

J Clin Invest. 1986 October; 78(4): 934-939.
doi: 10.1172/JCI112683.

PMCID: PMC423723

[Copyright notice](#)

Antigens of *Borrelia burgdorferi* recognized during Lyme disease. Appearance of a new immunoglobulin M response and expansion of the immunoglobulin G response late in the illness.

J E Craft, D K Fischer, G T Shimamoto, and A C Steere

This article has been [cited by](#) other articles in PMC.

Abstract

Using immunoblots, we identified proteins of *Borrelia burgdorferi* bound by IgM and IgG antibodies during Lyme disease. In 12 patients with early disease alone, both the IgM and IgG responses were restricted primarily to a 41-kD antigen. This limited response disappeared within several months. In contrast, among six patients with prolonged illness, the IgM response to the 41-kD protein sometimes persisted for months to years, and late in the illness during arthritis, a new IgM response sometimes developed to a 34-kD component of the organism. The IgG response in these patients appeared in a characteristic sequential pattern over months to years to as many as 11 spirochetal antigens. The appearance of a new IgM response and the expansion of the IgG response late in the illness, and the lack of such responses in patients with early disease alone, suggest that *B. burgdorferi* remains alive throughout the illness.

Full text

Full text is available as a scanned copy of the original print version. Get a printable copy (PDF file) of the [complete article](#) (1.6M), or click on a page image below to browse page by page. Links to PubMed are also available for [Selected References](#).

Formats: Summary | [Page Browse](#) | [PDF \(1.6M\)](#)

PubMed articles by these authors

- ▶ Craft, J.
- ▶ Fischer, D.
- ▶ Shimamoto, G.
- ▶ Steere, A.

PubMed related articles

- ▶ Early and late antibody responses to full-length and truncated constructs of outer surface protein A of Br [Infect Immun. 1995]
 - ▶ Establishment of enzyme-linked immunosorbent assay using purified recombinant 83-kilodalton antigen [J Clin Microbiol. 1995]
 - ▶ Humoral immune response to outer surface protein C of *Borrelia burgdorferi* in Lyme disease: role [Infect Immun. 1994]
 - ▶ **Review** Diagnosis of lyme borreliosis in europe. [Vector Borne Zoonotic Dis. 2003]
 - ▶ **Review** The pathogenesis of Lyme disease. [Rheum Dis Clin North Am. 1989]
- » See reviews... | » See all...

Recent Activity

[Turn Off](#) [Clear](#)

- The T-cell proliferative assay in the diagnosis of Lyme disease.
- [1883122\[uid\]](#) (1) PubMed
- Antigens of *Borrelia burgdorferi* recognized during Lyme disease. Appearance of a new immun...

Links

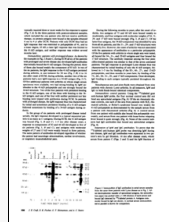
- ▶ PubMed
- ▶ Substance
- ▶ Taxonomy
- ▶ Taxonomy Tree



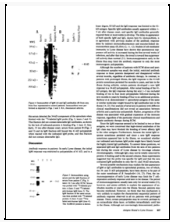
934



935



936



937



938



939

Images in this article

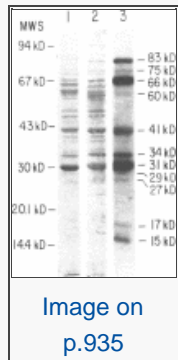


Image on p.935

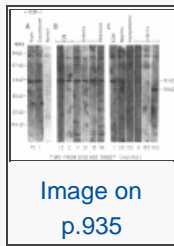


Image on p.935

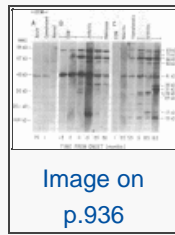


Image on p.936

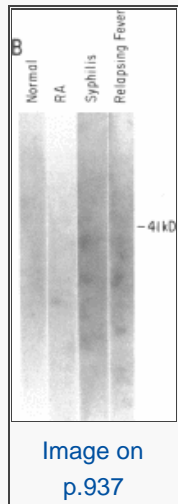


Image on p.937

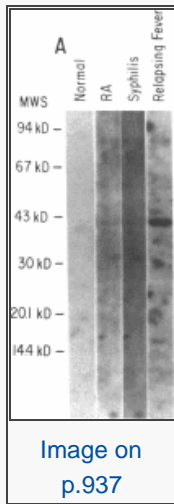


Image on p.937

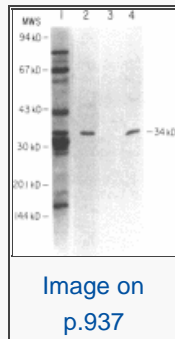


Image on p.937

Click on the image to see a larger version.

Selected References

These references are in PubMed. This may not be the complete list of references from this article.

- Burgdorfer W, Barbour AG, Hayes SF, Benach JL, Grunwaldt E, Davis JP. Lyme disease—a tick-borne spirochetosis? *Science*. 1982 Jun 18;216(4552):1317–1319. [[PubMed](#)]
- Steere AC, Grodzicki RL, Kornblatt AN, Craft JE, Barbour AG, Burgdorfer W, Schmid GP, Johnson E, Malawista SE. The spirochetal etiology of Lyme disease. *N Engl J Med*. 1983 Mar 31;308(13):733–740. [[PubMed](#)]
- Benach JL, Bosler EM, Hanrahan JP, Coleman JL, Habicht GS, Bast TF, Cameron DJ, Ziegler

JL, Barbour AG, Burgdorfer W, Edelman R, Kaslow RA. Spirochetes isolated from the blood of two patients with Lyme disease. *N Engl J Med*. 1983 Mar 31;308(13):740–742. [[PubMed](#)]

- Steere AC, Malawista SE, Hardin JA, Ruddy S, Askenase W, Andiman WA. Erythema chronicum migrans and Lyme arthritis. The enlarging clinical spectrum. *Ann Intern Med*. 1977 Jun;86(6):685–698. [[PubMed](#)]
- Steere AC, Bartenhagen NH, Craft JE, Hutchinson GJ, Newman JH, Rahn DW, Sigal LH, Spieler PN, Stenn KS, Malawista SE. The early clinical manifestations of Lyme disease. *Ann Intern Med*. 1983 Jul;99(1):76–82. [[PubMed](#)]
- Steere AC, Batsford WP, Weinberg M, Alexander J, Berger HJ, Wolfson S, Malawista SE. Lyme carditis: cardiac abnormalities of Lyme disease. *Ann Intern Med*. 1980 Jul;93(1):8–16. [[PubMed](#)]
- Reik L, Steere AC, Bartenhagen NH, Shope RE, Malawista SE. Neurologic abnormalities of Lyme disease. *Medicine (Baltimore)*. 1979 Jul;58(4):281–294. [[PubMed](#)]
- Pachner AR, Steere AC. The triad of neurologic manifestations of Lyme disease: meningitis, cranial neuritis, and radiculoneuritis. *Neurology*. 1985 Jan;35(1):47–53. [[PubMed](#)]
- Steere AC, Gibofsky A, Patarroyo ME, Winchester RJ, Hardin JA, Malawista SE. Chronic Lyme arthritis. Clinical and immunogenetic differentiation from rheumatoid arthritis. *Ann Intern Med*. 1979 Jun;90(6):896–901. [[PubMed](#)]
- Steere AC, Brinckerhoff CE, Miller DJ, Drinker H, Harris ED, Jr, Malawista SE. Elevated levels of collagenase and prostaglandin E2 from synovium associated with erosion of cartilage and bone in a patient with chronic Lyme arthritis. *Arthritis Rheum*. 1980 May;23(5):591–599. [[PubMed](#)]
- Craft JE, Grodzicki RL, Steere AC. Antibody response in Lyme disease: evaluation of diagnostic tests. *J Infect Dis*. 1984 May;149(5):789–795. [[PubMed](#)]
- Shrestha M, Grodzicki RL, Steere AC. Diagnosing early Lyme disease. *Am J Med*. 1985 Feb;78(2):235–240. [[PubMed](#)]
- Steere AC, Hardin JA, Ruddy S, Mummaw JG, Malawista SE. Lyme arthritis: correlation of serum and cryoglobulin IgM with activity, and serum IgG with remission. *Arthritis Rheum*. 1979 May;22(5):471–483. [[PubMed](#)]
- Barbour AG, Burgdorfer W, Grunwaldt E, Steere AC. Antibodies of patients with Lyme disease to components of the *Ixodes dammini* spirochete. *J Clin Invest*. 1983 Aug;72(2):504–515. [[PMC free article](#)] [[PubMed](#)]
- Barbour AG, Burgdorfer W, Grunwaldt E, Steere AC. Antibodies of patients with Lyme disease to components of the *Ixodes dammini* spirochete. *J Clin Invest*. 1983 Aug;72(2):504–515. [[PMC free article](#)] [[PubMed](#)]
- Barbour AG. Isolation and cultivation of Lyme disease spirochetes. *Yale J Biol Med*. 1984 Jul–Aug;57(4):521–525. [[PMC free article](#)] [[PubMed](#)]
- Barbour AG. Isolation and cultivation of Lyme disease spirochetes. *Yale J Biol Med*. 1984 Jul–Aug;57(4):521–525. [[PMC free article](#)] [[PubMed](#)]
- Barbour AG, Tessier SL, Todd WJ. Lyme disease spirochetes and ixodid tick spirochetes share a common surface antigenic determinant defined by a monoclonal antibody. *Infect Immun*. 1983 Aug;41(2):795–804. [[PMC free article](#)] [[PubMed](#)]
- Barbour AG, Tessier SL, Todd WJ. Lyme disease spirochetes and ixodid tick spirochetes share a common surface antigenic determinant defined by a monoclonal antibody. *Infect Immun*. 1983 Aug;41(2):795–804. [[PMC free article](#)] [[PubMed](#)]
- Bradford MM. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal Biochem*. 1976 May 7;72:248–254. [[PubMed](#)]
- Laemmli UK. Cleavage of structural proteins during the assembly of the head of bacteriophage T4. *Nature*. 1970 Aug 15;227(5259):680–685. [[PubMed](#)]

- Towbin H, Staehelin T, Gordon J. Electrophoretic transfer of proteins from polyacrylamide gels to nitrocellulose sheets: procedure and some applications. *Proc Natl Acad Sci U S A*. 1979 Sep;76(9):4350–4354. [[PMC free article](#)] [[PubMed](#)]
- Towbin H, Staehelin T, Gordon J. Electrophoretic transfer of proteins from polyacrylamide gels to nitrocellulose sheets: procedure and some applications. *Proc Natl Acad Sci U S A*. 1979 Sep;76(9):4350–4354. [[PMC free article](#)] [[PubMed](#)]
- Phillips DR, Morrison M. Exposed protein on the intact human erythrocyte. *Biochemistry*. 1971 May 11;10(10):1766–1771. [[PubMed](#)]
- Moffat CM, Sigal LH, Steere AC, Freeman DH, Dwyer JM. Cellular immune findings in Lyme disease. Correlation with serum IgM and disease activity. *Am J Med*. 1984 Oct;77(4):625–632. [[PubMed](#)]
- Barbour AG. Immunochemical analysis of Lyme disease spirochetes. *Yale J Biol Med*. 1984 Jul–Aug;57(4):581–586. [[PMC free article](#)] [[PubMed](#)]
- Barbour AG. Immunochemical analysis of Lyme disease spirochetes. *Yale J Biol Med*. 1984 Jul–Aug;57(4):581–586. [[PMC free article](#)] [[PubMed](#)]
- Barbour AG, Tessier SL, Hayes SF. Variation in a major surface protein of Lyme disease spirochetes. *Infect Immun*. 1984 Jul;45(1):94–100. [[PMC free article](#)] [[PubMed](#)]
- Barbour AG, Tessier SL, Hayes SF. Variation in a major surface protein of Lyme disease spirochetes. *Infect Immun*. 1984 Jul;45(1):94–100. [[PMC free article](#)] [[PubMed](#)]
- Coffey EM, Eveland WC. Experimental relapsing fever initiated by *Borrelia hermsii*. II. Sequential appearance of major serotypes in the rat. *J Infect Dis*. 1967 Feb;117(1):29–34. [[PubMed](#)]
- Stoenner HG, Dodd T, Larsen C. Antigenic variation of *Borrelia hermsii*. *J Exp Med*. 1982 Nov 1;156(5):1297–1311. [[PMC free article](#)] [[PubMed](#)]
- Antigenic variation of *Borrelia hermsii*. *J Exp Med*. 1982 Nov 1;156(5):1297–1311. [[PMC free article](#)] [[PubMed](#)]
- Steere AC, Malawista SE, Bartenhagen NH, Spieler PN, Newman JH, Rahn DW, Hutchinson GJ, Green J, Snyderman DR, Taylor E. The clinical spectrum and treatment of Lyme disease. *Yale J Biol Med*. 1984 Jul–Aug;57(4):453–464. [[PMC free article](#)] [[PubMed](#)]
- Steere AC, Malawista SE, Bartenhagen NH, Spieler PN, Newman JH, Rahn DW, Hutchinson GJ, Green J, Snyderman DR, Taylor E. The clinical spectrum and treatment of Lyme disease. *Yale J Biol Med*. 1984 Jul–Aug;57(4):453–461. [[PMC free article](#)] [[PubMed](#)]
- Hardin JA, Steere AC, Malawista SE. Immune complexes and the evolution of Lyme arthritis. Dissemination and localization of abnormal C1q binding activity. *N Engl J Med*. 1979 Dec 20;301(25):1358–1363. [[PubMed](#)]
- Musher DM, Schell RF, Jones RH, Jones AM. Lymphocyte transformation in syphilis: an in vitro correlate of immune suppression in vivo? *Infect Immun*. 1975 Jun;11(6):1261–1264. [[PMC free article](#)] [[PubMed](#)]
- Musher Daniel M, Schell Ronald F, Jones Ronald H, Jones Alice M. Lymphocyte Transformation in Syphilis: an In Vitro Correlate of Immune Suppression In Vivo? *Infect Immun*. 1975 Jun;11(6):1261–1264. [[PMC free article](#)] [[PubMed](#)]
- Pavia Charles S, Folds James D, Baseman Joel B. Cell-mediated immunity during syphilis. A review. *Br J Vener Dis*. 1978 Jun;54(3):144–150. [[PMC free article](#)] [[PubMed](#)]
- Pavis CS, Folds JD, Baseman JB. Cell-mediated immunity during syphilis. *Br J Vener Dis*. 1978 Jun;54(3):144–150. [[PMC free article](#)] [[PubMed](#)]
- Hanff PA, Fehniger TE, Miller JN, Lovett MA. Humoral immune response in human syphilis to polypeptides of *Treponema pallidum*. *J Immunol*. 1982 Sep;129(3):1287–1291. [[PubMed](#)]
- Moskophidis M, Müller F. Molecular analysis of immunoglobulins M and G immune response to protein antigens of *Treponema pallidum* in human syphilis. *Infect Immun*. 1984 Jan;43(1):127–132. [[PMC free article](#)] [[PubMed](#)]

- Moskophidis M, Müller F. Molecular analysis of immunoglobulins M and G immune response to protein antigens of *Treponema pallidum* in human syphilis. *Infect Immun*. 1984 Jan;43(1):127–132. [[PMC free article](#)] [[PubMed](#)]
- O'Neill P, Nicol CS. IgM class antitreponemal antibody in treated and untreated syphilis. *Br J Vener Dis*. 1972 Dec;48(6):460–463. [[PMC free article](#)] [[PubMed](#)]
- O'Neill P, Nicol CS. IgM class antitreponemal antibody in treated and untreated syphilis. *Br J Vener Dis*. 1972 Dec;48(6):460–463. [[PMC free article](#)] [[PubMed](#)]
- Wilkinson AE, Rodin P. IgM-FTA test in syphilis in adults. Its relation to clinical findings. *Br J Vener Dis*. 1976 Aug;52(4):219–223. [[PMC free article](#)] [[PubMed](#)]
- Wilkinson AE, Rodin P. IgM-FTA test in syphilis in adults. Its relation to clinical findings. *Br J Vener Dis*. 1976 Aug;52(4):219–223. [[PMC free article](#)] [[PubMed](#)]
- Hoffman SL, Piessens WF, Ratiwayanto S, Hussein PR, Kurniawan L, Piessens PW, Campbell JR, Marwoto HA. Reduction of suppressor T lymphocytes in the tropical splenomegaly syndrome. *N Engl J Med*. 1984 Feb 9;310(6):337–341. [[PubMed](#)]
- Pedersen NS, Petersen CS, Vejtorp M, Axelsen NH. Serodiagnosis of syphilis by an enzyme-linked immunosorbent assay for IgG antibodies against the Reiter treponeme flagellum. *Scand J Immunol*. 1982 Apr;15(4):341–348. [[PubMed](#)]
- Pedersen NS, Petersen CS, Axelsen NH. Enzyme-linked immunosorbent assay for detection of immunoglobulin M antibody against the Reiter treponeme flagellum in syphilis. *J Clin Microbiol*. 1982 Oct;16(4):608–614. [[PMC free article](#)] [[PubMed](#)]
- Pedersen NS, Petersen CS, Axelsen NH. Enzyme-linked immunosorbent assay for detection of immunoglobulin M antibody against the Reiter treponeme flagellum in syphilis. *J Clin Microbiol*. 1982 Oct;16(4):608–614. [[PMC free article](#)] [[PubMed](#)]
- Johnston YE, Duray PH, Steere AC, Kashgarian M, Buza J, Malawista SE, Askenase PW. Lyme arthritis. Spirochetes found in synovial microangiopathic lesions. *Am J Pathol*. 1985 Jan;118(1):26–34. [[PMC free article](#)] [[PubMed](#)]
- Johnston YE, Duray PH, Steere AC, Kashgarian M, Buza J, Malawista SE, Askenase PW. Lyme arthritis. Spirochetes found in synovial microangiopathic lesions. *Am J Pathol*. 1985 Jan;118(1):26–34. [[PMC free article](#)] [[PubMed](#)]
- Steere AC, Green J, Schoen RT, Taylor E, Hutchinson GJ, Rahn DW, Malawista SE. Successful parenteral penicillin therapy of established Lyme arthritis. *N Engl J Med*. 1985 Apr 4;312(14):869–874. [[PubMed](#)]

Articles from *The Journal of Clinical Investigation* are provided here courtesy of American Society for Clinical Investigation



You are here: [NCBI](#) > [Literature](#) > PubMed Central

[Write to the Help Desk](#)

GETTING STARTED

- [NCBI Help Manual](#)
- [NCBI Handbook](#)
- [Training & Tutorials](#)

RESOURCES

- [Literature](#)
- [DNA & RNA](#)
- [Proteins](#)
- [Sequence Analysis](#)
- [Genes & Expression](#)
- [Genomes & Maps](#)
- [Domains & Structures](#)
- [Genetics & Medicine](#)
- [Taxonomy](#)
- [Data & Software](#)
- [Training & Tutorials](#)
- [Homology](#)
- [Small Molecules](#)
- [Variation](#)

POPULAR

- [PubMed](#)
- [PubMed Central](#)
- [Bookshelf](#)
- [BLAST](#)
- [Gene](#)
- [Nucleotide](#)
- [Protein](#)
- [GEO](#)
- [Conserved Domains](#)
- [Structure](#)
- [PubChem](#)

FEATURED

- [GenBank](#)
- [Reference Sequences](#)
- [Map Viewer](#)
- [Genome Projects](#)
- [Human Genome](#)
- [Mouse Genome](#)
- [Influenza Virus](#)
- [Primer-BLAST](#)
- [Sequence Read Archive](#)

NCBI INFORMATION

- [About NCBI](#)
- [Research at NCBI](#)
- [NCBI Newsletter](#)
- [NCBI FTP Site](#)

