen J; Viljanen MK. <i>Annals of Medicine</i>, 31(3):225-32. 1999.</p> <p>(3) Epilepsy disclosing neuroborreliosis. Mourin S; Bonnier C; Bigaignon G; Lyon G. <i>Rev Neurol (Paris)</i>, 149(8-9):489-91. 1993.</p> <p>(4) Lyme Disease and the Nervous System. Louis Reik, Jr., M.D. New York:Thieme Medical Publishers. 1993.</p> <p>(5) Lyme disease: Acute focal meningoencephalitis in a child. Feder HM; Zalneraitis EL; Reik L. <i>Pediatrics</i>, 82:931-34. 1988.</p> <p>(6) Inflammatory brain changes in Lyme borreliosis: A report on three patients and review of literature. Oksi J; Kalimo H; Marttila RJ; Marjamaki M; Sonninen P; et al. <i>Brain</i>, 119 (Pt 6):2143-54. 1996.</p>
<p>Sensory abnormalities “Sensory symptoms were common: eight patients had regional or generalized cutaneous hyperesthesia to touch or temperature.” (1)</p>	<p>(1) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. <i>Medicine</i>, 58(4):281-94. 1979.</p>
<p>Shooting or stabbing pains “Peripheral neuropathies (motor or sensory) may result in sharp shooting or stabbing pains, burning pains, paresthesias, weakness, or fasciculations.” (1)</p>	<p>(1) The underdiagnosis of neuropsychiatric Lyme disease in children and adults. Fallon BA; Kochevar JM; Gaito A; Niels J. <i>Psychiatric Clinics of North America</i>, 21(3):693-703. 1998.</p>

Symptoms	Citations
<p>Sleep disturbances “Greater sleep latency, decreased sleep efficiency and a greater arousal index were noted in Lyme patients. ... Three patients demonstrated alpha-wave intrusion into NREM sleep.” (1)</p> <p>“Lyme encephalopathy, primarily manifested by disturbances in memory, mood, and sleep, is a common late neurologic manifestation of Lyme disease.” (2)</p> <p>“Other associated symptoms and signs [of Lyme encephalopathy] may include...excessive daytime sleepiness.” (4)</p>	<p>(1) Sleep quality in Lyme disease. Greenberg HE; Ney G; Scharf SM; Ravdin L; Hilton E. <i>Sleep</i>, 18(10):912-6. 1995.</p> <p>(2) Memory impairment and depression in patients with Lyme encephalopathy: comparison with fibromyalgia and nonpsychotically depressed patients. Kaplan RF; Meadows ME; Vincent LC; Logigian EL; Steere AC. <i>Neurology</i>, 42(7):1263-7. 1992.</p> <p>(3) Chronic neurologic manifestations of Lyme disease. Logigian EL; Kaplan RF; Steere AC. <i>New England Journal of Medicine</i>, 323(21):1438-44. 1990.</p> <p>(4) Reversible cerebral hypoperfusion in Lyme encephalopathy. Logigian EL; Johnson KA; Kijewski MF; Kaplan RF; Becker JA; Jones KJ; Garada BM; Holman BL; Steere AC. <i>Neurology</i>, 49(6):1661-1670. 1997.</p>
<p>Smells – abnormalities “smells may seem overly intense and noxious” (1)</p>	<p>(1) The neuropsychiatric manifestations of Lyme borreliosis. Fallon BA; Niels JA; Liegner K; DelBene D; Liebowitz MR. <i>Psychiatric Quarterly</i>, 63(1):95-117. 1992</p>
<p>Stroke “A 56-year-old Connecticut woman suffered multiple strokes 18 months after antibiotic treatment for early Lyme disease with facial palsy. Pleocytosis, intrathecal synthesis of anti-Borrelia burgdorferi antibody, and the response to antibiotic treatment substantiated the diagnosis of neuroborreliosis. (1)</p> <p>“We conclude that Lyme neuroborreliosis may imitate stroke...” (3)</p> <p>“We report on a 12-year-old, previously healthy girl with an acute hemiparesis as the predominant clinical manifestation of Lyme neuroborreliosis (LNB)... We conclude that LNB should be considered in every stroke-like episode of unknown origin in children, even in the absence of a history of a tick bite or typical skin lesions.” (4)</p>	<p>(1) Stroke due to Lyme disease. Reik L Jr. <i>Neurology</i>, 43(12):2705-7. 1993.</p> <p>(2) Lyme disease presenting as a stroke in the vertebrobasilar territory: MRI. Defer G; Levy R; Brugieres P; Postic D; Degos JD. <i>Neuroradiology</i>, 35(7):529-31. 1993.</p> <p>(3) Screening for neuroborreliosis in patients with stroke. Hammers-Berggren S; Grondahl A; Karlsson M; von Arbin M; Carlsson A; Stiernstedt G. <i>Stroke</i>, 24(9):1393-6. 1993.</p> <p>(4) Large cerebral vessel occlusive disease in Lyme neuroborreliosis. Klingebiel R; Benndorf G; Schmitt M; von Moers A; Lehmann R. <i>Neuropediatrics</i>, 33(1):37-40. 2002.</p>
<p>Taste – abnormalities “Foods may taste abnormally sour or bitter” (1)</p> <p>“taste disappeared on the left side of his tongue” (2)</p> <p>“decreased taste” (3)</p>	<p>(1) The neuropsychiatric manifestations of Lyme borreliosis. Fallon BA; Niels JA; Liegner K; DelBene D; Liebowitz MR. <i>Psychiatric Quarterly</i>, 63(1):95-117. 1992.</p> <p>(2) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. <i>Medicine</i>, 58(4):281-94. 1979.</p> <p>(3) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. <i>Laryngoscope</i>, 101(6 Pt 1):592-5. 1991.</p>

Symptoms	Citations
<p>Tourette's-like syndrome "Rapid efficacy of antibiotic treatment followed by a decrease in Borrelia-specific antibody titres suggests that the multiple motor and vocal tics were at least partially caused by the tertiary stage of borreliosis." (1)</p>	<p>(1) Lyme disease presenting as Tourette's syndrome. Riedel M; Straube A; Schwarz MJ; Wilske BM; Muller N. <i>Lancet</i>, 351(9100):418-419. 1998.</p>
<p>Tumor "We report a patient with verified Borrelia burgdorferi infection who developed a tumor in the cerebello-pontine angle. The origin of this tissue is almost certainly causally related to the B. burgdorferi infection. ... This is the first report of an expansive cerebral lesion in the chronic phase of Lyme disease." (1)</p> <p>"We report a 10 year-old child who had parenchymal brainstem and hemi- spheric mass lesions with no previous stigmata of Lyme disease. The lesions proved to be Lyme neuroborreliosis confirmed by stereotactic biopsy and serological studies..." (2)</p>	<p>(1) Chronic Lyme disease with an expansive granulomatous lesion in the cerebellopontine angle. Mokry M; Flaschka G; Kleinert G; Kleinert R; Fazekas F; Kopp W. <i>Neurosurgery</i>, 27(3):446-51. 1990.</p> <p>(2) Lyme neuroborreliosis manifesting as an intracranial mass lesion. Murray R; Morawetz R; Kepes J; el Gammal T; LeDoux M. <i>Neurosurgery</i>, 30(5):769-73. 1992.</p> <p>(3) Lyme neuroborreliosis masquerading as a brainstem tumor in a 15-year-old. Curless RG; Schatz NJ; Bowen BC; Rodriguez Z; Ruiz A. <i>Pediatr Neurol</i>, 15(3):258-60. 1996.</p>
<p>Transverse myelitis "The history, physical examination, imaging, and serologic studies were consistent with transverse myelitis related to Lyme disease and babesiosis. The severity and permanence of this patient's deficits were greater than those reported in the majority of previous cases of transverse myelitis due to Lyme disease alone, suggesting a possible role for coinfection with babesiosis." (1)</p> <p>"acute transverse myelitis (ATM) was the prominent neurological manifestation... This patient had ATM with involvement of sensory and motor tracts on both sides of the spinal cord." (2)</p>	<p>(1) Transverse myelitis secondary to coexistent Lyme disease and babesiosis. Oleson CV; Sivalingam JJ; O'Neill BJ; Staas WE Jr. <i>J Spinal Cord Med</i>, 26(2):168-71. 2003.</p> <p>(2) Acute transverse myelitis as presenting neurological feature of Lyme disease. Rousseau JJ; Lust C; Zangerle PF; Bizgaignon G. <i>Lancet</i>, 2(8517):1222-3. 1986.</p> <p>(3) Lyme borreliosis: a case of transverse myelitis with syrinx cavity. Kohler J. <i>Neurology</i>, 39(11):1553-4. 1989.</p>
<p>Tremors/shaking</p>	<p>(1) Chronic encephalomyelitis caused by Borrelia burgdorferi. Case report. Pavlovic D; Levic Z; Dmitrovic R; Ocic G. <i>Glas Srp Akad Nauka [Med]</i>, (43):225-8. 1993.</p>
<p>Vertigo "Ten patients (14%) had serological evidence of Borrelia infection. All 10 patients had severe, incapacitating vertigo." (2)</p> <p>"Six of the patients had rotational vertigo, one had positional vertigo and one had drop attacks of the Tumarkin type. ...vertigo can be the presenting symptom of Lyme disease." (3)</p>	<p>(1) Otolaryngologic aspects of Lyme disease. Moscatello AL; Worden DL; Nadelman RB; Wormser G; Lucente F. <i>Laryngoscope</i>, 101(6 Pt 1):592-5. 1991.</p> <p>(2) Borrelia infection and vertigo. Rosenhall U; Hanner P; Kaijser B. <i>Acta Otolaryngol</i>, 106(1-2):111-6. 1988.</p> <p>(3) Lyme borreliosis -- an unusual cause of vertigo. Peltomaa M; Pyykkö I; Seppälä I; Viljanen M. <i>Auris Nasus Larynx</i>, 25:233-242. 1998.</p>

Symptoms	Citations
<p>Walking – difficulty/ataxia “Weeks to years after the initial infection, behavioral changes, ataxia, and/or weakness in bulbar or peripheral muscles developed.” (1)</p> <p>“he [a 9-year old boy diagnosed with Lyme disease] developed severe headache and difficulty walking... On December 7, he was unable to walk without support” (3)</p> <p>“Our patient showed a chronic and progressive clinical picture consisting of instability on walking and distal paresthesia of lower limbs, suggestive of posterior column disfunction.” (4)</p>	<p>(1) Central nervous system manifestations of Lyme disease. Pachner AR; Duray P; Steere AC. Archives of Neurology, 46(7):790-5. 1989.</p> <p>(2) Inflammatory brain changes in Lyme borreliosis: A report on three patients and review of literature. Oksi J; Kalimo H; Marttila RJ; Marjamaki M; Sonninen P; Nikoskelainen J; Viljanen MK. Brain, 119 (Pt 6):2143-54. 1996.</p> <p>(3) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. Medicine, 58(4):281-94. 1979.</p> <p>(4) Isolated posterior cord syndrome in Lyme disease: a clinico-neurophysiological study. Gutierrez MA; de Pablos C; Oterino A; Garcia Monco JC. Rev Neurol, 33(10):954-7. 2001.</p>

Symptoms	Citations
<p>Psychological Symptoms</p>	<p><i>“A broad range of psychiatric reactions have been associated with Lyme disease including paranoia, dementia, schizophrenia, bipolar disorder, panic attacks, major depression, anorexia nervosa, and obsessive-compulsive disorder.”</i></p> <p>Lyme disease: a neuropsychiatric illness. Fallon BA, Nields JA. American Journal of Psychiatry, 151(11):1571-83. 1994.</p> <p><i>“As sometimes happened with tertiary syphilis, one of our patients was even hospitalized in a state psychiatric hospital before the realization that his apparent “psychiatric illness” might be due to Lyme disease.”</i></p> <p>Central nervous system manifestations of Lyme disease. Pachner AR; Duray P; Steere AC. Archives of Neurology, 46(7):790-5. 1989.</p>
<p>Anxiety “Mental disorders are part of clinical picture of the acute stage of Lyme Disease, and could also be its sequel. The most commonly found mental disorders are: encephalopathy, other cognitive disorders, mood disorders (depression), anxiety disorders and less often: psychotic disorders and eating disorders (anorexia nervosa).” (1)</p>	<p>(1) [Mental disorders in Lyme disease.] Rudnik-Szalaj I; Poplawska R; Zajkowska J; Szulc A; Pancewicz SA; Gudel I. Pol Merkuriusz Lek, 11(65):460-2. 2001.</p>
<p>Behavioral changes “The most common presentation (13 pts) was diffuse, chronic brain involvement leading to behavioral changes” (1)</p>	<p>(1) Borrelia burgdorferi in the nervous system: the new "great imitator". Pachner AR. Annals NY Academy of Sciences, 539:56-64. 1988.</p> <p>(2) Central nervous system manifestations of Lyme disease. Pachner AR; Duray P; Steere AC. Archives of Neurology, 46(7):790-5. 1989.</p>
<p>Depression “varied forms of psychoneurosis including depression” (2)</p> <p>“The most common psychiatric manifestations were depressive disorders--episodes of depression or organic mood disorders, and cognitive deficits which manifest themselves as mild cognitive disorder or dementia.” (3)</p> <p>“depression, when severe, may be associated with frontal, paralimbic hypoperfusion on SPECT [single photon emission computed tomography].” (1)</p>	<p>(1) Reversible cerebral hypoperfusion in Lyme encephalopathy. Logigian EL; Johnson KA; Kijewski MF; Kaplan RF; Becker JA; Jones KJ; Garada BM; Holman BL; Steere AC. Neurology, 49(6):1661-1670. 1997.</p> <p>(2) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(3) [Mental disorders in the course of Lyme borreliosis and tick-borne encephalitis] Juchnowicz D; Rudnik I; Czernikiewicz A; Zajkowska J; Pancewicz SA. Przegl Epidemiol, 56 Suppl 1:37-50. 2002.</p>
<p>Emotional lability (overly emotional reactions)</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(2) The neuropsychiatric manifestations of Lyme borreliosis. Fallon BA; Nields JA; Liegner K; DelBene D; Liebowitz MR. Psychiatric Quarterly, 63(1):95-117. 1992</p>

Symptoms	Citations
<p>Hallucinations – auditory, visual, olfactory</p> <p>“Lyme disease appears to be capable of causing syndromes which manifest as... hallucinations (auditory, visual, and olfactory”... (1)</p> <p>“We report the first cases of musical hallucinations in two patients with neurologic Lyme disease. ...Musical hallucinations had a sudden onset and took the form of patriotic or operatic music.” (2)</p>	<p>(1) The underdiagnosis of neuropsychiatric Lyme disease in children and adults. Fallon BA; Kochevar JM; Gaito A; Niels J. <i>Psychiatric Clinics of North America</i>, 21(3):693-703. 1998.</p> <p>(2) Musical hallucinations in patients with Lyme disease. Stricker RB; Winger EE. <i>Southern Medical Journal</i>, 96(7):711-715. 2003.</p> <p>(3) Painful hallucinations and somatic delusions in a patient with the possible diagnosis of neuroborreliosis. Bar KJ; Jochum T; Hager F; Meissner W; Sauer H. <i>Clin J Pain</i>, 21(4):362-3. 2005.</p>
<p>Inappropriate laughter</p>	<p>(1) Central nervous system manifestations of Lyme disease. Pachner AR; Duray P; Steere AC. <i>Archives of Neurology</i>, 46(7):790-5. 1989.</p>
<p>Irritability</p> <p>“Mild encephalopathy, including difficulty with concentration and memory, and <i>irritability</i> and emotional lability may occur.” (2) [italics added]</p>	<p>(1) Reversible cerebral hypoperfusion in Lyme encephalopathy. Logigian EL; Johnson KA; Kijewski MF; Kaplan RF; Becker JA; Jones KJ; Garada BM; Holman BL; Steere AC. <i>Neurology</i>, 49(6):1661-1670. 1997.</p> <p>(2) Clinical manifestations of Lyme disease. Sigal L. <i>New Jersey Medicine</i>, 87(7):549-555. 1990.</p> <p>(2) Neurocognitive abnormalities in children after classic manifestations of Lyme disease. Bloom BJ; Wyckoff PM; Meissner HC; Steere AC. <i>Pediatr Infect Dis J</i>, 17(3):189-96. 1998.</p>
<p>Mood changes</p> <p>Mood changes (1) Mood swings (2)</p>	<p>(1) Chronic neurologic manifestations of Lyme disease. Logigian EL; Kaplan RF; Steere AC. <i>New England Journal of Medicine</i>, 22;323(21):1438-44. 1990.</p> <p>(2) Neurologic involvement in the third stage of Lyme disease: CNS manifestations can mimic multiple sclerosis and psychiatric illness. [poster presentation] Pachner AR; Steere AC. <i>Neurology</i>, 36(suppl 1):286. 1986.</p>
<p>Nightmares</p>	<p>(1) A 25-year-old woman with hallucinations, hypersexuality, nightmares, and a rash. Stein SL; Solvason HB; Biggart E; Spiegel D. <i>American Journal of Psychiatry</i>, 153(4):545-51. 1996.</p>
<p>Panic attacks/panic disorder</p> <p>“We describe three patients who experienced psychiatric symptoms for the first time during their illness with Lyme borreliosis. ...To our knowledge, this is the first report to link panic disorder and mania to Lyme borreliosis.” (1)</p>	<p>(1) Psychiatric manifestations of Lyme borreliosis. Fallon BA; Niels JA; Parsons B; Liebowitz MR; Klein DF. <i>Journal of Clinical Psychiatry</i>, 54(7):263-8. 1993.</p> <p>(2) Panic attacks may reveal previously unsuspected chronic disseminated Lyme disease. Sherr VT. <i>Journal of Psychiatric Practice</i>, 6(6):352-356. 2000.</p>
<p>Paranoia</p> <p>“Over the next 12 days, his headache progressively worsened... his family noted that he was becoming increasingly agitated and paranoid.” (1)</p>	<p>(1) Lyme meningoencephalitis -- report of a severe, penicillin resistant case. Dinger MN; Halperin JJ; Dattwyler RJ. <i>Arthritis & Rheumatism</i>, 30:705-708. 1987.</p>
<p>Rage or violent outbursts</p>	<p>(1) Central nervous system manifestations of Lyme disease. Pachner AR; Duray P; Steere AC. <i>Archives of Neurology</i>, 46(7):790-5. 1989.</p>

Symptoms	Citations
<p>Schizophrenia-like disorder “To our knowledge this is the first reported case with an exclusive psychiatric manifestation of Lyme disease.” (1)</p> <p>“We describe a case with no neurological signs but marked psychiatric symptoms induced by borrelia burgdorferi, whose clinical picture was indistinguishable from an endogenous schizophrenia. ...The case demonstrated the aetiologic nonspecificity of paranoid symptoms and hallucinations...” (3)</p>	<p>(1) Borrelia burgdorferi central nervous system infection presenting as an organic schizophrenialike disorder. Hess A; Buchmann J; Zettl UK; Henschel S; Schlaefke D; Grau G; Benecke R. Biol Psychiatry, 45(6):795. 1999.</p> <p>(2) Untreated neuroborreliosis: Bannwarth's syndrome evolving into acute schizophrenia-like psychosis. A case report. Roelcke U; Barnett W; Wilder-Smith E; Sigmund D; Hacke W. J Neurol, 239(3):129-31. 1992.</p> <p>(3) Endogenous paranoid-hallucinatory syndrome caused by Borrelia encephalitis. Barnett W; Sigmund D; Roelcke U; Mundt C. Nervenarzt, 62(7):445-7. 1991.</p> <p>(4) <i>Geographic correlation of schizophrenia to ticks and tick-borne encephalitis.*</i> Brown JS. Schizophrenia Bulletin, 20(4):755-75. 1994.*</p> <p>[*Note: Citation #4 reports a statistically significant correlation between the incidence of Lyme disease, schizophrenia, and the presence of Ixodes ticks. The author does not propose a causal link between Lyme disease and schizophrenia.]</p>
<p>Cognitive Symptoms</p>	<p>“Considering the association of neuroborreliosis with vasculitis, the close correlation between cerebral blood flow and neural activity, and the recent findings of cerebral hypoperfusion in late Lyme borreliosis suggest there might be a pathophysiological link between perfusion deficits and neuropsychiatric symptoms in neuroborreliosis as suggested before in other conditions.”</p> <p>Primarily chronic and cerebrovascular course of Lyme neuroborreliosis: case reports and literature review. Wilke M; Eiffert H; Christen HJ; Hanefeld F. Arch Dis Child, 83(1):67-71. 2000.</p>
<p>“Brain fog” “She [a patient diagnosed with stage II Lyme disease] also complained of being in a mental ‘fog.’” (1)</p>	<p>(1) Cognitive functioning in late Lyme borreliosis. Krupp LB; Masur D; Schwartz J; Coyle PK; Langenbach LJ; Fernquist SK; Jandorf L; Halperin JJ. Arch Neurol, 48(11):1125-9. 1991.</p> <p>(2) Neurologic presentations in Lyme disease. Coyle PK; Schutzer SE. Hospital Practice, 26(11):55-66; discussion 66, 69-70. 1991.</p>
<p>Concentration difficulties “Mild encephalopathy, including difficulty with concentration and memory... may occur.” (1)</p> <p>“The symptoms of cerebral involvement included... poor memory and concentration” (2)</p> <p>“neuropsychiatric symptoms such as headache, attention problems, memory difficulties and depression” (3)</p>	<p>(1) Clinical manifestations of Lyme disease. Sigal L. New Jersey Medicine, 87(7):549-555. 1990.</p> <p>(2) Neurologic abnormalities of Lyme disease. Reik L; Steere AC; Bartenhagen NH; Shope RE; Malawista SE. Medicine, 58(4):281-94. 1979.</p> <p>(3) Chronic symptoms are common in patients with neuroborreliosis – a questionnaire follow-up study. Vrethem M; Hellblom L; Widlund M; Ahl M; Danielsson O; Ernerudh J; Forsberg P. Acta Neurol Scand, 106(4):205-8. 2002.</p>
<p>Confusion</p>	<p>(1) Cognitive functioning in late Lyme borreliosis. Krupp LB; Masur D; Schwartz J; Coyle PK; Langenbach LJ; Fernquist SK; Jandorf L; Halperin JJ. Arch Neurol, 48(11):1125-9. 1991.</p>
<p>Declining school performance</p>	<p>(1) Neurocognitive abnormalities in children after classic manifestations of Lyme disease. Bloom BJ; Wyckoff PM; Meissner HC; Steere AC. Pediatric Infectious Disease Journal, 17(3):189-96. 1998.</p>

Symptoms	Citations
<p>Facial recognition difficulties “Other reported problems included word-finding difficulty (n=2) and problems with facial recognition (n=1).” (1)</p>	<p>(1) Cognitive functioning in late Lyme borreliosis. Krupp LB; Masur D; Schwartz J; Coyle PK; Langenbach LJ; Fernquist SK; Jandorf L; Halperin JJ. Arch Neurol, 48(11):1125-9. 1991</p>
<p>Memory impairment/word retrieval difficulties “difficulty...remembering details such as names or appointment times. All engaged in new compensatory behavior, such as daily list-making, in an effort to overcome their disorder of memory and learning, but their performance usually still suffered.”(1)</p> <p>“Compared with controls, patients with Lyme disease exhibited marked impairment on memory tests and particularly on selective reminding measures of memory retrieval.” (3)</p> <p>“Other reported problems included word-finding difficulty” (3)</p> <p>“Our findings appear to demonstrate that processes involving the retrieval of stored information were particularly vulnerable to disruption.” (4)</p>	<p>(1) Reversible cerebral hypoperfusion in Lyme encephalopathy. Logigian EL; Johnson KA; Kijewski MF; Kaplan RF; Becker JA; Jones KJ; Garada BM; Holman BL; Steere AC. Neurology, 49(6):1661-1670. 1997.</p> <p>(2) Memory impairment and depression in patients with Lyme encephalopathy: comparison with fibromyalgia and nonpsychotically depressed patients. Kaplan RF; Meadows ME; Vincent LC; Logigian EL; Steere AC. Neurology, 42(7):1263-7. 1992.</p> <p>(3) Cognitive functioning in late Lyme borreliosis. Krupp LB; Masur D; Schwartz J; Coyle PK; Langenbach LJ; Fernquist SK; Jandorf L; Halperin JJ. Archives of Neurology, 48(11):1125-9. 1991.</p> <p>(4) Neurologic complications of late and chronic Lyme disease. Coyle PK. 9th Annual International Scientific Conference on Lyme Disease & Other Tick-Borne Disorders, Westin Copley Plaza Hotel, Boston, MA, April 19-20, 1996.</p>
<p>Spatial disorientation - getting lost/going to the wrong place</p> <p>“Loss of orientation” (2)</p>	<p>(1) The neuropsychiatric manifestations of Lyme borreliosis. Fallon BA; Niels JA; Liegner K; DelBene D; Liebowitz MR. Psychiatric Quarterly, 63(1):95-117. 1992</p> <p>(2) Chronic neurologic manifestations of erythema migrans borreliosis. Ackermann R; Rehse-Kupper B; Gollmer E; Schmidt R. Annals of the New York Academy of Sciences, 539:16-23. 1988.</p>
<p>Spelling difficulties, dyslexic reversals “Cognitive problems were evident, such as misspelling of words, letter reversals, and word finding problems.” (1)</p>	<p>(1) Psychiatric manifestations of Lyme borreliosis. Fallon BA; Niels JA; Parsons B; Liebowitz MR; Klein DF. J Clin Psychiatry, 54(7):263-8. 1993.</p>
<p>Task performance difficulties “The patients reported new difficulty at home and in the workplace for performance of multiple parallel tasks, for single tasks requiring sustained attention, and for remembering details such as names or appointment times.” (1)</p>	<p>(1) Reversible cerebral hypoperfusion in Lyme encephalopathy. Logigian EL; Johnson KA; Kijewski MF; Kaplan RF; Becker JA; Jones KJ; Garada BM; Holman BL; Steere AC. Neurology, 49(6):1661-1670. 1997.</p>

Symptoms	Citations
<p>Verbal difficulties, impaired or slurred speech “language difficulty” (1) “impairment in verbal fluency” (1) dysarthric speech [poorly articulated speech] (3) (4)</p> <p>“We describe a child whose first manifestation of Lyme disease was an acute, focal meningoencephalitis with signs and symptoms such as fever, headache, <i>slurred speech</i>, hemiparesis, seizure, and CSF pleocytosis.” (2) [italics added]</p> <p>“This report presents a case of dysarthria due to hypoglossal nerve mono-neuropathy as the only consequence of neuroborreliosis. ... The speech of the patient was slow and laboured.” (4)</p>	<p>(1) Cognitive functioning in late Lyme borreliosis. Krupp LB; Masur D; Schwartz J; Coyle PK; Langenbach LJ; Fernquist SK; Jandorf L; Halperin JJ. Arch Neurol, 48(11):1125-9. 1991.</p> <p>(2) Lyme disease: Acute focal meningoencephalitis in a child. Feder HM; Zalneraitis EL; Reik L. Pediatrics, 82:931-34. 1988.</p> <p>(3) Chronic neurologic manifestations of erythema migrans borreliosis. Ackermann R; Rehse-Kupper B; Gollmer E; Schmidt R. Annals of the New York Academy of Sciences, 539:16-23. 1988.</p> <p>(4) Dysarthria as the isolated clinical symptom of borreliosis--a case report. Gustaw K; Mirecka U. Ann Agric Environ Med, 8(1):95-97. 2001.</p> <p>(5) Lyme meningoencephalitis -- report of a severe, penicillin resistant case. Diringer MN; Halperin JJ; Dattwyler RJ. Arthritis & Rheumatism, 30:705-708. 1987.</p>
<p>Word reversals or transpositions when speaking “Word transpositions are not uncommon, such that a patient might say, ‘I put the microwave in the dinner’ instead of ‘I put the dinner in the microwave.’” (2)</p>	<p>(1) The neuropsychiatric manifestations of Lyme borreliosis. Fallon BA; Nields JA; Liegner K; DelBene D; Liebowitz MR. Psychiatric Quarterly, 63(1):95-117. 1992.</p> <p>(2) The underdiagnosis of neuropsychiatric Lyme disease in children and adults. Fallon BA; Kochevar JM; Gaito A; Nields J. Psychiatric Clinics of North America, 21(3):693-703. 1998.</p>
<p>Writing - dyslexic reversals of letters</p>	<p>(1) The neuropsychiatric manifestations of Lyme borreliosis. Fallon BA; Nields JA; Liegner K; DelBene D; Liebowitz MR. Psychiatric Quarterly, 63(1):95-117. 1992.</p>

Symptoms	Citations
Reproduction/Sexuality	
Impotence	(1) Central nervous system manifestations of Lyme disease. Pachner AR; Duray P; Steere AC. Archives of Neurology, 46(7):790-5. 1989.
<p>Pregnancy/maternal-fetal transmission of Lyme</p> <p>“It is clear that <i>B. burgdorferi</i> can be transmitted in the blood of infected pregnant women across the placenta into the fetus. This has now been documented with resultant congenital infections... Spirochetes can be recovered or seen in the infant’s tissues including the brain, spleen and kidney.” (1)</p> <p>“There is no placental protection or barrier that protects the fetus from the spirochete once the microbe has entered the maternal bloodstream.”... “It is documented that transplacental transmission of the spirochete from mother to fetus is possible.” [Includes photographs of Bb in fetal brain, kidney, myocardium, and placenta.] (2)</p> <p>“We now demonstrate <i>B. burgdorferi</i> in the brain and liver of a newborn whose mother had been treated with oral penicillin for LB [Lyme borreliosis]... The death of the newborn was probably due to a respiratory failure as a consequence of perinatal brain damage.” (4)</p> <p>“We report a culture positive neonatal death occurring in California, a low endemic region. ...Bb was grown from a frontal cerebral cortex inoculation” (5)</p> <p>“both humoral and cellular <i>B. burgdorferi</i>-specific responses can be detected in cord blood of previously infected neonates” (7)</p>	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(2) Gestational Lyme borreliosis: implications for the fetus. MacDonald AB. Rheumatic Diseases Clinics of North America, 15(4):657-677. 1989.</p> <p>(3) Maternal-fetal transmission of the Lyme disease spirochete, <i>Borrelia burgdorferi</i>. Schlesinger PA; Duray PH; Burke BA; Steere AC; Stillman MT. Annals of Internal Medicine, 103(1):67-8. 1985.</p> <p>(4) <i>Borrelia burgdorferi</i> in a newborn despite oral penicillin for Lyme borreliosis during pregnancy. Weber K; Bratzke HJ; Neubert U; Wilske B; Duray PH. Pediatric Infectious Disease Journal, 7:286-9. 1988.</p> <p>(5) Culture positive seronegative transplacental Lyme borreliosis infant mortality. Lavoie PE; Lattner BP; Duray PH; Barbour AG; Johnson HC. Arthritis Rheum, 30(4), 3(Suppl):S50. 1987.</p> <p>(6) Clinical manifestations of Lyme disease in the United States. Trock DH; Craft JE; Rahn DW. Connecticut Medicine, 53(6). 1989.</p> <p>(7) Immunologic aspects of Lyme borreliosis. Dattwyler RJ; Volkman DJ; Luft BJ. Rev Infect Dis, II(Suppl 6):S1494-98. 1989.</p> <p>(8) Gestational Lyme disease as a rare cause of congenital hydrocephalus. Onk G; Acun C; Kalayci M; Cagavi F; et al. J Turkish German Gynecology Association Artemis, 6(2):156-157. 2005.</p> <p>----- <i>Additional Quotation</i> “In a prospective study of abortuses in an area endemic for Lyme disease, four cases of fetal borreliosis were described with <i>B. burgdorferi</i> isolated from fetal liver. This observation suggests that <i>B. burgdorferi</i> may be an etiologic agent in fetal demise of uncertain cause. The development of these infants warrants further observation, especially since in another spirochetal infection, congenital syphilis, abnormalities are not always evident at birth” (6)</p>
<p>Testicular or pelvic pain/swelling</p> <p>“orchitis” (1)</p>	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(2) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>

Symptoms	Citations
<p>Skin/Hair</p>	<p><i>“Chronic Lyme disease is also associated with multiple and seemingly unrelated cutaneous manifestations such as acrodermatitis chronica atrophicans, sclerodermoid-like reactions, lichen sclerosus et atrophicus, subcuticular fibrous nodules, eosinophilic fasciitis-like lesions of the extremities, and, possibly, granuloma annulare. With care, spirochetes can be recovered or demonstrated by silver staining in most of the above lesions. Spirochetes have yet to be seen in the tissues of autonomic ganglia or peripheral nerves.”</i></p> <p>Clinical pathologic correlations of Lyme disease. Duray PH Rev Infect Dis, 11 Suppl 6:S1487-93. 1989.</p> <p><i>“Within several days after onset of the initial skin lesion (ECM), many patients develop multiple annular secondary lesions. Although their appearance is similar to initial lesions, they are generally smaller, migrate less, and lack indurated centers; ...in Lyme disease we have not seen blistering, mucosal lesions, or involvement of the palms and soles. During this [early] period, some patients develop other dermatologic findings including malar rash, conjunctivitis, urticaria, or small evanescent red blotches and circles.”</i></p> <p>The clinical spectrum and treatment of Lyme disease. Steere AC; Malawista SE; Bartenhagen NH; Spieler PN; Newman JH; Rahn DW; Hutchinson GJ; Green J; Snyderman DR; Taylor E. Yale Journal of Biology and Medicine, 57(4):453-64. 1984.</p>
<p>Acrodermatitis chronica atrophicans (ACA)</p> <p>“We have confirmed the spirochetal etiology of this lesion... This therefore establishes ACA as a part of the natural history as well as a late manifestation of untreated cutaneous Lyme disease in the United States” (1)</p> <p>“The atrophic stage may take years, even decades to develop, or it may never occur at all. When it does occur, it leaves the skin appearing parchment-like... Ulceration and malignancy may be complications. ... ACA unlike EM, does not spontaneously resolve.” (2)</p> <p>“Years after infection, acrodermatitis chronica atrophicans arises at distal body sites causing livid swelling and gradually skin atrophy. ...parenteral antibiotic therapy is sometimes necessary.” (4)</p>	<p>(1) Late cutaneous Lyme disease: acrodermatitis chronica atrophicans. Kaufman LD; Gruber BL; Phillips ME; Benach JL. Am J Med, 86(6 Pt 2):828-30. 1989.</p> <p>(2) Lyme borreliosis. [Chapter 63] In <i>Eye and Skin Disease</i>, ed M.J. Mannis et al. deLuise VP; Lesser RL; Scrimenti RJ. Lippencot-Raven Publishers, Philadelphia. 1996.</p> <p>(3) Spirochetes in atrophic skin lesions accompanied by minimal host response in a child with Lyme disease. Gellis SE; Stadecker MJ; Steere AC. J Am Acad Dermatol, 25(2 Pt 2):395-7. 1991.</p> <p>(4) Cutaneous manifestations of Lyme borreliosis. Aberer E, Klade H Infection, 19(4):284-6. 1991.</p>
<p>Anetoderma</p> <p>“patients with anetoderma should be examined for borreliosis including serology and polymerase chain reaction of lesional skin.” (1)</p>	<p>(1) Anetoderma: Another facet of Lyme disease? Bauer J; Leitz G; Palmedo G; Hugel H. J Am Acad Dermatol, 48(5 Suppl):S86-8. 2003.</p>
<p>Baker’s Cyst</p>	<p>(1) Lyme disease presenting with sequential episodes of ruptured baker cysts. Bhambhani N; Disla E; Cuppari G. J Clin Rheumatol, 12(3). 2006.</p>

Symptoms	Citations
<p>Breast nipple: pseudolymphoma</p> <p>“A substantial number of CPL [cutaneous pseudolymphoma] in the breast nipple is caused by antigenic stimulation by <i>Borrelia burgdorferi</i>. In some patients a tick bite is documented.” (1)</p>	<p>(1) [Pseudolymphoma of the breast nipple. The problem overview.] Boudova L; Kazakov DV; Hes O; Suvova B; Neprasova P; Treska V; Fakan F; Michal M. <i>Rozhl Chir</i>, 84(2):66-9. 2005.</p>
<p>Fibrous nodules</p> <p>“The patients presented with nodular or discoid fibrosis, partly in conjunction with acrodermatitis chronica atrophicans (ACA).” (1)</p>	<p>(1) Cutaneous fibroses induced by <i>Borrelia burgdorferi</i>. Marsch WC; Mayet A; Wolter M. <i>Br J Dermatol</i>, 128(6):674-8. 1993.</p> <p>(2) Periarticular fibrous nodules in Lyme borreliosis. Espana A; Torrelo A; Guerrero A; Suarez J; Rocamora A; Ledo A. <i>Br J Dermatol</i>, 125(1):68-70. 1991.</p>
<p>Hair loss (alopecia)</p>	<p>(1) Diffuse reversible alopecia in patients with Lyme meningitis and tick-borne encephalitis. Cimperman J; Maraspin V; Lotric-Furlan S; Ruzic-Sabljić E; Avsic-Zupanc T; Strle F. <i>Wien Klin Wochenschr</i>, 111(22-23):976-7. 1999.</p> <p>(2) Localized alopecia at the site of erythema migrans. Spach DH; Shimada JK; Paauw DS. <i>J Am Acad Dermatol</i>, 27(6 Pt 1):1023-4. 1992.</p>
<p>Lymphocytoma ear lobe; nipple/areolae (1)</p> <p>“Borreliolymphocytoma can often be observed at particular sites such as the ear lobe or the nipple. Borreliolymphocytoma presents usually as a small solitary bluish-red plaque or nodule. Multiple lesions may occur, too. ...It appears to be a sign of all stages of Lyme borreliosis, but may be most commonly encountered during the second stage (Weber 1989a).” (2)</p>	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. <i>Annals NY Academy of Sciences</i>, 539:65-79. 1988.</p> <p>(2) Clinical features of Lyme borreliosis. Weber K; Pfister HW; Reimers CD. In <i>Aspects of Lyme Borreliosis</i>, ed. Klaus Weber, M.D., Willy Burgdorfer, Ph.D., M.D. Berlin Heidelberg:Springer-Verlag:pp 93-104. 1993.</p>
<p>B-Cell Lymphoma (a form of skin cancer)</p> <p>“<i>Borrelia burgdorferi</i> infection has been implicated in cutaneous B-cell lymphoma. We report a case of multilesional primary cutaneous large B-cell lymphoma without extracutaneous spread in a patient with elevated <i>B. burgdorferi</i> titers. After antibiotic therapy, clinical remission and a subsequent drop in <i>B. burgdorferi</i> antibody titers were obtained.” (4)</p>	<p>(1) Primary cutaneous B-cell lymphoma and <i>Borrelia burgdorferi</i> infection in patients from the Highlands of Scotland. Goodlad JR; Davidson MM; Hollowood K; Ling C; MacKenzie C; et al. <i>Am J Surg Pathol</i>, 24(9):1279-85. 2000.</p> <p>(2) Eradication of <i>Borrelia burgdorferi</i> infection in primary marginal zone B-cell lymphoma of the skin. Roggero E; Zucca E; Mainetti C; Bertoni F; Valsangiacomo C; Pedrinis E; et al. <i>Hum Pathol</i>, 31(2):263-8. 2000.</p> <p>(3) Infection by <i>Borrelia burgdorferi</i> and cutaneous B-cell lymphoma. Cerroni L; Zochling N; Putz B; Kerl H. <i>J Cutan Pathol</i>, 24(8):457-61. 1997.</p> <p>(4) Multilesional primary cutaneous diffuse large b-cell lymphoma responsive to antibiotic treatment. Hofbauer GF; Kessler B; Kempf W; Nestle FO; Burg G; Dummer R. <i>Dermatology</i>, 203(2):168-70. 2001.</p>
<p>Petechia (small spots of bleeding under the skin, ranging from pinpoint to pinhead in size, even with the skin surface)</p> <p>“Uncommonly, petechiae have also been seen within erythema migrans lesions.”</p>	<p>(1) Central nervous system infection caused by <i>Borrelia burgdorferi</i>. Clinico-pathological correlation of three post-mortem cases. Bertrand E; Szpak GM; Pilkowska E; Habib N; et al. <i>Folia Neuropathol</i>, 37(1):43-51. 1999.</p> <p>(2) Diagnosis of Lyme disease based on dermatologic manifestations. Malane MS; Grant-Kels JM; Feder HM; Luger SW. <i>Annals of Internal Medicine</i>, 114:490-8. 1991.</p>

Symptoms	Citations
<p>Rash – erythema migrans (EM)</p> <p>“[EM] gradually expands to form a large annular lesion, often with a central clearing. Multiple lesions (acute dissemination) may be observed ...not all patients with Lyme borreliosis have erythema migrans.” (1)</p> <p>“When present in its typical form it is diagnostic. The rash often expands over several days to greater than 10 centimeters in diameter. If untreated, the rash usually fades within one to four weeks, although occasionally it persists for months.” (2)</p> <p>“EM is usually erythematous but may be purplish or brownish; is usually round but may be elongated or triangular; is usually smooth but may be stippled, bumpy, or even vesicular, necrotic, hemorrhagic, crusty, or scaly; usually shows central clearing as it expands (if duration is longer than 3 weeks) but may be homogeneous (if duration is short) or have secondary concentric annuli (“bull’s-eye” appearance) in the center; and is usually asymptomatic but may be associated with minimal pruritus, burning, dysesthesia, and regional adenopathy. Some lesions have recurred over as long as 1 year” (3)</p> <p>“The surface... is often warmer than the surrounding skin. ...While the lesion is usually asymptomatic, it may itch or burn in as many as one-third of cases.” (4)</p> <p>“recurrent” EM lesions (5)</p> <p><i>[EM appearing during treatment:]</i> “We describe an adolescent girl in whom the rash appeared after the initiation of ceftriaxone therapy for aseptic meningitis.” (6)</p> <p>“Spontaneous and posttreatment disappearance of erythema migrans is therefore not identical with cure of Lyme borreliosis.” (7)</p> <p>“These findings demonstrate the capacity of viable <i>B. burgdorferi</i> sensu lato organisms to persist in clinically normal-appearing skin at the site of a resolved erythema migrans rash for periods ranging from 2 months to 3.5 years.” (8)</p>	<p>(1) Complications of Lyme borreliosis. Cooke WD; Dattwyler RJ. Annual Review of Medicine, 43:93-103. 1992.</p> <p>(2) Treatment of Lyme disease. Schoen RT. Connecticut Medicine, 53(6):335-337. 1989.</p> <p>(3) Lyme disease. Gardner T. In <i>Infectious Diseases of the Fetus and Newborn Infant</i>, ed. Remington JS; Klein JO. Philadelphia:W.B. Saunders Company. pp. 519-641. 2001.</p> <p>(4) Lyme Disease and the Nervous System. Louis Reik, Jr., M.D. New York:Thieme Medical Publishers. 1993.</p> <p>(5) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p> <p>(6) Erythema migrans after ceftriaxone treatment of aseptic meningitis caused by <i>Borrelia burgdorferi</i>. Jhaveri R; Cherry JD; Phillips S; Korb J. Pediatr Infect Dis J, 20(10):1010-2. 2001.</p> <p>(7) Treatment failure in erythema migrans - a review. Weber K. Infection, 24:73-5. 1996.</p> <p>(8) Persistence of <i>Borrelia burgdorferi</i> sensu lato in resolved erythema migrans lesions. Strle F; Cheng Y; Cimperman J; Maraspin V; Lotric-Furlan S; Nelson JA; et al. Clin Infect Dis, 21(2):380-389. 1995.</p> <p>(9) Early dissemination of <i>Borrelia burgdorferi</i> without generalized symptoms in patients with erythema migrans. Oksi J; Marttila H; Soini H; Aho H; et al. APMIS, 109(9):581-8. 2001.</p> <p>(10) Recognition and treatment of erythema migrans: are we off target? Nadelman RB; Wormser GP. Annals of Internal Medicine, 136(6):477-479. 2002.</p> <p>(11) Clinical characteristics and treatment outcome of early Lyme disease in patients with microbiologically confirmed erythema migrans. Smith RP; Schoen RT; Rahn D; Sikand VK; Nowakowski J; Parenti DL; Holman M; Persing, DH; Steere AC. Annals of Internal Medicine, 136(6):421-428. 2002.</p> <p>(12) Laboratory diagnostic techniques for patients with early Lyme disease associated with erythema migrans: a comparison of different techniques. Nowakowski J; Schwartz I; Liveris D; Wang G; Agüero-Rosenfeld ME; Girao G; McKenna D; Nadelman RB; Cavaliere LF; Wormser GP; Lyme Disease Study Group. Clinical Infectious Diseases, 33(12):2023-7. 2001.</p> <p><i>Additional Quotations:</i> “We conclude that EM lesions are more often homogenous than ring-like.” (9)</p> <p>“Because U.S. patients with Lyme disease present sooner than they did in the past, erythema migrans is usually characterized by a homogeneous rash rather than by a target appearance or central clearing.” (10)</p> <p>“59% of the rashes consisted of homogeneous erythema and 32% had more intense central erythema surrounded by a paler peripheral ring. Atypical lesions, such as those with vesicular or ulcerated centers, were occasionally noted. Nine patients (7.6%) had multiple annular skin lesions, a sign of disseminated infection.” (11)</p> <p>“Quantitative PCR on skin biopsy-derived material was the most sensitive diagnostic method (80.9%)... No single diagnostic modality is suitable for detection of <i>B. burgdorferi</i> in every patient with erythema migrans.” (12)</p>

Symptoms	Citations
<p>Rash – erythema migrans “mini EM” [A "mini EM" is] "An erythema migrans (EM) remaining smaller than 5 cm in diameter..." "Conclusion: The mini EM represents an important and apparently uncommon sign of early Lyme borreliosis." (1)</p>	<p>(1) Mini erythema migrans – a sign of early Lyme borreliosis. Weber K; Wilske B. Dermatology, 212(2): 113-116. 2006.</p>
<p>Rash – maculopapular</p>	<p>(1) Fatal adult respiratory distress syndrome in a patient with Lyme disease. Kirsch M; Ruben FL; Steere AC; Duray PH; Norden CW; Winkelstein A. Journal of the American Medical Association, 259(18):2737-9. 1988.</p>
<p>Rash – malar</p>	<p>(1) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
<p>Rash – urticarial (hives) “Other cutaneous manifestations of Lyme disease include localized and generalized urticaria...” (2)</p>	<p>(1) Urticarial lesions and Lyme disease. McFadden JP; Greaves MW. J Am Acad Dermatol, 25(1 Pt 1):131-2. 1991.</p> <p>(2) Urticarial vasculitis and Lyme disease. Olson J; Esterly NB. J Am Acad Dermatol, 22(6), Part 1:1114-1116. 1990.</p> <p>(3) The early clinical manifestations of Lyme disease. Steere AC; Bartenhagen NH; Craft JE; Hutchinson GJ; Newman JH; Rahn DW; Sigal LH; Spieler PN; Stenn KS; Malawista SE. Annals of Internal Medicine, 99(1):76-82. 1983.</p>
<p>Rash – necrotic skin wound “We report a case of Lyme disease with clinical features resembling those described from brown recluse spider bites. The most striking manifestation was a necrotic skin wound. ...infection with Borrelia burgdorferi should be considered in the differential diagnosis of necrotic arachnidism in regions endemic for Lyme disease.” (1)</p>	<p>(1) Lyme disease masquerading as brown recluse spider bite. Osterhoudt KC; Zaoutis T; Zorc JJ. Annals of Emergency Medicine, 39(5):558-561. 2002.</p>
<p>Skin sclerosis - scleroderma “Fourteen days after the end of [antibiotic] treatment the skin was no longer stiff and indurated and had returned to its normal predisease state. This case suggests that Lyme disease should be considered in atypical cases of skin sclerosis in patients predisposed to the development of systemic scleroderma.” (1)</p>	<p>(1) Acute exacerbation of systemic scleroderma in Borrelia burgdorferi infection. Wackernagel A; Bergmann AR; Aberer E. J Eur Acad Dermatol Venereol, 19(1):93-6. 2005.</p>

Symptoms	Citations
<i>Other (including cancer-like presentation)</i>	
<p>Lyme simulating malignancy</p> <p>“Neuroborreliosis might imitate cancer. Symptoms such as loss of weight and pain appear malignant. Furthermore we have also found that mononuclear cells found in CSF might appear atypical and malignant. Two patients in Sweden have been misdiagnosed as having meningeal lymphoma.” (1)</p> <p>“We conclude that Lyme disease may present as atypical spinal fluid lymphoplasmacytic cellular infiltrates that simulate malignant lymphoma...” (2)</p> <p>“Analysis of the cerebrospinal fluid revealed... an elevated number of large atypical cells, resembling lymphoma cells.” (4)</p> <p>“Brain MRI suggested malignancies in two patients before histopathological studies were carried out. One of these two patients was a child with sudden hemiparesis.” (7)</p>	<p>(1) Clinical manifestations and diagnosis of neuroborreliosis. Stiernstedt G; Gustafsson R; Karlsson M; Svenungsson B; Skoldenberg B. Annals NY Academy of Sciences, pp 46-53. 1988.</p> <p>(2) Lyme disease meningopolyneuritis simulating malignant lymphoma. Szyfelbein WM; Ross JS. Mod Pathology, 1(6):464-8. 1988.</p> <p>(3) Borrelia meningitis mimicking meningeal lymphoma. Garcia-Monco JC; Gomez-Beldarrain M; Benach JL; Anda P; Alvarez J; Ojanguren J. Neurology, 44 2207. 1994.</p> <p>(4) Nervous system borreliosis with pseudo-lymphoma cells in cerebrospinal fluid. Kaminsky P; Grignon Y; Deibener J; Maurer P; Duc M. Rev Neurol (Paris), 154(2):170-2. 1998.</p> <p>(5) Erythema chronicum migrans as the presenting manifestation of juvenile chronic myelocytic leukemia. Inoue S; Gordon R; Berner G. Cutis, 43(4):333-7. 1989.</p> <p>(6) Lyme borreliosis mimicking central nervous system malignancy: the diagnostic pitfall of cerebrospinal fluid cytology. Kielich M; Fiedler A; Driever PH; Weis R; Schwabe D; Jacobi G. Brain Dev, 22(6):403-6. 2000.</p> <p>(7) Inflammatory brain changes in Lyme borreliosis: A report on three patients and review of literature. Oksi J; Kalimo H; Marttila RJ; Marjamaki M; Sonninen P; et al. Brain, 119 (Pt 6):2143-54. 1996.</p>
<p>Sarcoidosis (association with exposure to Lyme)</p> <p>“CONCLUSION: In a region [in Japan] where Lyme borreliosis is endemic, Borrelia infection may be partially associated with sarcoidosis.” (1)</p>	<p>(1) Seroprevalence of anti-Borrelia antibodies among patients with confirmed sarcoidosis in a region of Japan where Lyme borreliosis is endemic. Ishihara M; Ohno S; Ono H; Isogai E; Kimura K; Isogai H; Aoki K; et al. Graefes Arch Clin Exp Ophthalmol, 236(4):280-4. 1998.</p>

Fatality Reports

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Arch Pathol Lab Med, 127(9):1204-6. 2003.
- (2) *Borrelia burgdorferi* detected by culture and PCR in clinical relapse of disseminated Lyme borreliosis.
Oksi J; Marjamaki M; Nikoskelainen J; Viljanen MK. *Annals of Medicine*, 31(3):225-32. 1999.
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<i>Detection of Borrelia burgdorferi in Host Tissues & Fluids</i>	
Bladder	<p><i>Monkey model:</i> (1) Localization of <i>Borrelia burgdorferi</i> in the nervous system and other organs in a nonhuman primate model of Lyme disease. Cadavid D; O'Neill T; Schaefer H; Pachner AR. Laboratory Investigation, 80(7):1043-52. 2000.</p> <p><i>Mouse model:</i> (2) Chronic Lyme borreliosis in the laboratory mouse. Barthold SW; de Souza MS; Janotka JL; Smith AL; Persing DH. American Journal of Pathology, 143(3):959-71. 1993.</p>
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Bone	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(2) Bone marrow manifestation of Lyme disease (Lyme Borreliosis). Kvasnicka HM; Thiele J; Ahmadi T. British Journal of Haematology, 120(5):723. 2003.</p>
Brain	<p>(1) Inflammatory brain changes in Lyme borreliosis. A report on three patients and review of literature. Oksi J; Kalimo H; Marttila RJ; et al. Brain, 199(Pt 6):2143-54. 1996.</p> <p>(2) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(3) Lyme disease of the brainstem. Kalina P; Decker A; Kornel E; Halperin JJ. Neuroradiology, Sep 13, 2005.</p>
Breast milk	<p>(1) Detection of <i>Borrelia burgdorferi</i> DNA by polymerase chain reaction in the urine and breast milk of patients with Lyme borreliosis. Schmidt BL; Aberer E; Stockenhuber C; Klade H; Breier F; Luger A. Diagn Microbiol Infect Dis, 21:121-128. 1995.</p>
Cerebrospinal fluid (CSF)	<p>(1) Detection of <i>Borrelia burgdorferi</i> DNA by polymerase chain reaction in cerebrospinal fluid in Lyme neuroborreliosis. Nocton JJ; Bloom BJ; Rutledge BJ; Persing DH; Logigian EL; Schmid CH; Steere AC. J Infect Dis, 174(3):623-7. 1996.</p> <p>(2) The spirochetal etiology of Lyme disease. Steere AC; Grodzicki RL; Kornblatt AN; Craft JE; Barbour AG; Burgdorfer W; Schmid GP; et al. New England Journal of Medicine, 308:733-740. 1983.</p>
Ear	<p><i>Mouse model:</i> (1) Chronic Lyme borreliosis in the laboratory mouse. Barthold SW; de Souza MS; Janotka JL; Smith AL; Persing DH. American Journal of Pathology, 143(3):959-71. 1993.</p> <p><i>Rodent model:</i> (2) Comparison of urinary bladder and ear biopsy samples for determining prevalence of <i>Borrelia burgdorferi</i> in rodents in central Europe. J Clin Microbiol, 34(5):1310-2. 1996. Petney TN; Hassler D; Bruckner M; Maiwald M.</p>

<i>Detection of Borrelia burgdorferi in Host Tissues & Fluids</i>	
Eye	<p>(1) First isolation of <i>Borrelia burgdorferi</i> from an iris biopsy. Preac-Mursic V; Pfister HW; Spiegel H; Burk R; Wilske B; Reinhardt S; Bohmer R. Journal of Clinical Neuroophthalmology, 13(3):155-61; discussion 162. 1993.</p> <p><i>Hamster model:</i> (2) The histopathology of experimentally infected hamsters with the Lyme disease spirochete, <i>Borrelia burgdorferi</i>. Duray PH; Johnson RC. Proc Soc Exp Biol Med, 181(2):263-9. 1986.</p>
Heart	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(2) Isolation of <i>Borrelia burgdorferi</i> from the myocardium of a patient with longstanding cardiomyopathy. Stanek G; Klein J; Bittner R; Glogar D. New England Journal of Medicine, 322: 249-52. 1990.</p>
Kidney	<p>(1) Visceral histopathology in Lyme borreliosis: new observations. Duray PH. Zentralbl Bacteriol (Suppl), 18:116-125. 1989.</p> <p>(2) Gestational Lyme borreliosis. Implications for the fetus. MacDonald AB. Rheum Dis Clin North Am, 15(4):657-77. 1989.</p>
Ligament	<p>(1) Persistence of <i>Borrelia burgdorferi</i> in ligamentous tissue from a patient with chronic Lyme borreliosis. Haupt T; Hahn G; Rittig M; Krause A; Schoerner C; Schonherr U; Kalden JR; Burmester GR. Arthritis Rheum, 36(11):1621-6. 1993.</p>
Liver	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(2) <i>Borrelia burgdorferi</i> in a newborn despite oral penicillin for Lyme borreliosis during pregnancy. Weber K; Bratzke HJ; Neubert U; Wilske B; Duray PH. Pediatric Infectious Disease Journal, 7:286-9. 1988.</p>
Lung	<p><i>Cow model:</i> (1) Arthritis and systemic disease caused by <i>Borrelia burgdorferi</i> infection in a cow. Burgess EC; Gendron-Fitzpatrick A, Wright WO. J Am Vet Med Assoc, 191(11):1468-70. 1987.</p>
Lymph nodes	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p><i>Mouse model:</i> (2) Heritable susceptibility to severe <i>Borrelia burgdorferi</i>-induced arthritis is dominant and is associated with persistence of large numbers of spirochetes in tissues. Yang L; Weis JH; Eichwald E; Kolbert DP; Persing DH; Weis JJ. Infect. Immun., 62(2):492-500. 1994.</p>
Muscle	<p>(1) Detection of <i>Borrelia burgdorferi</i> DNA by gene amplification in the muscle of a patient with fibromyalgia. Frey M; Jaulhac B; Sibilia J; Monteil H; Kuntz JL; Vautravers P. Presse Med, 24(34):1623. 1995.</p>
Nerve	<p><i>Monkey model:</i> (1) Localization of <i>Borrelia burgdorferi</i> in the nervous system and other organs in a nonhuman primate model of Lyme disease. Cadavid D; O'Neill T; Schaefer H; Pachner AR. Laboratory Investigation, 80(7):1043-52. 2000.</p>
Ovary/Testis	<p><i>Monkey model:</i> (1) Localization of <i>Borrelia burgdorferi</i> in the nervous system and other organs in a nonhuman primate model of Lyme disease. Cadavid D; O'Neill T; Schaefer H; Pachner AR. Laboratory Investigation, 80(7):1043-52. 2000.</p>
Plasma	<p>(1) Inflammatory brain changes in Lyme borreliosis. A report on three patients and review of literature. Oksi J; Kalimo H; Marttila RJ; et al. Brain, Dec, 199(Pt 6):2143-54. 1996.</p>

<i>Detection of Borrelia burgdorferi in Host Tissues & Fluids</i>	
Skin	<p>(1) Isolation and characterization of the Lyme disease spirochete from the skin of patients with erythema chronicum migrans. Berger BW; Kaplan MH; Rotherberg IR; Barbour AG. J Am Acad Dermatol, 13:444-449. 1985.</p> <p>(2) The spirochetal etiology of Lyme disease. Steere AC; Grodzicki RL; Kornblatt AN; Craft JE; Barbour AG; Burgdorfer W; Schmid GP; et al. New England Journal of Medicine, 308:733-740. 1983.</p>
Spinal cord	<p><i>Monkey model:</i></p> <p>(1) Localization of Borrelia burgdorferi in the nervous system and other organs in a nonhuman primate model of Lyme disease. Cadavid D; O'Neill T; Schaefer H; Pachner AR. Laboratory Investigation, 80(7):1043-52. 2000.</p>
Spleen	<p>(1) Clinical pathologic correlations of Lyme disease by stage. Duray PH; Steere AC. Annals NY Academy of Sciences, 539:65-79. 1988.</p> <p>(2) Human necrotizing splenitis caused by Borrelia burgdorferi. Rank EL; Dias SM; Hasson J; Duray PH; Johnson RC; Magnarelli LA; Fister RD. Am J Clin Pathol, 91(4):493-8. 1989.</p>
Synovial (joint) fluid	<p>(1) Ultrastructural demonstration of spirochetal antigens in synovial fluid and synovial membrane in chronic Lyme disease: possible factors contributing to persistence of organisms. Nanagara R; Duray PH; Schumacher HR Jr. Human Pathology, 27(10):1025-34. 1996.</p> <p>(2) Borrelia burgdorferi in joint fluid in chronic Lyme arthritis. Snydman DR; Schenkein DP; Berardi VP; Lastavica CC; Pariser KM. Annals of Internal Medicine, 104:798-800. 1986.</p>
Synovial (joint) membrane	<p>(1) Ultrastructural demonstration of spirochetal antigens in synovial fluid and synovial membrane in chronic Lyme disease: possible factors contributing to persistence of organisms. Nanagara R; Duray PH; Schumacher HR Jr. Human Pathology, 27(10):1025-34. 1996.</p> <p>(2) Detection of Borrelia burgdorferi by polymerase chain reaction in synovial membrane, but not in synovial fluid from patients with persisting Lyme arthritis after antibiotic therapy. Priem S; Burmester GR; Kamradt T; Wolbart K; Rittig MG; Krause A. Annals of the Rheumatic Diseases, 57(2):118-21. 1998.</p>
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Uterus	<p><i>Mouse model:</i></p> <p>(1) Heritable susceptibility to severe Borrelia burgdorferi-induced arthritis is dominant and is associated with persistence of large numbers of spirochetes in tissues. Yang L; Weis JH; Eichwald E; Kolbert DP; Persing DH; Weis JJ. Infect. Immun., 62(2):492-500. 1994.</p>