

Pediatric Acute-Onset Neuropsychiatric Syndrome: Microbes and Mental Health

1. Swedo SE, Leonard HL, Kiessling LS. Speculations on antineuronal antibody-mediated neuropsychiatric disorders of childhood. *Pediatrics*. 1994;93 (2): 323–6.
2. Swedo SE, Leonard HL, Garvey M, Mittleman B, Allen AJ, Perlmutter S, Lougee L, Dow S, Zamkoff J, Dubbert BK. Pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections: clinical description of the first 50 cases. *Am J Psych*. 1998;155:264–271.
3. Murphy ML, Pichichero ME. Prospective Identification and Treatment of Children With Pediatric Autoimmune Neuropsychiatric Disorder Associated With Group A Streptococcal Infection (PANDAS). *Arch Pediatr Adolesc Med*. 2002;156(4):356–361.
4. Quinn, A., Kosanke, S., Fischetti, V.A., Factor, S.M. & Cunningham, M.W. Induction of autoimmune valvular heart disease by recombinant streptococcal M protein. *Infect. Immun*. 2001;69:4072–4078.
5. Cusick MF, Libbey JE, Fujinami RS. Molecular mimicry as a mechanism of autoimmune disease. *Clin Rev Allergy Immunol*. 2012;42(1):102–111.
6. Cunningham MW, Cox CJ. Autoimmunity against dopamine receptors in neuropsychiatric and movement disorders: a review of Sydenham chorea and beyond. *Acta Physiol (Oxf)*. 2016;216(1):90–100. doi:10.1111/apha.12614
7. Cox C. J., Sharma M., Leckman J. F., Zuccolo J., Zuccolo A., Kovoov A., et al. Brain human monoclonal autoantibody from Sydenham chorea targets dopaminergic neurons in transgenic mice and signals dopamine D2 receptor: Implications in human disease. *J Immunol*. 2013;191(11):5524–5541
8. Brimberg L., Benhar I., Mascaro-Blanco A., Alvarez K., Lotan D., Winter C., et al. Behavioral, pharmacological, and immunological abnormalities after streptococcal exposure: a novel rat model of Sydenham chorea and related neuropsychiatric disorders. *Neuropsychopharmacology*. 2012;37(9):2076–2087.
9. Kirvan C. A., Swedo S. E., Heuser J. S., Cunningham M. W. Mimicry and autoantibody-mediated neuronal cell signaling in Sydenham chorea. *Nat Med*. 2003;9(7):914–920.
10. Kirvan C. A., Swedo S. E., Snider L. A., Cunningham M. W. Antibody-mediated neuronal cell signaling in behavior and movement disorders. *J Neuroimmunol*. 2006a;179(1-2):173–179.

11. Kirvan CA, Cox CJ, Swedo SE, Cunningham MW. *J Immunol*. Tubulin is a neuronal target of autoantibodies in Sydenham's chorea. 2007;178(11):7412-742.
12. Kirvan C. A., Swedo S. E., Heuser J. S., Cunningham M. W. Mimicry and autoantibody-mediated neuronal cell signaling in Sydenham chorea. *Nature Medicine*. 2003;9(7):914–920.
13. Robison AJ. Emerging role of CaMKII in neuropsychiatric disease. *Trends Neurosci*. 2014 Nov;37(11):653-62.
14. Chang K, Frankovich J, Cooperstock M, Cunningham MW, Latimer ME, Murphy TK, Pasternack M, Thienemann M, Williams K, Walter J, Swedo SE, and from the PANS collaborative consortium. Clinical Evaluation of Youth with Pediatric Acute-Onset Neuropsychiatric Syndrome (PANS): Recommendations from the 2013 PANS Consensus Conference. *J Child Adolesc Psychopharmacol*. 2015;25(1):3–13.
15. Frankovich J, Thienemann M, Rana S, Chang K. Five youth with pediatric acute-onset neuropsychiatric syndrome of differing etiologies. *J Child Adolesc Psychopharmacol*. 2015;25(1):31-7.
16. Tisi M et al. Pediatric acute onset neuropsychiatric syndrome associated with Epstein–Barr infection in child with Noonan syndrome. *Europ Psychiatry*. 2017;419(supp):S456.
17. Breitschwerdt EB, Greenberg R, Maggi RG, Mozayeni BR, Lewis A, Bradley JM. *Bartonella henselae* Bloodstream Infection in a Boy With Pediatric Acute-Onset Neuropsychiatric Syndrome. *J Cent Nerv Syst Dis*. 2019;11:1179573519832014.
18. <https://www.thelancet.com/action/showPdf?pii=S2352-4642%2821%2900135-8> (Accessed June 14, 2021)
19. Shimanski C et al. Evaluation of the Cunningham Panel in PANDASS and PANS: changes in antineuronal antibody titers parallel changes in patient symptoms. *J Neuroimmunol*. In Press-15 February 2020. Online ahead of print. [https://www.jni-journal.com/article/S0165-5728\(19\)30352-2/fulltext#secst0005](https://www.jni-journal.com/article/S0165-5728(19)30352-2/fulltext#secst0005)
20. Bransfield RC. Neuropsychiatric Lyme Borreliosis: An Overview with a Focus on a Specialty Psychiatrist's Clinical Practice. *Healthcare (Basel)*. 2018;6(3):104. Published 2018 Aug 25. doi:10.3390/healthcare6030104
21. Greenberg R. Aggressiveness, violence, homicidality, homicide, and Lyme disease. *Neuropsychiatr Dis Treat*. 2018;14:1253-1254. Published 2018 May 14. doi:10.2147/NDT.S168751
22. Bransfield, RC. Neuropsychiatric Lyme Borreliosis: An Overview with a Focus on a Specialty Psychiatrist's Clinical Practice. *Healthcare (Basel)*. 2018 Aug 25;6(3).

23. Fallon BA et al. Inflammation and central nervous system Lyme. *Neurobiol Dis.* 2010 Mar;37(3):534-41.
-
24. Singh SK, Girschick HJ. Lyme borreliosis: from infection to autoimmunity. *Clin Microbiol Infect.* 2004 Jul;10(7):598-614. doi: 10.1111/j.1469-0691.2004.00895.x. PMID: 15214872.
25. Bransfield RC. Lyme Disease, comorbid tick-borne diseases, and neuropsychiatric disorders. *Psychiatr Times.* 2007Dec1;24(14):59–61.
26. Fallon BA, Niels JA, Burrascano JJ, Liegner K, Delbene D, Liebowitz MR. The neuropsychiatric manifestations of Lyme borreliosis. *Psychiatr Q.* 1992;63(1):95–117. DOI: 10.1007/bf01064684.
27. Fallon BA, Niels JA. Lyme disease: a neuropsychiatric illness. *Am J Psychiatry.* 1994;151(11):1571–83. DOI: 10.1176/ajp.151.11.1571.
28. Fallon BA, Kochevar JM, Gaito A, Niels JA. The Underdiagnosis Of Neuropsychiatric Lyme Disease in Children And Adults. *Psychiatr Clin N Am.* 1998;21(3):693–703. DOI: 10.1016/s0193-953x(05)70032-0.
29. Bransfield RC. Aggressiveness, violence, homicidality, homicide, and Lyme disease. *Neuropsychiatric Dis Treat.* 2018;14:693–713. DOI: 10.2147/ndt.s155143.
30. Mattingley D, Koola M. Association of Lyme Disease and Schizoaffective Disorder, Bipolar Type: Is it Inflammation Mediated? *Indian J Psychol Med.* 2015;37(2):243–6. DOI: 10.4103/0253-7176.155660.
31. Rhee H, Cameron DJ. Lyme disease and pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections (PANDAS): an overview. *Int J Gen Med.* 2012;5:163-74.
32. Chandra A et al. Anti-neural antibody reactivity in patients with a history of Lyme borreliosis and persistent symptoms. *Brain Behav Imm.* 2010; 24:1018-1024.
33. Steere AC, Drouin EE, Glickstein LJ. Relationship between immunity to *Borrelia burgdorferi* outer-surface protein A (OspA) and Lyme arthritis. *Clin Infect Dis.* 2011;52 Suppl 3(Suppl 3):s259–s265.
34. Raveche ES et al. Evidence of *Borrelia* autoimmunity-induced component of Lyme carditis and arthritis. *J Clin Microb.* 2005;43:850-856.
35. Fallon BA et al. Anti-lysoganglioside and other anti-neuronal autoantibodies in post-treatment Lyme Disease and Erythema Migrans after repeat infection. *Brain Behav Immun.* 2020;2:100015.
36. Kinderlehrer DA. Does Lyme Disease Cause PANS? *J Biomed Res Environ Sci.* 2021;2(3):126-131.

37. Greenberg R. Infections and Childhood Psychiatric Disorders: Tick-Borne Illness and Bipolar Disease in Youth. *Bipolar Disord.* 2017;3(1):1-4.
38. Breitschwerdt EB, Sontakke S, Hopkins S. Neurological Manifestations of Bartonellosis in Immunocompetent Patients: A Composite of Reports from 2005-2012. *J. Neuroparasitol.* 2012;3:1-15.
39. Flegr J, Preiss M, Balátová P. Depressiveness and Neuroticism in Bartonella Seropositive and Seronegative Subjects—Preregistered Case-Controls Study. *Front. Psychiatry.* 2018;9:314.
40. Breitschwerdt EB, Greenberg R, Maggi RG, Mozayeni BR, Lewis A, Bradley JM. Bartonella henselae Bloodstream Infection in a Boy with Pediatric Acute-Onset Neuropsychiatric Syndrome. *J. Cent, Nerv. Syst. Dis.* 2019;11:1179573519832014.
41. Breitschwerdt, E.B.; Bradley, J.M.; Maggi, R.G.; Lashnits, E.; Reicherter, P. Bartonella Associated Cutaneous Lesions (BACL) in People with Neuropsychiatric Symptoms. *Pathogens.* 2020;9:1023.
42. Maluki A, Breitschwerdt E, Bemis L, Greenberg R, Mozayeni BR, Dencklau J, Ericson M. Imaging analysis of Bartonella species in the skin using single-photon and multi-photon (second harmonic generation) laser scanning microscopy. *Clin. Case Rep.* 2020;8(8):1654-1570.
43. Bannerjee B, Peterson K. Psychosis Following Mycoplasma Pneumonia. *Mil. Med.* 2009;174(9):1001-1004.
44. Moor S, Skrine H. Psychosis in mycoplasma infection. *Postgrad Med J.* 1989;65(760):96-97.
45. Ercan TE, Ercan G, Sevrge B, Arpaozu M, Karasu G. Mycoplasma pneumoniae infection and obsessive-compulsive disease: a case report. *J Child Neurol.* 2008;23(3):338-40.
46. Becker MA, Cannon J, Certa K. A Case of Mycoplasma Pneumoniae Encephalopathy Presenting as Mania. *JACLP.* 2021;62(1):150-154.
47. Toufexis MD, Hommer R, Gerardi DM, Grant P, Rothschild L, D'Souza P, Williams K, Leckman J, Swedo SE, Murphy TK. Disordered eating and food restrictions in children with PANDAS/PANS. *J. Child Adolesc. Psychopharmacol.* 2015;25(1):48-56.
48. Piras C, Pintas R, Pruna D, Dessi A, Atzoril L, Fanos V. Pediatric Acute-onset Neuropsychiatric Syndrome and Mycoplasma Pneumoniae Infection: A Case Report Analysis with a Metabolomics Approach. *Curr Pediatr Rev.* 2020;16(3):183-193.
49. Frankovich J, Thienemann M, Rana S, Chang K. Five youth with pediatric acute-onset neuropsychiatric syndrome of differing etiologies. *J. Child Adolesc. Psychopharmacol.* 2015;25(1):31-7.

50. Kinderlehrer DA, Brown N. Microbial Induced Autoimmune Inflammation as a Cause of Mental Illness in Adolescents. *Global J Med Res.* 2021;21(1):1-13.
51. Calaprice D et al. Treatment of Pediatric Acute-Onset Neuropsychiatric Disorder in a Large Survey Population. *J Child Adolesc Psychopharmacol.* 2018;28(2):92-103.
52. Dale RC, Brilot F, Duffy LV, et al. Utility and safety of rituximab in pediatric autoimmune and inflammatory CNS disease. *Neurology.* 2014;83(2):142-150.
53. Katz A. (2018, November). NADAL—Neuropsychiatric Autoimmune Disorder Associated With Lyme Disease –A PANDAS/PANS Equivalent: Diagnosis and Treatment. Presented at the 19th annual conference of The International Lyme and Associated Diseases conference, Chicago, IL.
54. Erol AYG. The Role of Mast Cells and Neuroglia in Neuroinfectious Diseases. *Euro J Neuroinfect Dis.* 2015;6(4):1-5.
55. Walker ME, Hatfield JK, Brown MA. New insights into the role of mast cells in autoimmunity: evidence for a common mechanism of action?. *Biochim Biophys Acta.* 2012;1822(1):57–65.
56. Rosa JS et al. Allergic Diseases and Immune-Mediated Food Disorders in Pediatric Acute-Onset Neuropsychiatric Syndrome. *Pediatr Allergy Immunol Pulmonol.* 2018 Sep 1;31(3):158-165.
57. http://nac.nationalautismassociation.org/wp-content/uploads/2019/05/Ingles_LDI.pdf (Accessed December 3, 2019)
58. Younger J, Parkitny L, McLain D. The use of low-dose naltrexone (LDN) as a novel anti-inflammatory treatment for chronic pain. *Clin Rheumatol.* 2014;33(4):451–459. doi:10.1007/s10067-014-2517-2
59. Song H, Fang F, Tomasson G, et al. Association of Stress-Related Disorders With Subsequent Autoimmune Disease. *JAMA.* 2018;319(23):2388–2400.
60. <http://www.eegspectrum.com/applications/autoimmune-dysfunction/introautoimmune/> (Accessed December 3, 2019)
61. Vieira SM, Pagovich OE, Kriegel MA. Diet, microbiota and autoimmune diseases. *Lupus.* 2014;23(6):518–26.
62. Manzel A, Muller DN, Hafler DA, Erdman SE, Linker RA, Kleinewietfeld M. Role of “Western Diet” in Inflammatory Autoimmune Diseases. *Curr Allergy Asthma Rep.* 2014;14(1):404.
63. Gold LS, Ward MH, Dosemeci M, Roos AJD. Systemic Autoimmune Disease Mortality and Occupational Exposures. *Arthritis Rheum.* 2007;56(10):3189–201.

64. Lundberg I, Alfredsson L, Plato N, Sverdrup B, Klareskog L, Kleinau S. Occupation, Occupational Exposure to Chemicals and Rheumatological Disease: A register based cohort study. *Scand J Rheumatol*. 1994;23(6):305–10.
-
65. Guerriero F, Ricevuti G. Extremely low frequency electromagnetic fields stimulation modulates autoimmunity and immune responses: a possible immuno-modulatory therapeutic effect in neurodegenerative diseases. *Neural Regen Res*. 2016;11(12):1888-1895.
66. Yehuda R, Lehrner A. Intergenerational transmission of trauma effects: putative role of epigenetic mechanisms. *World Psychiatry*. 2018;17(3):243-257.
67. McFarlane AC. The long-term costs of traumatic stress: intertwined physical and psychological consequences. *World Psychiatry*. 2010;9(1):3-10.
68. <https://aeon.co/essays/how-the-sufferings-of-one-generation-are-passed-on-to-the-next> (accessed December 2, 2021)