Persistence of Lyme Disease Spirochete *Borrelia burgdorferi*

The following references for persistence of Lyme disease (Lyme borreliosis) are listed alphabetically and chronologically:

1. Aalto A, Sjowall J, Davidsson L, Forsberg P, Smedby O. Brain magnetic resonance imaging does not contribute to the diagnosis of chronic neuroborreliosis. Acta Radiol 2007; 48: 755-762. [white matter hyperintensities or basal ganglia lesions].
septic Lyme arthritis of the knee for seven years, despite multiple antibiotic trials and synovectomies. Bb documented in synovium and synovial fluid.]


21. Bayer ME, Zhang L, Bayer MH. *Borrelia burgdorferi* DNA in the urine of treated patients with chronic Lyme disease symptoms. A PCR study of 97 cases. Infection 1996; 24: 347-353. [97 patients who had been treated with antibiotics for extended periods of time and had symptoms of chronic Lyme were PCR-positive.]


32. Brorson O and Brorson S-H. Transformation of cystic forms of *Borrelia burgdorferi* to normal mobile spirochetes. Infection. 1997; 25: 240-246. [change in physical characteristics; change of spirochetes to other pleomorphic forms, i.e., cell wall deficient forms, namely cysts.]

33. Brorson O and Brorson S. *In vitro* conversion of *Borrelia burgdorferi* to cystic forms in spinal fluid, and transformation to mobile spirochetes by incubation in BSK-H medium. Infection. 1998; 26: 144-150. [change in physical characteristics; change of spirochetes to other pleomorphic forms, i.e., cell wall deficient forms, namely cysts.]


54. Chmielewski T, Tylewska-Wierzhanowska S. Inhibition of fibroblast apoptosis by Borrelia afzelii, Coxiella burnetii and Bartonella henselae. Poll Microbiol 2011; 60(3); 269-272.
57. Cleveland CP, Dennler PS, Duray PH. Recurrence of Lyme disease presenting as a chest wall mass: Borrelia burgdorferi was present despite five months of IV ceftriaxone 2 g, and three months of oral cefixime 400 mg BID. The presence of Borrelia burgdorferi confirmed by biopsy and culture. Poster presentation at V Lyme Disease Foundation International Scientific Conference. Stamford, CT, April 10-11, 1992.


126. James FM, JB Engiles, and J Beech. Meningitis, cranial neuritis, and radiculoneuritis associated with *Borrelia burgdorferi* infection in a horse. J Am Vet Med Assoc 2010; 237: 1180-1185. ([Horse was seropositive for Bb, and PCR assay of CSF for *B. burgdorferi* DNA was positive; horse was treated with doxycycline, responded well, then relapsed, treated with oxytetracycline and later died; diagnosis consistent with neuroborreliosis.]


test with Bb antigens were strongly positive; a year later, paired serum and CSF samples were strongly positive.]
156. Livengood JA and Gilmore RD, Jr. Invasion of human neuronal and glial cells by an infectious strain of Borrelia burgdorferi. Microbes and Infection. 2006; 8: 2832-2840. [intracellular sanctuaries of Bb]


188. Mattman LH. Cell wall deficient forms: stealth pathogens. 2nd edition. CRC Press, Inc., Boca Raton, FL. 1993. [change in physical characteristics; change of spirochetes to other pleomorphic forms, i.e., cell wall deficient forms, namely cysts.]


200. Miklossy, J. 2011. Alzheimer’s disease – a neurospirochetosis. Analysis of the evidence following Koch’s and Hill’s criteria. 2011; 8: 90 (http://www.jneuroinflammation.com/content/8/1/90) [91% of the brains of Alzheimer’s patients sampled were positive for spirochetes; 25% of Alzheimer’s patients analyzed had B. burgdorferi spirochetes in their brains. Persistence occurs when spirochetes change physical characteristics by converting to dormant cysts.]


220. Oksi J, Marjamäki M, Nikoskelainen J, and Viljanen MK. Borrelia burgdorferi detected by culture and PCR in clinical relapse of disseminated Lyme borreliosis. Ann Med 1999; 31(3): 225-232. [40% (13/32) patients had clinical relapses that were PCR or culture-confirmed.]


262. Preac Mursic V, Marget W, Busch U, Rigler DP, Hagl S. Kill kinetics of *Borrelia burgdorferi* and bacterial findings in relation to the treatment of Lyme borreliosis. Infection 1996; 24(1): 9-16. [Bb was isolated by culture in five patients, four of whom had previously tested antibody-negative.]

243. Priem S, Burmester GR, Kamradt T, Wollbart K, Rittig MG, et al. (1998) 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. Ann Rheum Dis 57(2): 118-121. doi: 10.1136/ard.57.2.118 [After antibiotic treatment, synovial membrane still demonstrates spirochetes.][Although PCR was negative in synovial fluid and urine, PCR confirmed Bb in synovial membrane of four previously treated patients with Lyme arthritis; intracellular sanctuaries of Bb]


260. Schmitz JL, Schell RF, Lovrich SD, Callister SM and Coe JE; Characterization of the protective antibody response to *Borrelia burgdorferi* in experimentally infected white-footed mice (*Peromyscus leucopus*). J Clin Microbiol 26: 893-895. [white-footed mice]


276. Straubinger RK, Straubinger AF, Jacobson RH, Chang Y, Summers BA, Erb HN, and Appel MJG. Two lessons from the canine model of Lyme disease: migration of *Borrelia burgdorferi* in tissues and persistence after antibiotic treatment. J Spir Tick-Borne Dis 1997; 4: 24-31. [In dogs: 30-day treatment diminished but failed to eliminate persistent infection in dogs. Antibody titers fell, but after antibiotic treatment was discontinued antibody levels began to rise again, presumably in response to proliferation of the surviving pool of spirochetes.]


278. Straubinger RK. PCR-based quantification of *Borrelia burgdorferi* organisms in canine tissues over a 500-day postinfection period. J Clin Microbiol 2000; 38: 2191-2199. [All 8 infected dogs previously treated with 30-day antibiotics were PCR positive from tissue samples after necrosis; 25 tissue samples per dog were used. Interestingly, the number of *B. burgdorferi* organisms detected in skin biopsy samples was inversely to the antibody levels measured by enzyme-linked immunosorbent assay.]


Compiled by: John D. Scott, Research Division, Lyme Ontario
August 2014