Infection Associated Neuropsychiatric Conditions: Implications for U.S. Health Policy

An Educational Paper from Center for Lyme Action and the National Alliance for PANS/PANDAS Action





Table of Contents

Executive Summary 3

1. Background 5

2. Problem Overview 7

2.1 IANC Overview 7

2.2 Lyme Disease IANC 9

2.3 Bartonellosis 10

2.4 PANS and PANDAS 12

3. Patient and Clinical Challenges 14

3.1 Access to Care 14

3.2 Diagnosis Delays and Misdiagnosis 16

3.3 Coding Challenges and Disparities 17

3.4 Quality of Life and Caregiver Burden 18

3.5 Stigma 20

4. Epidemiological Evidence 22

4.1 Lyme Disease IANC 22

4.2 Bartonellosis 23

4.3 PANS and PANDAS 23

5. Contributing Factors 25

5.1 Biological Factors and Causation 26

Lyme IANC 26

Bartonellosis 26

PANS and PANDAS 27

Persistent and Latent Infection 28

5.2 Genetic and Immune Factors 28

5.3 Environmental Factors 29

6. Policy Landscape30

6.1 Federal Policy 30

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

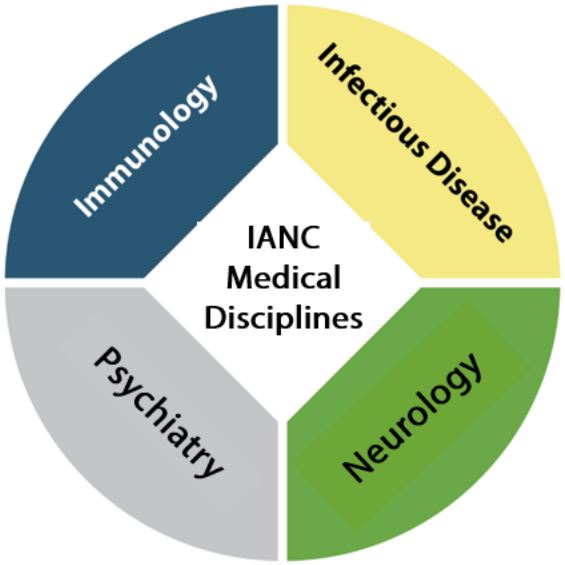
6.2 State Policy 32
7. Health System & Economic Burdens 34
7.1 Alignment with National Health Priorities 35
7.2 CDC: Alignment with the CDC Mental Health Strategy 35
7.3 NIH: Alignment with the NIH Strategic Plan 36
7.4 HHS: Alignment with National Vector-Borne Disease Strategy 37
8. Major Research Gaps 38
All IANC 38
Lyme IANC 38
Bartonellosis and Neurobartonellosis 38
PANS and PANDAS 39
9. Policy Recommendations 40
10. Conclusion & Call to Action 41
About the Author 42
References 43
Appendix A: Glossary 53
Appendix B: Enacted Tickborne Disease-Related State Legislation 56
Appendix C: PANS/PANDAS-Related State Legislation 61

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

Executive Summary

With both a long-documented history and an emerging body of scientific evidence, Infection Associated Neuropsychiatric Conditions (IANC) represent a severe, underrecognized, understudied, and underfunded public health challenge with significant implications for children, adolescents, and adults across the United States. In this paper, IANC is used as an umbrella term rather than a formal diagnostic category, intended to describe conditions in which neuropsychiatric symptoms are triggered and potentially exacerbated by infection-mediated immune activation. IANC include conditions such as Lyme disease, bartonellosis, Pediatric Acute-onset Neuropsychiatric Syndrome (PANS), and Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections (PANDAS). These complex, multisystem conditions sit at the intersection of infectious disease, immunology, neurology, and psychiatry. This publication explores the significant opportunity for federal lawmakers and public health system stakeholders to accelerate research, diagnostics, surveillance, clinical education, and patient outcomes.

Figure 1: IANC and Disciplinary Intersections. IANC patients often seek care across distinct and frequently disconnected medical disciplines, including infectious disease, immunology, psychiatry, and neurology.



While many conditions may meet the criteria for IANC, this paper primarily focuses on Lyme disease, bartonellosis, PANS, and PANDAS. Neuropsychiatric symptoms are often the dominant or most disabling

feature in these conditions and may include anxiety, depression, insomnia, impaired cognition, tics, obsessive-compulsive behaviors, restricted eating, fatigue, academic regression, and, in some cases, aggression, violence, or suicidality. This paper focuses on Lyme disease, bartonellosis, and PANS/PANDAS because their overlapping symptomatology and high likelihood of missed or delayed diagnoses make them ideal targets for developing a strategic, multidisciplinary framework for advancing research and patient care—one that may be extended to other IANC in the future.

These conditions are medically complex and frequently require coordinated evaluation and treatment among multiple disciplines, including infectious disease, neurology, immunology, rheumatology, psychiatry, internal medicine, cardiology, gastroenterology and pediatrics. In practice, they are often treated as purely psychiatric or purely infectious disorders, and the multi-system nature of these illnesses is overlooked. Familiarity with IANC remains limited in U.S. medical training and practice, contributing to diagnostic silos, inadequate care pathways, fragmented research, prolonged delays in diagnosis, and poor outcomes for misdiagnosed or undertreated patients.

Despite the potential role these conditions may play in the growing American mental health crisis, Congress has only approved very limited federal appropriations for IANC-related research. Significant research gaps remain, including estimating population prevalence, improving diagnostic accuracy and biomarker validation, clarifying disease mechanisms, evaluating treatment efficacy, and establishing coordinated surveillance infrastructure. The absence of standardized case definitions and national epidemiological tracking obscures understanding of the true scope, distribution, and economic burden of IANC.

Given sustained bipartisan attention to mental health, there is a timely opportunity to expand congressional and federal agency support for IANC surveillance, research, clinical guidance, education, and workforce training. Scientists and physicians engaged in this field increasingly recognize that infection and immune activation may contribute to mental health outcomes in a subset of patients. In this paper, we recommend targeted federal funding and policy actions to expand IANC research and clinical capacity, improve mental health outcomes, reduce healthcare and societal costs, shorten diagnostic delays, lessen burdens on families and educational systems, and improve quality of life for individuals living with IANC.

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

1. Background

Long before modern antibiotics or neuroscience, clinicians recognized a pattern in which patients appeared to recover from infection, only to later develop cognitive decline, personality changes, and behavioral disturbances. Known at the time as “general paralysis of the insane”—now understood as tertiary neurosyphilis—this condition often emerged decades after the initial infection and led to progressive loss of function. Its prevalence was reflected not only in medical practice but also in late 19th-century literature, including the works of Sir Arthur Conan Doyle (Lanska, 2010).

The story of neurosyphilis was not one of failure to recognize the link between illness and cognitive deterioration—clinicians had already identified the pattern accurately and repeatedly. What they lacked was an understanding of the exact cause and the tools needed to intervene. Only with the introduction of penicillin in the 20th century did physicians have the tools to eradicate new neurosyphilis cases (Lanska, 2010).

The recognition of infection-related neuropsychiatric symptoms precedes modern medicine. One of the earliest examples is chorea, or “dancing mania”, a term used to describe involuntary movements following pediatric streptococcal infection in medieval Europe. This would later be coined Sydenham chorea after the English physician Thomas Sydenham in 1686 (Vale & Cardoso, 2015). The development of an antibody test (antistreptolysin O titer) in the 1930s modernized the understanding of group A streptococcal pharyngitis as the cause of rheumatic fever (Lichty, 1941). While the incidence of Sydenham chorea has declined, a 2016 meta-analysis found the most common neuropsychiatric manifestation of streptococcal infection to be obsessive-compulsive disorder, often accompanied by other new comorbidities, such as attention-deficit-hyperactivity disorder, affective disorders, tic disorders, executive function disturbances, and psychotic features (Cunningham, 2016).

In this paper, Infection Associated Neuropsychiatric Conditions (IANC) is used as an organizing framework for conditions in which neuropsychiatric symptoms are triggered or exacerbated by infection-mediated immune activation. These conditions are often complex, with treatment requiring coordination among medical disciplines that oftentimes treat patients within their silos. For instance, they are often treated as purely psychiatric disorders or infectious disease mechanisms, overlooking their multi-system nature. The concept of IANC is not integrated into the United States medical system, creating diagnostic silos,

inadequate care pathways, fractured research, and poor outcomes for misdiagnosed or mistreated patients. This paper will specifically focus on Lyme disease, bartonellosis, and PANS/PANDAS. Conditions such as PANS and PANDAS are inherently IANC, as by definition, most of these patients experience infection-triggered neuropsychiatric sequelae. In contrast, Lyme disease and bartonellosis may result in IANC in some cases, but not all. Furthermore, the Lyme disease bacteria and Bartonella are potential infectious triggers for both PANS and PANDAS.

What is IANC? IANC, or Infection Associated Neuropsychiatric Conditions, is an umbrella term used in this paper to describe conditions in which neuropsychiatric symptoms are triggered or potentially exacerbated by infection-mediated immune activation. This framework includes infection-associated presentations of Lyme disease, bartonellosis, and PANS, as well as Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections (PANDAS).

Throughout history, infections that were initially considered to be unrelated to brain function have later been shown to cause profound neurologic and psychiatric effects. There are repeated examples in which symptoms were treated in isolation while the underlying cause remained unrecognized for years. Yet despite this knowledge, early detection, coordinated care, and timely treatment have progressed slowly and remain scarce. This white paper draws on those lessons to examine IANC today, and underscores how early detection and treatment, coordinated care across disciplines, and public policies that reflect the full complexity of these illnesses can address the substantial societal burdens associated with IANC.

2. Problem Overview

2.1 IANC Overview

IANC is often misunderstood by healthcare providers and the broader public because the neuropsychiatric sequelae of many associated infectious diseases are not widely recognized. IANC affect both adults and children and often have a sawtooth trajectory of symptom expression, remission, and relapse (Fallon et al., 1998; Swedo et al., 2017; Breitschwerdt et al., 2010). The neuropsychiatric presentations in Lyme, bartonellosis, PANS, and PANDAS are heterogeneous and may appear immediately or significantly after an active infection (Cooperstock et al, 2017).

> *"The microbial impact upon human mental functioning is more extensive than generally appreciated."*
>
> - Bransfield et al., 2023

Many scientists and clinicians who work closely at the intersection of infectious disease, vector-borne illness, and neuropsychiatric conditions agree that infection is a major cause of mental disorders. A landmark 2023 study identified at least 43 known bacteria, viruses, parasites, and fungi with documented association or causation for mental illness diagnoses, concluding, "[F]urther investigation into the association between infectious/immune processes and mental disorders may lead to greater use of antimicrobial and immune-modulating agents in the treatment of psychiatric conditions. This may prevent and reduce mental illness morbidity, disability, and mortality" (Bransfield et al., 2023). Additionally, a landmark 2015 study highlights that the "brain is not immune-privileged," overturning the assumption that the central nervous system is completely immune-isolated (Louveau et al., 2015). Yet, clinical and scientific progress in IANC is challenging due to the complex immune mechanisms.

Table 1, adapted from Bransfield et al., 2023, provides a more comprehensive list of pathogens that are known to potentially cause neuropsychiatric sequelae.

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

Table 1: Pathogens with Potential Neuropsychiatric Associations

TYPE	PATHOGEN
Viruses	Borna disease virus Chikungunya virus Coronaviruses (excluding SARS-CoV-2) Cytomegalovirus (CMV) Enteroviruses Epstein–Barr virus (EBV) Hepatitis C virus (HCV) Human endogenous retroviruses (HERVs) Human immunodeficiency virus (HIV) Human T-cell lymphotropic virus type 1 (HTLV-1) Influenza virus Measles virus Parvovirus B19 Poliovirus Rubella virus SARS-CoV-2 Tickborne encephalitis virus West Nile virus
Bacteria – Spirochetes	Borrelia burgdorferi sensu lato (including B. burgdorferi s.s., B. afzelii, B. garinii) Leptospira species Relapsing fever group Borrelia Treponema pallidum
Bacteria - Other	Actinomyces species Bartonella henselae (and other Bartonella species) Brucella species Chlamydia species Coxiella burnetii Ehrlichia chaffeensis Helicobacter pylori Mycoplasma pneumoniae (and other Mycoplasma species) Rickettsia species Streptococcus pyogenes (Group A Streptococcus) Tropheryma whipplei
Parasites - Protozoa	Babesia species (including B. microti, B. duncani, and others) Leishmania species Plasmodium species Toxoplasma gondii Trypanosoma species
Parasites – Helminths	Filarial worms (Filaria species) Taenia solium
Fungi	Aspergillus species Candida species Cryptococcus neoformans

Note. Adapted from Bransfield, R. C., et al. (2023). Microbes and mental illness: Past, present, and future. Healthcare, 12(83).

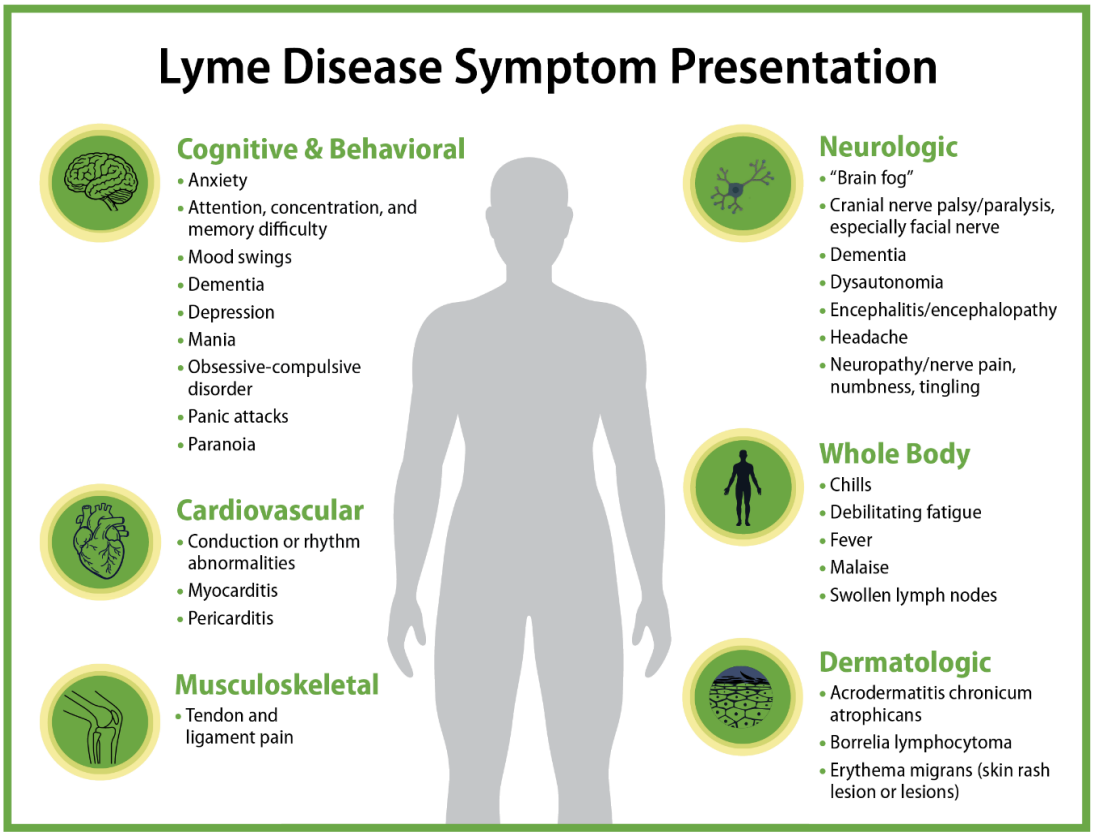
2.2 Lyme Disease IANC

Starting in the late 1970s, a group of mothers and then medical professionals observed a cluster of pediatric and adult arthritis cases centered around Lyme, Connecticut, earning the condition the name Lyme disease (LD) (Steere, 2024). Neurologic symptoms with Lyme were observed as early as 1978 (Steere et al., 1978, Reik et al., 1979). In June 1982, an article by Dr. Willy Burgdorfer in the journal *Science* described the isolation of spirochete bacteria in ticks, and soon thereafter it was recovered in humans (Burgdorfer et al., 1982). Early stage physical manifestations of LD may include fever, chills, headache, fatigue, muscle and joint aches, swollen lymph nodes, and an erythematous skin rash, sometimes in the form of a bull's-eye. Later signs or symptoms may include headaches, neck stiffness, facial paralysis, arthritis, heart palpitations, carditis, dizziness, or shortness of breath (Centers for Disease Control, 2024). Neurologic and neuropsychiatric signs and symptoms may include meningitis, encephalitis, cranial neuritis, radiculitis with weakness or pain, paresthesia, cognitive problems, mood changes, sleep disturbance, depression, and mania.

LD is the most common vector-borne illness in the United States (HHS, 2025; CDC, 2025). Although well documented, both the public and many healthcare professionals are less aware of the neuropsychiatric presentations of LD. Epidemiological evidence associates LD with conditions such as paranoia, dementia, schizophrenia, bipolar disorder, panic attacks, major depression, anorexia nervosa, and obsessive-compulsive disorder. In 1994, Fallon et al. noted that up to 40% of patients with Lyme disease develop neurologic involvement of either the peripheral or central nervous system, with 26%–66% experiencing depressive states (Fallon et al., 1994; Reik et al., 1979; Fallon et al., 1998), and generally, individuals with LD present increased incidence of any mental disorder, affective disorders, suicide attempts, and death by suicide (Fallon et al., 2021). Psychiatric studies have found evidence that the impacts of LD on "immune, biochemical, neurotransmitter, and neural circuit reactions…can cause impairments associated with violence" (Bransfield, 2018). Another study of LD in Denmark showed the risk of suicide increased by 75% among those with a hospital-based diagnosis of LD compared to a control group (Fallon et al., 2021). Cognitive impairment can occur in early and late stage LD. Approximately 24% of patients with early stage disease have concentration problems (Aucott et al., 2013). Among patients with persistent symptoms, up to 90% complain of cognitive difficulties while 7-30% have displayed measurable deficiencies in short-term memory, verbal fluency, and processing speed (Kaplan et al., 1992; Keilp et al., 2006; Krupp et al., 1991; Touradji et al., 2019).

There is still much to be understood about patients who experience persistent Lyme disease symptoms, including the terminology used to describe these conditions. Lyme Infection Associated Chronic Illness (Lyme-IACI) is a recently developed, increasingly-accepted term that describes the condition of symptom persistence despite prior antibiotic treatment for LD (National Academies, 2025). The association of persistent neurological symptoms despite treatment for LD has been documented for over 30 years. Yet despite this association, the precise mechanism remains unclear, as there are many potential causes for symptom persistence (CDC, 2026).

Figure 2: Lyme Disease Symptom Presentation by Category



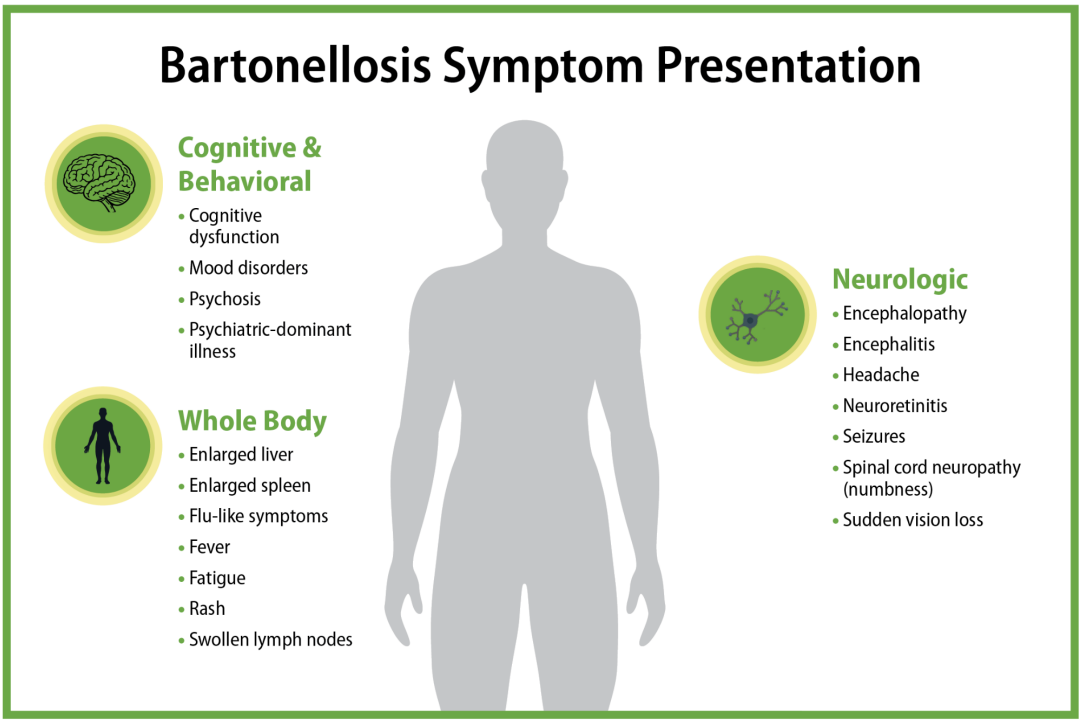
2.3 Bartonellosis

Three diseases described in the 20th century—Oroya fever, trench fever, and cat scratch disease—were later connected to Bartonella bacteria transmitted by arthropod vectors (Spach & Koehler, 1998; Raoult & Roux, 1999). Neurologic manifestations, including encephalopathy, seizures, neuroretinitis, and cognitive dysfunction, were documented, with some cases presenting primarily with psychiatric symptoms (Carithers,

1985; Marra, 1995; Breitschwerdt et al., 2005). These observations reframed bartonellosis as a multisystem condition with neurologic and neuropsychiatric relevance.

Bartonellosis patients may experience sudden vision loss, encephalitis, and spinal cord involvement or peripheral neuropathy resulting in numbness; while neuropsychiatric symptoms—including cognitive dysfunction, mood disorders, and psychosis—may be prominent without fever or lymph node enlargement (Cheslock & Embers, 2019; Bush et al., 2024). Additionally, physical manifestations of bartonellosis include swollen lymph nodes, rash, flu-like symptoms, headache, fever, fatigue, enlarged liver or spleen, and more (Cleveland Clinic, 2025). Notably, neuropsychiatric symptoms represent the primary or sole clinical manifestation of *Bartonella* infection in some patients (Breitschwerdt et al., 2019; Schaller et al., 2007; Delaney et al., 2024).

Figure 3: Bartonellosis Symptom Presentation by Category

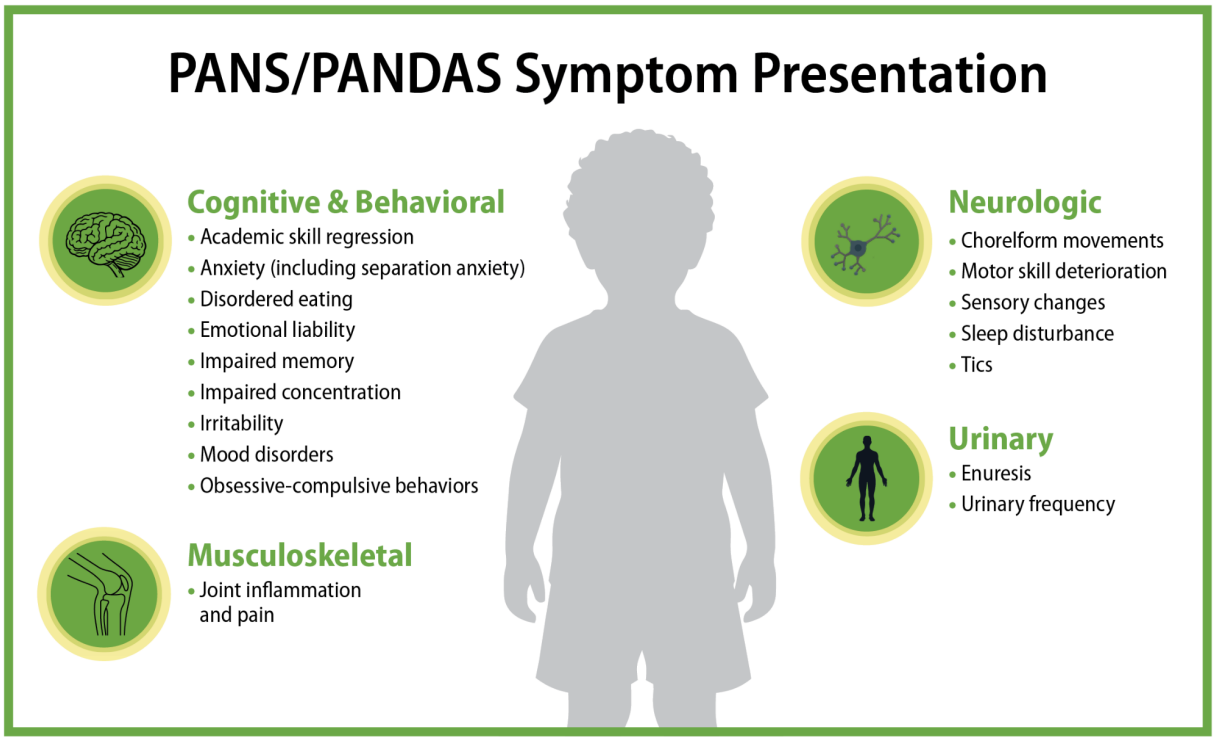


With over 60 identified species of *Bartonella*, human disease trajectories remain unclear. While Bartonellosis transmission has long been associated with fleas and body lice, emerging research suggests other insects and ticks are also vectors for various Bartonella species (Cheslock & Embers, 2019).

2.4 PANS and PANDAS

In 1998, Swedo et al. described pediatric patients with acute onset obsessive-compulsive disorder and tic syndromes associated with streptococcal infections, termed Pediatric Autoimmune Neuropsychiatric Disorder Associated with Streptococcal Infections (PANDAS) (Swedo et al., 1998). Similar presentations without confirmed streptococcal infection were later categorized as Pediatric Acute-onset Neuropsychiatric Syndrome (PANS) (Swedo et al., 2012). The PANS diagnostic criteria do not have an age-of-onset requirement and acknowledge that the infectious trigger may not have been identified during active infection (Grandinetti et al., 2024; Leonardi et al., 2024; Gagliano et al., 2020). Despite decades of research, medical knowledge of PANS and PANDAS remains fragmented across specialties, including infectious disease, psychiatry, immunology, rheumatology, and neurology.

Figure 4: PANS/PANDAS Symptom Presentation by Category

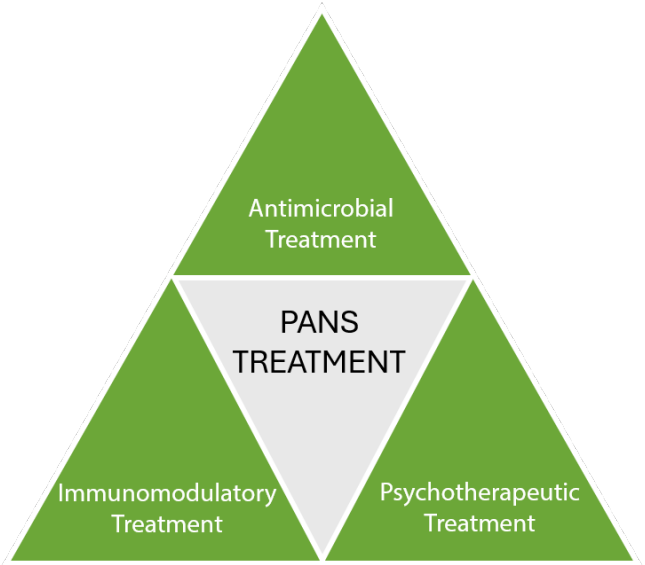


PANS and its streptococcus-triggered counterpart, PANDAS, often present with acute onset of neuropsychiatric symptoms in addition to cognitive, orthostatic, urinary, sensorimotor, and musculoskeletal changes (NIH NIMH, 2025). These symptoms can occur rapidly, even overnight, but may also develop over weeks or months. Most commonly, the neuropsychiatric symptoms include obsessive-compulsive

behaviors or eating restrictions, anxiety, including severe separation anxiety, irritability, and emotional instability (Swedo et al., 2017; Thieneman et al., 2021; Arcilla et al., 2025, Kapphahn et al., 2025). Cognitive symptoms include academic skill regression, impaired memory and concentration, and sleep disruption (Masterson et al., 2024; Santoro et al., 2018). Patients may also experience involuntary or frequent urination (Leonardi et al., 2024). Musculoskeletal changes include motor skill deterioration–especially seen with handwriting– tics or choreiform movements, and joint inflammation and pain (Thienemann et al., 2017, NIH, 2026).

Current treatment guidelines were developed by the PANS/PANDAS Research Consortium and published in the 2017 Journal of Child and Adolescent Psychopharmacology (Swedo et al., 2017). These guidelines recommend a three-pronged approach for PANS/PANDAS treatment, focusing on infection control through antimicrobials, immune modulation, and psychiatric support. Treatment strategies are tailored to symptom severity, ranging from antimicrobials and anti-inflammatories for mild cases to IVIG or plasma exchange for severe cases (Figure 5). Thienemann et al provide further analysis of the use of psychiatric medications in PANS/PANDAS patients, indicating that PANS/PANDAS patients appear to be more sensitive to adverse reactions and tolerate lower doses than doses typically used in psychiatry (Thienemann et al., 2017; Thienemann, 2021). The NIH National Institute of Mental Health highlights the need for further research into the cause of PANS and PANDAS.

Figure 5: The PANS treatment triangle. (adapted from Swedo et. al, 2017)



3. Patient and Clinical Challenges

3.1 Access to Care

Patients and families experiencing IANC face many challenges, with access to comprehensive care being among the most significant. Although all medical students receive training in psychiatry and infectious disease, providers often become increasingly siloed in their specialty beginning in their residency. As one author states, "in healthcare, this process starts early in training and becomes fixed as providers become progressively specialized" (Bakewell, 2025).

In addition to the siloed nature of American medical practice, workforce shortages further limit access across key specialties needed to manage complex, multisystem conditions. Most U.S. counties lack an infectious disease (ID) physician, and ID fellowship programs have persistently low fill rates (Walensky et al., 2015; National Resident Matching Program [NRMP], 2025). Demand for neurologic care is projected to exceed supply by nearly 20%, while rheumatology faces a deficit of more than 4,700 physicians by 2030 (American Academy of Neurology, 2013; American College of Rheumatology, 2021). Psychiatry shortages are also significant, with projected deficits exceeding 12,000 by 2030 (Health Resources and Services Administration [HRSA], 2016; American Psychiatric Association, 2023).

> *"A problem is that many psychiatrists don't know much about infectious diseases, and many infectious disease doctors don't know much about psychiatry. The link between the two is the immune system, and it's often how the immune system functions within the brain."*
>
> - Robert Bransfield, MD

Despite the clinically relevant overlap of infectious, neurologic, psychiatric, and rheumatologic presentations of IANC, very few medical programs provide cross-training in these areas, creating challenges in diagnosis and care (Johns Hopkins Medicine, n.d.; Mount Sinai, n.d.; Columbia University Irving Medical Center, n.d.). The gold standard for cross-disciplinary centers of clinical, laboratory, and population science was established through the National Cancer Act of 1971 — an attainable prospect for emerging and misunderstood conditions today (Institute of Medicine, 1989). While limited dual-certification pathways exist, most notably in neurology-psychiatry and internal medicine-psychiatry, the number of physicians completing such training remains small (American Board of Medical Specialties, 2023). Researchers note "diagnostic uncertainty underscores the challenges professionals and families face in accessing effective care, emphasizing the need for education and evidence-based clinical practice guidelines" (Goren et al., 2025). This information forms a complete picture that few clinicians have the knowledge to provide comprehensive IANC diagnosis and care.

Certain geographic populations are at a greater risk for LD and other vector exposures. Rural residents experience higher residential exposure risk for LD compared to urban populations (Gould et al., 2025). Yet, rural populations in the United States often travel two to three times the distance of their urban counterparts to access medical care, specifically specialty care (Chan et al., 2006). This creates a significant access barrier for IANC patients living in rural areas. Military members and their families represent another high-risk population for IANC: approximately 6,000 active-duty Service Members and nearly 56,000 Service Member beneficiaries were diagnosed with a reportable tickborne disease between 2006 and 2020 (Armed Forces Health Surveillance Branch, n.d.). Seventy-five percent of US military installations are located in the states from which 99% of all CDC-reported tickborne disease cases from 2004 to 2016 originated (Department of Defense Congressionally Directed Medical Research Programs, 2019). Frequent relocation, the rural nature of military bases, or deployments to undeveloped regions may exacerbate barriers to care and increase exposure to pathogens. Due to the potential for high exposure to ticks and lice, people experiencing homelessness are also at high risk for vector-borne disease and, therefore, IANC (Rich et al., 2024; TBDWG, 2022). It is also important to note that an estimated 67% of people experiencing homelessness have a mental health disorder (Barry et al, 2024), of which an unknown proportion may be infection-associated.

3.2 Diagnosis Delays and Misdiagnosis

Delays in the diagnosis of IANC are well documented and associated with poorer patient outcomes, particularly regarding symptom severity, chronicity, and recurrence (Calaprice-Whitty et al., 2023; Mead, 2015; Worsmer et al., 2007; Hirsch et al., 2020; Cameron, 2026). Diagnostic delays may arise from epistemic factors—such as misdiagnosis or denial of an infectious or immune-mediated etiology—or structural factors, including lack of referral pathways, limited specialist availability, and financial or insurance-related barriers.

In one study surveying clinicians who treat LD, respondents identified the following as contributors to delayed diagnosis (Johnson & Maloney, 2022):

- Inadequate physician education about tickborne diseases (86%)
- False-negative laboratory testing (61%)
- Prior misdiagnosis (52%)
- Absence of erythema migrans rash (37%)
- Patient residence in a state perceived as low incidence (25%)
- Initial manifestations reflecting late-stage disease (21%)
- Public misinformation (16%)

A small qualitative survey of 11 medical provider families navigating a PANS or PANDAS diagnosis identified additional diagnostic barriers (Tang et al., 2021):

- Clinician's lack of awareness (82%)
- Clinician skepticism regarding diagnosis (82%)
- Overreliance on diagnostic testing in the absence of definitive biomarkers (91%)
- Out-of-pocket expenses exceeding $100 USD (82%)
- Difficulty identifying a provider to coordinate care (64%)
- Psychological misdiagnosis (55%)

A larger study of 441 PANS/PANDAS patient caregivers found:

- A median of 3 providers before both PANS and PANDAS diagnosis
- 62.3% of families traveled further than 50 miles for PANS / PANDAS treatment

- High family financial burdens: (high out-of-pocket treatment costs, noninsurance reimbursed care for services, lost time at work for caregivers)
- Mean caregiver burden fell above 'burnout' level (O'Dor SL et al., 2022)

In 2023, Calaprice-Whitty et al. surveyed 698 PANS PANDAS caregivers over four years and, on average, found a two-year lag between symptom onset and diagnosis/treatment.

Due to its relatively recent recognition as a multisystem human disease, there is currently no systematic data examining the impact of delayed diagnosis on outcomes in bartonellosis, representing a significant gap in the evidence base and an important area for future research (Breitschwerdt et al., 2019; Bush et al., 2024). However, existing analyses of individuals with high-risk animal exposures experiencing bartonellosis saw up to five specialists for diagnosis and care, displaying a significant financial, logistical, and emotional challenge (Maggi et al., 2012).

Because IANC frequently involves multiple organ systems, limited provider education and poor coordination across specialties can result in missed diagnoses and incomplete assessments. Moreover, patients with PANS and PANDAS are often diagnosed with multiple comorbid conditions, including Postural Orthostatic Tachycardia Syndrome (POTS), Mast Cell Activation Syndrome (MCAS), hypermobile Ehlers-Danlos Syndrome (hEDS), Attention-Deficit/Hyperactivity Disorder (ADHD), gastrointestinal disorders, and allergic conditions, further complicating diagnostic clarity and care coordination (Chan et al., 2022).

3.3 Coding Challenges and Disparities

The heterogeneous presentation, medical stigma, and lack of awareness and understanding of IANC create challenges to healthcare providers' ability to properly code when treating patients with IANC. Table 2 shows codes from the International Classification of Diseases, 10th Revision (ICD-10) that may be used by healthcare professionals treating IANC. Note that LD has a code, A69.22, which could be used specifically for Lyme-IANC. However, neurobartonellosis has no neuropsychiatric coding. And significantly, PANS and PANDAS have no condition-specific codes. This creates insurance limitations, especially as patients may need a combination of antimicrobials, immunotherapy, and multidisciplinary care. As a workaround, PANS and PANDAS providers often use codes for related conditions.

Table 2: IANC ICD-10 Codes

IANC	Pertinent ICD-10 Codes
Lyme disease	A69.20 - Lyme disease, unspecified A69.21 - Meningitis due to Lyme disease A69.22 - Other neurologic disorders in Lyme disease A69.23 - Arthritis due to Lyme disease A69.29 - Other conditions associated with Lyme disease
Bartonellosis	A44.0 - Systemic bartonellosis A44.1 - Cutaneous and mucocutaneous bartonellosis A44.8 - Other forms of bartonellosis A44.9 - bartonellosis, unspecified
PANS/PANDAS	D89.9 - Disorder involving immune mechanism, unspecified G04.81 - Other encephalitis and encephalomyelitis G04.90 - Encephalitis and encephalomyelitis, unspecified

3.4 Quality of Life and Caregiver Burden

The Center for Disease Control and Prevention's Health Related Quality of Life (HRQoL) shows the impact LD has on patients' quality of life. This research notes that 72% of individuals with ongoing symptoms reported fair or poor health status, compared with 16% of overall respondents. Patients in this study also reported 20 physical and 16 mental poor health days in a 30-day period, compared to 5 and 3 in the general population, respectively. Forty-two percent of respondents living with LD reported they had to stop working because of their health status (Johnson et al., 2014). Caregivers of both pediatric and adult patients with Lyme-IACI experience substantial burden, with the mental and emotional toll—stress, worry, frustration, and fear over their loved one's deterioration—emerging as the most significant strain. Financial concern is also prominent, particularly when patient symptom severity is higher, suggesting that more intense or persistent symptoms increase economic strain on families. In addition, caregivers report moderately severe levels of anxiety and depression, indicating that caregiving in this context is closely tied to diminished quality of life and poorer mental health outcomes (Deschene, 2021).

"For affected children and their families, PANDAS/PANS represents more than an academic curiosity — it constitutes a profoundly disruptive life experience that demands compassionate, informed clinical care."

- Haridass, 2025

Caregiver burden is an immense but often underappreciated consequence of PANS and PANDAS. Frankovich et al. found that in the PANS population treated at their Stanford Clinic, "the median Caregiver Burden Index (CBI) score during a patient's first flare was higher than the average found in a study of the CBI in Alzheimer's disease" (Frankovich et al, 2018). Earlier entry into specialized care has been associated with improved outcomes for caregivers of PANS/PANDAS patients (O'Dor et al., 2022). In another PANS-related study, approximately half of caregivers reported burden levels high enough to warrant respite care, even at the point of initial disease flare (Frankovich et al., 2018). Caregiver burden was significantly higher during disease flares but declined over time with continued participation in a multidisciplinary clinic. In the Stanford PANS Clinic, shorter wait time between symptom onset and clinical treatment also predicted a more rapid decrease in caregiver burden over time (Frankovich et al., 2018).

Other notable areas of concern for PANS/PANDAS families are household quality of life and the impact a PANS/PANDAS diagnosis has on the educational environment (Demchick et al., 2019). A 2025 review notes, "For affected children and their families, PANDAS/PANS represents more than an academic curiosity — it constitutes a profoundly disruptive life experience that demands compassionate, informed clinical care" (Haridass, 2025). School personnel may struggle to understand and properly support the student, their functioning in the classroom, and their absences (Doran, 2015). During exacerbations, many children experience acute and severe regression in previously acquired academic and developmental skills, including mathematics, handwriting, and social–emotional regulation (Tona & Posner, 2011). They may also develop debilitating obsessive–compulsive symptoms, phobias, hyperactivity, and sensory dysregulation. Onset of these illnesses frequently occurs during critical windows of childhood development, when foundational academic and social skills are normally consolidated. As a result, regression of previously mastered abilities and missed developmental milestones may carry long-term consequences for

educational attainment, emotional regulation, and overall life outcomes (LaRusso et al., 2024; Han et al., 2025).

School personnel must spend significant time and resources on the development of Individualized Education Plans (IEPs) and accommodations (Doran et al., 2015; PANDAS Physician Network, n.d.). When public school systems are unable to adequately address the needs of students with IANC, outplacement may be required, potentially costing states over $100,000 annually per pupil (Deninger & O'Donnell, 2009). Due to the disruptive nature of their children's symptoms, more than 50% of American families in one PANS and PANDAS study noted that their child received some at-home instruction (Doran et al., 2015). In one United Kingdom survey of PANS and PANDAS parents, 35% stated their children were away from school for at least six months due to their symptoms (PANS PANDAS UK, 2020). A 2023 study urged clinicians and educators to become aware of the high burden placed on caregivers during PANS exacerbations and encouraged further research concerning posttraumatic stress among families and children (Tona et al., 2023).

3.5 Stigma

Stigma is often tied to behavioral health and psychiatric diagnoses. Due to the emerging nature of IANC, stigma presents itself in a variety of forms:

> Epistemic stigma: The dismissal of IANC symptoms as purely psychological, fabricated, or exaggerated.
>
> Professional stigma: Risk to a provider's reputation or licensure for diagnosing and treating IANC.
>
> Institutional stigma: Reluctance on the part of major medical, governmental, and insurance institutions to validate IANC or to view symptoms through a medical lens.

Disagreement around the acute versus chronic nature of LD, the lack of attention received by bartonellosis and neurobartonellosis, and the multi-system complexity of PANS/PANDAS remains entrenched in medical and scientific circles despite ever-mounting evidence. While measuring stigma is imprecise, there are historical examples in which infectious agents were dismissed, only to later be proven unequivocally. For example, stomach ulcers were long thought to be caused by stress, until Australian physician Barry Marshall observed curved bacteria in gastric biopsy specimens from patients with gastritis and peptic ulcer

disease. At the time, prevailing medical consensus attributed ulcers primarily to stress and psychosomatic factors, while infectious causes were largely dismissed. It was not until Marshall self-experimented in 1984 by ingesting *Helicobacter pylori*– subsequently developing gastritis– that clinicians began to accept that bacteria, not stress, was the primary agent in gastritis and ulcers, a discovery later recognized with the 2005 Nobel Prize in Physiology or Medicine (Kyle et al., 2016). Thus, Marshall's discovery resulted in effective treatment to cure gastric ulcers (Ford et al., 2006).

When stigma persists in the absence of clear diagnostic frameworks, its effects may extend beyond delayed or inappropriate medical care and into broader institutional responses. Notably, these barriers have been documented even among the children of physicians and other healthcare professionals, highlighting significant gaps in clinical awareness and diagnostic infrastructure (Tang et al., 2021; Global Alliance for Vaccines and Immunization, 2024). In some cases, child protective services have become involved when severe symptoms such as restrictive eating, aggression, hallucinations or self-harm are mistaken by social service professionals for signs of neglect or serious untreated mental health issues (Global Alliance for Vaccines and Immunization, 2024). Parents have also reported being accused of Factitious Disorder Imposed on Another (formerly known as Munchausen syndrome by proxy) (Penna, 2023).

Institutionalized stigma for the Lyme community was exemplified through the release of internal CDC emails referring to Lyme patients as "Lyme loonies" (U.S. Senate, Committee on Health, Education, Labor, and Pensions, 2012). Stigma surrounding IANC creates a burden on patients, caregivers, and support systems, while simultaneously delaying scientific and clinical progress. This problem can be addressed through clinician education, research investment, and institutional guidance.

4. Epidemiological Evidence

4.1 Lyme Disease IANC

The reported incidence and geographic distribution of LD have increased substantially in the United States over the past several decades. Cases reported to the CDC increased from 16,862 in 2001 to 61,802 in 2022, while the geographic distribution of LD has expanded beyond historically high-incidence areas in the Northeast and Midwest, with increasing incidence also observed in the Southeast (Sun et al., 2025). However, reported surveillance data capture only a portion of the overall disease burden. The CDC estimates that approximately 476,000 people are diagnosed and treated for LD annually (CDC, 2025).

A 2023 MyLymeData report provided self-reported outcomes from approximately 15,000 individuals with a LD diagnosis. Among these, the following neuropsychiatric symptoms were reported:

- Fatigue – 54%
- Cognitive impairment – 28%
- Psychiatric symptoms – 28%
- Memory loss – 27%

Despite the limitations of self-reported data, the high prevalence of neuropsychiatric symptoms reported across such a large patient cohort is notable. Additionally, 92% of these individuals reported being "unwell," with 91% reporting late, untreated, or chronic LD. It is also noteworthy that 42% of these reports had coinfection with *Bartonella* and 44% with *Babesia*, a microorganism also associated with neuropsychiatric symptoms (Locke et al., 2023).

A 2021 study by Fallon et al. used Denmark's National Patient Register and the Psychiatric Central Research Register, analyzing data from all residents of Denmark between 1994 and 2016 (n = 6,945,837). Of these, Lyme borreliosis–related hospital contacts were identified (n = 12,156). The authors concluded that individuals with Lyme borreliosis had significantly higher rates of multiple psychiatric outcomes compared with those without Lyme borreliosis (Fallon et al., 2021):

- Any mental disorder (IRR = 1.28; 95% CI = 1.20–1.37)
- Affective disorders (IRR = 1.42; 95% CI = 1.27–1.59)

- Suicide attempts (IRR = 2.01; 95% CI = 1.58–2.55)
- Death by suicide (IRR = 1.75; 95% CI = 1.18–2.58)

Risk was highest in the period immediately following diagnosis, with the first six months after Lyme diagnosis associated with the highest rate of any mental disorder and the first three years associated with the highest risk of suicide.

In a study of 37 youth diagnosed with bipolar disorder, laboratory evidence of the following vector-borne and infectious diseases was identified: Babesia in 51% (19/37), Bartonella in 49% (18/37), *Mycoplasma pneumoniae* in 38% (14/37), *Borrelia burgdorferi* in 22% (8/37), and Group A *Streptococcus* in 19% (7/37). Overall, 92% (34/37) had evidence of vector-borne or infectious exposure, with 81% (30/37) meeting both laboratory and clinical criteria (Greenberg, 2025). In another small study of schizophrenia patients and controls, 17 patients had schizophrenia and 12 of 17 had Bartonella DNA in their blood, as compared to only 1 of 13 in the control group (Lashnits et. al, 2021). While limited by small sample size and clinical selection bias, these findings highlight the frequent overlap between neuropsychiatric illness and infectious exposure in pediatric populations.

4.2 Bartonellosis

Unlike LD, there are currently no population-based epidemiological estimates for neurobartonellosis. Existing evidence related to Bartonella consists primarily of case reports, case series, specialty clinic cohorts, and seroprevalence studies, which are insufficient to determine prevalence, incidence, or population-level risk. The absence of epidemiological data should not be interpreted as evidence of rarity, but rather as a consequence of limited surveillance infrastructure, inconsistent case definitions, and a lack of systematic reporting.

4.3 PANS and PANDAS

Accurately estimating the incidence and prevalence of PANS/PANDAS remains challenging due to a variety of methodological and diagnostic limitations. However, several efforts start to shed light on the frequency of these conditions, using broad population databases and retrospective physician surveys.

First, a Danish study of 1,067,743 individuals under the age of 18 from 1996 through 2013 showed that individuals with a positive streptococcal test result had an increased risk of mental disorders, particularly of

OCD and tic disorders, compared with individuals without a positive test (Orlovska et al., 2017). Another study followed electronic health records of over 1 million Danish children to an average age of 9.76 years. The children who experienced an infection requiring hospitalization were 84% more likely to be diagnosed with a mental health disorder and 42% more likely to redeem a psychotropic medication (Köhler-Forsberg et al., 2019).

In another study, 52% of 100 consecutive subjects in a pediatric eating disorder program met PANS criteria (Aman 2022). In a pediatric OCD clinic, 5% of 136 subjects met PANS or PANDAS criteria (Jaspers-Fayer 2017). These figures suggest that PANS/PANDAS 1) may be underrecognized and 2) may share important mechanistic overlap with a broader group of psychiatric conditions.

A retrospective analysis designed to estimate the prevalence of PANS/PANDAS directly surveyed over 90,000 primary care pediatric records from 3 US academic centers. The author estimated annual PANS incidence at 1 in 11,765 among children aged 3-12 years (Wald, 2023). A 2-year Canadian survey of over 2700 pediatric practices yielded a minimum prevalence estimate of 1 in 60,155 (Goren et al., 2024).

Unfortunately, efforts to estimate PANS/PANDAS frequency risk underidentification of cases. PANS and PANDAS diagnoses are made on clinical grounds (history and physical) rather than laboratory or imaging studies. In this respect, they resemble many well-established autoimmune and inflammatory conditions that are diagnosed using clinical criteria, but case counts are more difficult due to the lack of a single, common diagnostic test. Because no ICD-10 diagnostic codes exist for PANS or PANDAS, studies cannot identify patients with these disorders directly but instead rely on proxies such as related symptom-based diagnostic codes. Further, many patients are diagnosed by outside specialists with recognized expertise in PANS/PANDAS, whose care may not be captured in centralized electronic health databases. Low knowledge of these conditions among medical providers, with misdiagnosis as primary psychiatric disorders, leads to further underreporting (Gagliano et al., 2023; Wald et al., 2023; Goren et al., 2024; Prato et al., 2021; Grandinetti et al., 2024).

Capturing the full spectrum of affected patients will require large, multicenter studies that attempt to account for all diagnostic limitations discussed. Until such studies are conducted, existing epidemiologic estimates will primarily reflect only the subset of affected individuals who have successfully navigated the diagnostic process to receive clinical recognition rather than the full burden of disease. An NIH-funded study is in progress to clarify strategies to measure PANS incidence.

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

5. Contributing Factors

5.1 Biological Factors and Causation

Researchers have identified various mechanisms that provide biologically plausible explanations for symptoms such as obsessive-compulsive behaviors, anxiety, mood instability, cognitive dysfunction, school refusal, and sleep disturbance observed in subsets of patients. While causality remains incompletely understood in certain contexts, the convergence of immunologic, neuroimaging, and clinical data supports the concept that infection-associated immune processes can contribute to neuropsychiatric syndromes in susceptible individuals (Bransfield et al., 2018, Breitswerdt et al. 2019, Swedo et al., 2017).

A selection of possible mechanisms for IANC includes:

- Infection-triggered immune activation: A pathogen initiates a host immune response that may persist beyond pathogen clearance, influencing other organ systems, including the brain, and contributing to downstream behavioral effects (Rupprecht et al., 2008; Halperin, 2014; Swedo et al., 1998; Frankovich et al., 2017; Breitschwerdt et al., 2012, 2020).
- Cytokine-mediated neuroinflammation: Inflammation within the central nervous system driven by cytokines released during immune activation, which can alter neural circuits and contribute to cognitive, mood, or behavioral symptoms (Ljøstad et al., 2008; Rupprecht et al., 2008; Cunningham, 2019; Thienemann et al., 2017; Breitschwerdt et al., 2020; Bransfield, 2023).
- Basal ganglia neuroinflammation: Dysfunction in brain regions responsible for movement, behavior, motivation, habit formation, and cognitive control, potentially leading to neuropsychiatric symptoms (Giedd et al., 2000; Cunningham, 2019; Halperin, 2014; Breitschwerdt et al., 2020).
- Microvascular/endothelial dysfunction: Injury or inflammation of small blood vessels and their endothelial lining, contributing to altered blood flow, immune signaling, and potential neurologic or psychiatric effects (Kempf et al., 2001; Breitschwerdt et al., 2020; van de Beek et al., 2016; Halperin, 2014; Frankovich et al., 2017).
- Dopamine and glutamate disruption: Abnormal signaling in key neurotransmitter systems involved in movement, learning, mood, and executive function, which may underlie behavioral and cognitive changes (Cunningham, 2019; Fallon et al., 2008; Rupprecht et al., 2008; Breitschwerdt et al., 2020; Bransfield, 2023).

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

While these conditions differ in pathogen and pathophysiology, they share a common theme of infection-associated immune activation with potential downstream neuroinflammatory effects, though mechanisms are not uniformly shared across conditions.

Lyme IANC

In some cases, LD causes inflammation of the brain or spinal cord, potentially causing direct injury to the central nervous system in which the bacteria infect brain tissue and provoke inflammation around blood vessels and immune cell infiltration. In other cases, neuropsychiatric symptoms may arise indirectly even without clear evidence of active infection in the brain. Immune responses to infection can become misdirected, leading to antibodies and immune cells that mistakenly target the body's own neural tissue. Early symptoms are often driven by pro-inflammatory immune signaling, which can interfere with normal brain function and manifest as fatigue, cognitive slowing, and "brain fog." Other symptoms—such as obsessive thoughts, tics, irritability, and behavioral changes—may be mediated by autoimmune processes affecting neural circuits. In later or persistent stages, inflammation may contribute to more sustained brain changes, including chronic neuroinflammation and neurodegenerative-like features (Bransfield et al, 2023).

Bartonellosis

Emerging evidence suggests that some vector-borne pathogens, including *Bartonella* species, may persist in the human body in a low-level or latent state. In these cases, pathogens may survive within protected biological niches—such as central nervous system tissues—where they evade routine diagnostic testing. This form of persistence may not result in symptom manifestation for extended periods, yet could still contribute to chronic immune activation, neuroinflammation, or symptom flares. In a recent pediatric case, *Bartonella henselae* DNA was identified in brain tissue despite the patient repeatedly testing negative in blood tests, providing direct evidence of *Bartonella* DNA within central nervous system tissue (Breitschwerdt et al., 2025). The patient's symptoms gradually improved following combination antimicrobial treatment and discontinuation of psychiatric medications, allowing a return to all pre-illness activities and supporting a potential causal role for *Bartonella*. Similar persistence mechanisms have been proposed for other vector-borne and zoonotic pathogens, which may help explain delayed onset, sawtooth trajectories, or treatment-resistant neuropsychiatric symptoms observed in some IANC.

PANS and PANDAS

Infection-triggered, immune-mediated neuroinflammation is a suspected cause of PANS and PANDAS, as supported by emerging evidence in animal and human studies (Leonardi et al., 2024). Scientists have demonstrated the process by which an initial acute infection triggers an immune response that disrupts the blood-brain-barrier (BBB).

Antibodies targeting Group A Streptococcus (GAS) bacteria may become misdirected towards the brain in PANDAS through molecular mimicry, a phenomenon well-established in Acute Rheumatic Fever and Sydenham's Chorea (Frick et al., 2018; Chain et al., 2020; Xu et al., 2024). Animal studies have demonstrated that autoantibodies, or antibodies misdirected toward oneself rather than invaders, cross and thereby compromise a protective gateway to the central nervous system, the blood-brain barrier (Dileepan et al., 2016; Cutforth, 2016; Platt et al., 2017; Platt et al., 2020). Once in the brain, they bind to neuronal targets, cells, and neurotransmitter receptors on the surface of structures principally in the basal ganglia (Leonardi et al., 2024; Vreeland et al., 2023).

Triggers for PANS may include pathogens such as the influenza virus, Mycoplasma pneumoniae, or environmental factors (Leonardi et al., 2024). Inflammatory changes in the brain have been confirmed with diffusion-weighted magnetic resonance imaging in PANS patients (Zheng et al., 2020) and magnetic resonance images in PANDAS patients (Cabrera et al., 2019), specifically in the basal ganglia, thalamus, and amygdala. Importantly, the role of these structures in functions such as movement, sleep, cognition, emotional regulation, and behavior aligns with the neurological and neuropsychiatric clinical presentations of patients with PANS and PANDAS (Cox et al., 2015). Additionally, circulating inflammatory monocytes have been found to be elevated during active PANS episodes, while anti-inflammatory monocytes have been associated with improvement. Researchers postulate that persistent inflammation predisposes patients "to a relapsing/remitting disease course, as is true with multiple sclerosis" (Swedo et al., 2015; Leonardi et al., 2024), and that brain inflammation "might be accompanied by or associated with systemic inflammation," placing them at risk of developing arthritis and other autoimmune diseases (Ma et al., 2024). The NIH National Institute of Mental Health highlights the need for further research into the cause of PANS and PANDAS (NIMH, 2025).

Persistent and Latent Infection

Evidence suggests that persistent or latent infection may play a role in symptoms for some IANC patients. For LD, clinical guidelines from the International Lyme and Associated Diseases Society point to the possibility that *Borrelia burgdorferi* can persist after standard antibiotic treatment. Animal models and human studies have shown viable pathogens after treatment has been completed (Embers et al., 2012; Hodzic et al., 2008). In Bartonellosis research, some evidence suggests that *Bartonella* species may persist intracellularly, including in the cells from the linings of blood vessels and lymph nodes (Dehio, 2001). There are also case reports where bacterial DNA has been identified in tissue despite negative blood tests (Breitschwerdt et al., 2025). More recently, postmortem molecular testing identified Bartonella and/or Babesia DNA in chronically ill individuals with severe neuropsychiatric illness who committed suicide, further supporting the need to investigate persistent vector-borne infections (Breitschwerdt et al., 2026). PANS and PANDAS are generally framed as immune-mediated conditions that follow infection, but guidance from the National Institute of Mental Health and others note that ongoing or recurrent infections may still play a role in triggering symptom flares (Swedo et al., 2017; Frankovich et al., 2017). Taken together, persistent or latent infection is not a uniform explanation for IANC, but remains a plausible mechanism in need of further study.

5.2 Genetic and Immune Factors

Two genetic studies have found de novo (new, not inherited from parents) and ultra-rare variants in some PANS and PANDAS patients. In 2022, researchers performed whole exome sequencing (WES) on a U.S. cohort of 386 cases, and whole genome sequencing (WGS) on ten cases with severe PANS from the European Union. The researchers found mutations in 11 genes among 21 patients. These genes fall into two main groups: one group helps control the immune system and brain immune cells, while the other is mainly involved in how brain cells communicate with each other. Many of these same genes have also been linked to other neurological and developmental disorders (Trifiletti, 2022). They also noted that some of these genes are active in the gut's nervous system, which aligns with growing evidence that the gut-brain microbiome may play a role in neurodegenerative, neuropsychiatric, and autoimmune conditions, including PANS (Trifiletti, 2022). In a follow-up study, researchers looked at genetic data from 32 individuals and found harmful or likely harmful changes in genes related to DNA repair in 14 people with PANS or developmental regression. They suggest that problems with DNA repair could be one of the underlying

mechanisms driving the immune system dysfunction linked to behavioral regression in PANS (Cunningham, 2025).

Several recent studies point to a genetic component in susceptibility to LD (Strausz et al., 2024; Bataller et al., 2024; Vrijmoeth et al., 2024). Population-level analyses have identified genetic variants in individuals associated with increased risk of LD, including variants tied to immune system function (Strausz et al., 2024). Other studies have found associations between immune-related genetic factors—particularly those involved in inflammatory and immune response—and differences in both susceptibility and patient outcomes (Bataller et al., 2024; Vrijmoeth et al., 2024). Genetic variants have also been identified in individuals with Lyme-IACI, highlighting how an individual's genetics may play a role in more persistent or complex disease presentations (Clarke et al., 2022).

5.3 Environmental Factors

LD cases reported to the Centers for Disease Control and Prevention (CDC) increased from 16,862 reported cases in 2001 to 61,802 in 2022. During this period, the disease has expanded beyond the Northeast and Midwest regions of the United States to become more common in the Southeastern region (Sun et al., 2025). It should be noted that these reported cases represent a fraction of total incidence, which the CDC currently estimates to be 476,000 annually (CDC, 2025). Scientists suggest that changes in temperature, forest fragmentation, and changes in land use account for the increase and geographic spread of the disease (Talbot et al., 2019; Heylen et al., 2019; Ogrzewalska et al., 2011; Brownstein et al., 2005; Nuttall, 2022; Simon et al., 2014; Ogden et al., 2021). As Americans have increased pet ownership and kept pets in their homes, opportunities for zoonotic transmission have also escalated, including transmission of *Bartonella* (Chomel & Sun, 2011). Zoonotic transmission of *Bartonella* is especially opportunistic for veterinarians and individuals who rehome stray cats (Lantos et al., 2014; Maggi et al., 2022; Manvell et al., 2021). Incidence of PANS and PANDAS may also coincide with increased incidence of GAS from 3.6 cases per 100,000 in 2013 to 8.2 cases per 100,000 in 2022 (Gregory et al., 2025).

6. Policy Landscape

6.1 Federal Policy

Congress has appropriated modest increases in funding for LD—approximately $169.5 million in federal fiscal year 2026 (Center for Lyme Action, 2026). However, almost none of this funding was specifically appropriated to research, surveil, or improve care for Lyme-IANC. Furthermore, Lyme advocates and policy analysts have noted that current research funding is fragmented across agencies and pathogen-specific silos, limiting coordinated investigation of multisystem and neuropsychiatric outcomes (Center for Lyme Action, 2024; Tick-Borne Disease Working Group [TBDWG], 2022).

Despite appropriations language appearing in federal budgets and legislation since 2019 encouraging research into PANS/PANDAS and pediatric IANC, federal research investment has remained extremely limited. In federal fiscal year 2024, funding for PANS and PANDAS was approximately $800,000—substantially lower than funding allocated to many other pediatric conditions (NIH RePORTER, n.d.). In FY 2025, $2,784,070 supported an intramural project at the National Institute of Mental Health (NIMH) Translational Immunopsychiatry Unit examining antibody-binding patterns in individuals with neuropsychiatric illness, including PANDAS (NIH RePORTER, n.d.). More recently, PANS/PANDAS was included for the first time as an eligible research topic in the Department of Defense's FY 2026 Peer Reviewed Medical Research Program.

These developments represent important progress, but federal investment remains insufficient to support the large-scale clinical trials, biomarker development, national surveillance, and coordinated research infrastructure needed to advance understanding, diagnosis, and treatment of these disorders. Consequently, much of the existing research continues to rely on relatively small, investigator-initiated studies rather than sustained, coordinated national research programs.

Federal research gaps extend to bartonellosis as well. To date, there has been no dedicated federal research funding for bartonellosis or neurobartonellosis in humans, despite growing recognition of Bartonella infection as an emerging and potentially multisystem disease (Breitschwerdt et al., 2019; Bush et al., 2024.

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

Federal programs to provide for research, care, prevention, and surveillance of tickborne disease receive broad bipartisan support, as is evident from the continued reauthorization and federal funding for these activities. In recent years, significant federal policy initiatives shaping the national response to tickborne diseases include the 21st Century Cures Act—which established the Tick-Borne Disease Working Group—and the Kay Hagan Tick Act (HHS, 2024; Office of the Assistant Secretary for Health [OASH], 2023).

The Tick-Borne Disease Working Group's 2022 Report to Congress notes, "Although neuropsychiatric presentations of LD have been reported for more than three decades in the medical literature, rarely are the neuropsychiatric manifestations and mental health needs of LD described in medical textbooks or on government websites" (Fallon & Nields, 1994; Kohler, 1990; Pachner, 1988; TBDWG, 2022). There has been recent incremental movement within the U.S. Department of Health and Human Services (HHS) toward broader recognition of tickborne IANC. However, no HHS webpages are currently dedicated to the neuropsychiatric manifestations of bartonellosis, and only limited references to PANS/PANDAS exist across federal health agency websites, reflecting continued gaps in federal visibility and guidance (HHS, 2024).

In their 2022 Report to Congress, the Tick-Borne Disease Working Group identified two areas in which the federal government could improve research and treatment for tickborne IANC:

"Recommendation 5.1: Support additional research on the mechanisms of pathogenesis of tickborne disease, with a particular focus on central nervous system infection (including neuropsychiatric illness and neuropathic injury), persistent symptoms, allergy (Alpha-gal Syndrome), immunity, autoimmunity, pregnancy, and adverse fetal outcomes."

- Tick-Borne Disease Working Group, 2022

"Recommendation 7.3: Accelerate discovery, preclinical and clinical development of effective treatments for tickborne diseases. Increase funding for research into understudied areas of treatment for tickborne diseases, including but not limited to pediatric neuropsychiatric illnesses, pregnancy outcomes in infected women, and, in all age groups, persistent post-treatment symptoms with emphasis on LD."

- Tick-Borne Disease Working Group, 2022

The Kay Hagan Tick Act, signed into law in 2019 and reauthorized in September 2026, provides a legislative platform for further IANC action at the federal level through:

- National Vector-Borne Disease Strategy: The Act mandates a national strategy to identify gaps in research, surveillance, diagnostics, and care, creating a policy pathway to formally address IANC (OASH, 2023)
- Centers of Excellence: The Act authorizes regional Centers of Excellence to conduct research and develop innovations in care, providing an existing federal mechanism to advance IANC science (OASH, 2023)
- Surveillance System Improvements: The Act requires modernization of vector-borne disease surveillance systems, enabling policy improvements for IANC outcome tracking (OASH, 2023)
- Cross-Agency Coordination: The Act mandates federal coordination across agencies, establishing the framework needed to bridge CDC, NIH, HRSA, SAMHSA, DoD, and other silos around IANC (OASH, 2023)

6.2 State Policy

State LD legislation falls into a few common categories. Some states have passed physician protection laws that limit disciplinary action or liability against clinicians using alternative or longer-term treatment approaches. Other bills have emphasized public awareness and prevention, such as park warning signs, awareness days, or tick-bite education, such as those passed in Delaware, Colorado, New York, and Illinois.

Virginia and Maryland mandate a notification must be provided to patients that a negative Lyme test does not definitively rule out infection (Project Lyme, 2022). As many as 35 states have passed some form of tickborne disease legislation (Center for Lyme Action, 2026).

Currently, there are over three dozen bills related to PANS and PANDAS pending across 18 state legislatures. Insurance coverage for the diagnosis and treatment of these conditions has been a primary focus of state PANS/PANDAS policy. Fifteen states require such coverage in individual and group health insurance. A few of these laws also provide for Medicaid coverage, and one state has a mandate that applies to Medicaid only. Numerous states have established PANS/PANDAS advisory councils with currently active bodies in Massachusetts, Texas, and Virginia. Despite growing state-level focus on LD and PANS/PANDAS, the scope, consistency, and enforcement of these policies vary substantially, underscoring the need for federal guidance and a coordinated national strategy to address IANC across conditions and populations (The Louisa Adelynn Johnson Fund for Complex Disease, 2026).

For a list of tickborne disease state legislation, see Appendix B. For a list of PANS/PANDAS-Related State Legislation, please see Appendix C.

7. Health System & Economic Burdens

In recent years, researchers and economists have enumerated the cost of mental illness in the United States. Approximately 20% of US adults experience some form of mental illness, with 5.5% being classified as severe (SAMHSA, 2022). Expenditures for these conditions top $280 billion annually (Abramson et al., 2024); psychiatric visits to US emergency departments reached $5.9 billion in 2017 (Karaca & Moore, 2020); and $41.8 billion alone is spent on pediatric mental illness, $2.9 billion of which is spent out-of-pocket. These costs have increased from 22.4% of all pediatric medical spending in 2011 to 40.2% in 2022 (Foster et al., 2026). Economist Boaz Abramson notes, "If we eliminated mental illness, then the US economy would grow by 1.7% of GDP, or $282 billion…this is the size of a typical recession" (Columbia Business School, n.d.). Further evidence of an American pediatric mental health crisis is that chronic absenteeism remains above pre-pandemic levels, with recent estimates showing 21.8% of students were chronically absent in the 2024-2025 school year (Diliberti et al., 2025). Many of the symptoms driving mental health utilization in the United States—such as anxiety, obsessive-compulsive behaviors, mood instability, cognitive decline, and school refusal—are also features of IANC, raising the possibility that a subset of cases in the mental health system may have unrecognized infectious or immune-mediated contributors to their illness. Yet clinical guidelines for psychiatric presentation rarely, if ever, consider an infectious or immune-mediated trigger (American Psychiatric Association, 2013; Endres, 2022; Journalfeed, 2025). If, as many scientists increasingly suggest, a meaningful proportion of pediatric mental illness cases are caused or exacerbated by infectious or immune-mediated processes, there is a significant opportunity to improve clinical outcomes and reduce costs through targeted research, surveillance, and clinical education focused on IANC.

While it is difficult to define the exact economic burden of IANC, estimates for the annual cost of LD are up to $1.05 billion, with each episode costing $2,227 to $6,833 for disseminated disease in the United States (Yu et al., 2026). Little formal data exist on annual treatment costs for PANS/PANDAS, and available estimates may not capture substantial costs incurred before diagnosis due to diagnostic delays or misdiagnosis. Treatment costs also vary widely depending on symptom severity and response to treatment (Mandated Health Benefits Advisory Commission, 2026). Even fewer data points exist for Bartonellosis costs, especially given its relative obscurity in differential diagnosis.

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

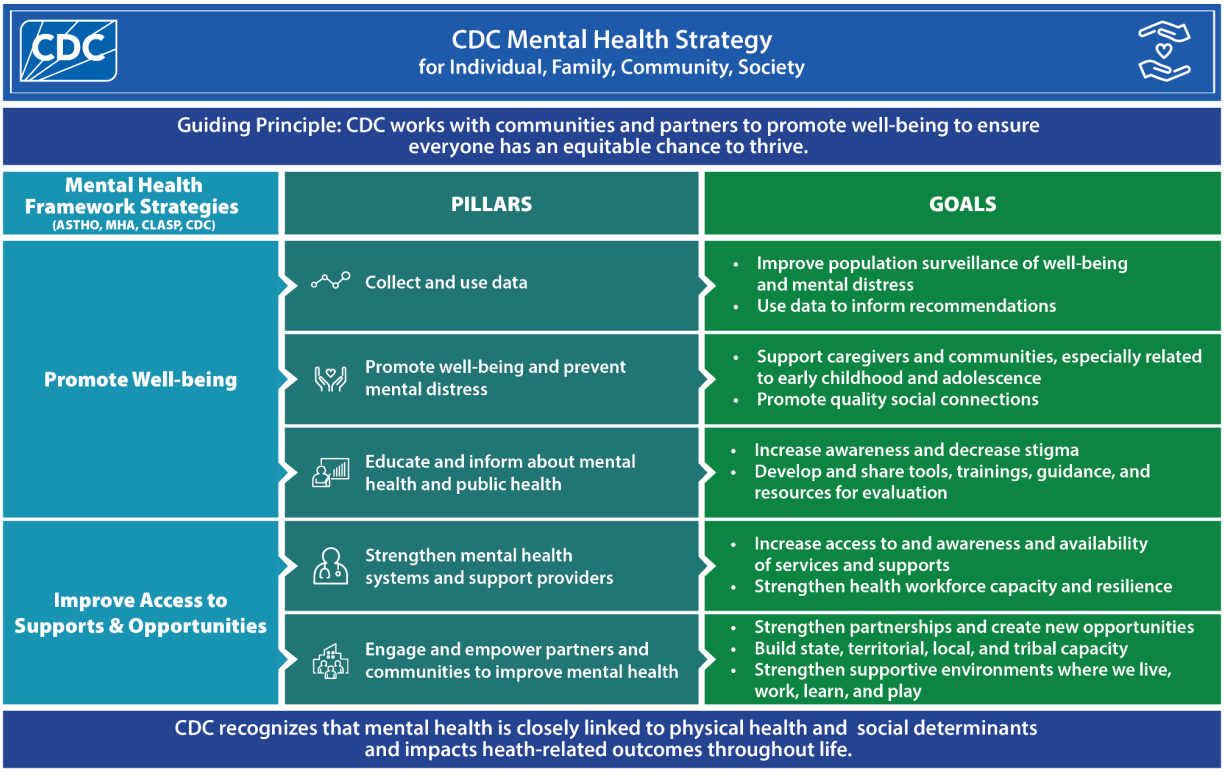
7.1 Alignment with National Health Priorities

Over the past two decades, mental health has emerged as an area of sustained bipartisan attention in U.S. health policy, driven by growing recognition of its impact on public health, workforce participation, education, and public safety. Lawmakers from both major political parties have supported expanded federal investment in mental health services, research, and workforce development, reflected in legislation addressing parity, crisis response, and access to care across the lifespan (Barry & Huskamp, 2011; Frank et al., 2014; Mechanic, 2014). As previously mentioned, vector-borne illness receives broad bipartisan support, reflected in various national strategies from federal health agencies.

7.2 CDC: Alignment with the CDC Mental Health Strategy

Increased federal attention and funding toward IANC aligns closely with the priorities outlined in the Centers for Disease Control and Prevention Mental Health Strategy (Figure 7), particularly in areas related to surveillance, access to care, workforce capacity, and public awareness.

Figure 7: CDC Mental Health Strategy. https://www.cdc.gov/mental-health/about/what-cdc-is-doing.html



Seen through the IANC lens, there are clear gaps that targeted investment could help address. The CDC's focus on improving data collection is especially relevant, given the lack of standardized case definitions, limited epidemiological data, and no IANC-specific coding—all of which make surveillance and evidence-based decision-making challenging. Efforts to promote well-being and prevent mental distress also line up with what patients and caregivers are experiencing, including social isolation, disruption in school and daily life, and limited support systems. The emphasis on education and stigma reduction reflects that IANC are still not well understood by many clinicians or the public, and stigma continues to affect diagnosis, care, and institutional response. Strengthening mental health systems and workforce capacity speaks to the reality that patients often wait months or years to access appropriate, multidisciplinary care. There is also a clear need for stronger partnerships—across psychiatry, infectious disease, neurology, and rheumatology—and more capacity at the state, territorial, and tribal levels. Taken together, increasing research, funding, and policy attention for IANC would directly support the goals of the CDC's Mental Health Strategy.

7.3 NIH: Alignment with the NIH Strategic Plan

In 2019, the NIH published the NIH Strategic Plan for Tickborne Disease Research (NIH, 2019). The strategy outlines 5 major initiatives:

- Improve fundamental knowledge of tickborne disease
- Advance research to improve the diagnosis of tickborne diseases
- Accelerate research to improve the prevention of tickborne diseases
- Promote research to improve treatment for all forms of tickborne diseases
- Support tools and research resources to advance understanding, prevention, diagnosis, and treatment of tickborne diseases

This strategic plan serves as a blueprint for areas of research needed to address the tickborne disease public health crisis. By acknowledging that symptoms of tickborne diseases can include neurological and neuropsychiatric symptoms, among others, this blueprint shows a clear alignment with increased focus on and funding toward IANC.

7.4 HHS: Alignment with National Vector-Borne Disease Strategy

In 2024, the U.S. Department of Health and Human Services published the National Public Health Strategy to Prevent and Control Vector-Borne Diseases in People (VBD National Strategy). A collaboration of 17 federal departments and agencies developed this interagency plan to combat vector-borne diseases. While comprehensive and aligned with the idea of IANC, the strategy document does not address neuropsychological symptoms for chronic illnesses caused by VBD.

8. Major Research Gaps

Through literature review and with the assistance of the jointly-convened Center for Lyme Action and NAPPA IANC Scientific Advisory Board, several research gaps were identified. These gaps directly inform and shape policy recommendations for policymakers and government employees outlined in Section 9.

All IANC

- Longitudinal studies incorporating infectious, immune, and psychiatric measures are needed to assess long-term outcomes and treatment efficacy
- Uniform case definitions are needed for all age groups, particularly for surveillance purposes
- Diagnostics often rely primarily on serum testing, without systematically incorporating clinical assessment, imaging, or functional measures (Bransfield et al., 2023)
- Experiences of medical dismissal or "medical gaslighting" may exacerbate some neuropsychiatric symptoms (Davis, 2022)
- Diagnostic protocols could benefit from the discovery and validation of additional biomarkers (Garg et al., 2025; Marques, 2024; NASEM, 2025; Prato et al., 2021; AAP, 2025)
- Underrepresented populations, specifically rural residents, are not always included in research due to their distance from major research centers
- Few mechanistic studies have been conducted to clearly understand the immune response that triggers these conditions and the varying timeframes between active infection and neuropsychiatric symptom onset (Arcilla et al., 2025)

Lyme IANC

- There are few validated diagnostic tests or treatments for Lyme-IANC and Lyme-IACI (NASEM, 2025)
- There are few effective, evidence-based treatments for Lyme-IACI (NASEM, 2025)
- While emerging evidence is beginning to explain underlying mechanisms, additional research is needed to further uncover the pathophysiology of Lyme-IANC (Brackett et al., 2024)

Bartonellosis and Neurobartonellosis

- Understanding of how Bartonella infection leads to neuropsychiatric symptoms remains limited
- Bartonella infections often evade standard diagnostics, supporting the need for additional diagnostic tools (Ericson et al., 2024)

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

- Epidemiological data for bartonellosis and neurobartonellosis are almost nonexistent (McCormick et al., 2023)
- Bartonella infection is infrequently considered in the differential diagnosis for neurological and psychiatric illness (Bush et al., 2024)

PANS and PANDAS

- Very few randomized clinical trials evaluating treatments for PANS and PANDAS have been conducted (Matera et al., 2025; Sigra et al., 2018; Frankovich et al., 2017)
- Lack of validated diagnostic biomarkers capable of identifying many infection-triggered neuroimmune disorders (Swedo et al., 2012; Cunningham, 2019; Frankovich et al., 2017)
- Limited understanding of immune mechanisms linking infection, autoantibodies, neuroinflammation, and abrupt psychiatric symptom onset (Chang et al., 2015; Swedo et al., 2012; Williams & Swedo, 2015)
- Absence of large longitudinal cohort studies tracking patients with PANS/PANDAS across the lifespan (Sigra et al., 2018; Johnson et al., 2019)
- Few randomized controlled trials evaluating antimicrobial, immunomodulatory, or neuroimmune therapies (Sigra et al., 2018; Thienemann et al., 2017)
- Limited data on the role of co-infections, including Lyme disease, Bartonella, Mycoplasma, influenza, and viral pathogens in triggering PANS (Swedo et al., 2012; Breitschwerdt et al., 2019; Chang et al., 2015)
- Lack of standardized clinical protocols for evaluation, diagnosis, and treatment across specialties (Thienemann et al., 2017; Frankovich et al., 2017)
- Limited integration of psychiatric, infectious disease, and immunology expertise in clinical research studies (Frankovich et al., 2015; Williams & Swedo, 2015)
- Limited epidemiological data estimating national prevalence and incidence of PANS/PANDAS (Sigra et al., 2018; Gromark et al., 2019)
- Lack of national registries or biobanks to support translational research (Frankovich et al., 2015; Johnson et al., 2019)

Researchers have many open systemic, mechanistic, and clinical questions about IANC. Systemic barriers constrain research infrastructure and clarity while mechanistic gaps prevent biological precision. Clinical gaps impede translation into consistent, evidence-based care. A more comprehensive list of research gaps can be found in Appendix E.

9. Policy Recommendations

Table 3: IANC Federal Policy Recommendations

1. Systemic Recommendations	
1.1 Integrate IANC into the National Public Health Strategy for Vector-Borne Diseases	CDC, OASH
1.2 Establish standardized IANC case definitions for both pediatric and adult populations	CDC, CMS, HRSA, NIH, SAMHSA
1.3 Implement national IANC surveillance through CDC using serologic, direct detection, and clinical evaluation data	CDC, CMS, DoD, HRSA, VA
2. Research Funding Recommendations	
2.1 Support large retrospective studies to assess infectious contributors to treatment-resistant mental illness	NIH, SAMHSA, VA
2.2 Fund biomarker discovery and validation for IANC diagnosis and stratification	CDMRP, FDA, NIH
2.3 Invest in clinical trials evaluating treatments for IANC, including Lyme, Bartonella, PANS / PANDAS.	CDMRP, NIH, PCORI
2.4 Fund biobanks collecting specimens from individuals with vector-borne disease, IACI, and IANC	DoD, NIH, VA
2.5 Expand federally funded research on bartonellosis as an underrecognized multisystem condition	CDC, NIH, USDA
2.6 Support mechanistic studies examining immune, inflammatory, and neurobiological pathways in IANC	CDMRP, NIH
2.7 Fund economic and health system impact studies assessing IANC-related costs to families and governments	AHRQ, CDMRP, CMS, NIH, HRSA
2.8 Establish a federally supported working group for PANS/PANDAS	NIH, CDC, HRSA
3. Clinical Care Recommendations	
3.1 Develop and fund multidisciplinary care models for IANC evaluation and treatment	AHRQ, CMS, HRSA, NIH
3.2 Support prospective, evidence-generating treatment studies in real-world clinical settings	CMS, HRSA, NIH, PCROI
3.3 Expand clinician education and continuing medical education (CME) on IANC recognition and evaluation	CDC, HRSA, SAMHSA
3.4 Support integrated screening protocols for abrupt or treatment-resistant psychiatric presentations	CDC, CMS, SAMHSA

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

10. Conclusion & Call to Action

The convergence of infectious disease, immunology, and psychiatry is no longer theoretical. A growing body of evidence demonstrates that infection-associated immune processes can contribute to neuropsychiatric illness in many Americans. Yet federal surveillance, funding, and clinical infrastructure have not followed.

Failure to address these gaps risks continued diagnostic delays, fragmented care, avoidable disability, educational disruptions, and unnecessary economic burden. Alternatively, federal investment in research, standardized definitions, and multidisciplinary care models could define prevalence, clarify mechanisms, improve treatment precision, and strengthen the nation's public health response.

With strategic, evidence-driven action, we call upon federal policymakers to prioritize IANC, increase federal funding, and grow programs to improve outcomes for patients and families across the United States.

- Team recommendation

The opportunity before policymakers is timely and essential. Intentional focus and funding for IANC is fully aligned with all existing federal mental health, infectious disease, and vector-borne strategies. Measurable research gaps can be closed through targeted investments in surveillance, case definitions, diagnostics, and interdisciplinary clinical models. With strategic, evidence-driven action, we call upon federal policymakers to prioritize IANC, increase federal funding, and grow programs to improve outcomes for patients and families across the United States.

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

About the Author

Eric D. Johnson, MPH, is a public health professional who has worked extensively in rural health systems strengthening, lupus self-management and patient engagement, HIV prevention and policy, and Native American health workforce development. Through his consulting work, he has partnered with organizations including the American Indian Higher Education Consortium, the Lupus Foundation of America, and REDi Health Analytics to support research training initiatives, chronic disease education efforts, and data-driven health improvement strategies. He earned his MPH from the University of North Carolina at Chapel Hill and is a Fellow of the Morehouse School of Medicine's Satcher Health Leadership Institute.

Acknowledgement

Center for Lyme Action is grateful to the Driscoll Family Foundation for its financial support of this paper. This publication was developed through a collaboration between the Center for Lyme Action, the National Alliance for PANS/PANDAS Action, and a number of experts forming a Scientific Advisory Board. We express deep appreciation to Robert C. Bransfield, MD, DLFAPA, DILADS; Edward B. Breitschwerdt, DVM, Melanie S. Steele Professor of Medicine and Infectious Disease Intracellular Pathogens Research Laboratory College of Veterinary Medicine; Shannon Delaney, MD; Amanda Elam, PhD, Cofounder/Director Galaxy Diagnostics Inc.; Charlotte Mao, MD MPH, Bay Area Lyme Foundation, advisory board and science committee member; David Putrino, PhD, Professor, Department of Rehabilitation and Human Performance, Icahn School of Medicine at Mount Sinai; Angela Tang, MD FACP Scientific Advisor, Brain Inflammation Collaborative; Bruce Patterson, MD, HealthBio, Inc.

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

References

Abramson, B., Boerma, J., & Tsyvinski, A. (2024). *Macroeconomics of mental health* (No. w32354). National Bureau of Economic Research.

Aman M, Coelho JS, Lin B, et al. Prevalence of pediatric acute-onset neuropsychiatric syndrome (PANS) in children and adolescents with eating disorders. *J Eat Disord.* 2022;10(1):194.

American Academy of Neurology. (2013). *Neurology workforce report*. https://www.aan.com

American Board of Medical Specialties. (2023). *Certification statistics*. https://www.abms.org

American College of Rheumatology. (2021). *Rheumatology workforce study*. https://www.rheumatology.org

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.).

American Psychiatric Association. (2023). *Mental health workforce shortages: Trends and projections*. https://www.psychiatry.org

Arcilla, C. K., & Singla, R. (2025). Pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections (PANDAS). *StatPearls*. https://www.ncbi.nlm.nih.gov/books/NBK606088/

Armed Forces Health Surveillance Branch. (n.d.). *Data on tick-borne disease surveillance in military populations*. U.S. Department of Defense.

Aucott, J. N., Rebman, A. W., Crowder, L. A., & Kortte, K. B. (2013). Post-treatment Lyme disease syndrome symptomatology and the impact on life functioning. *Quality of Life Research, 22*(1), 75–84.

Bakewell, F. (2025). Medical silos, social identity, and duty of care. *Healthcare Management Forum, 38*(2), 148–151.

Barry, C. L., & Huskamp, H. A. (2011). Moving beyond parity. *New England Journal of Medicine, 365*(11), 973–975.

Barry, R., et al. (2024). Prevalence of mental health disorders among individuals experiencing homelessness. *JAMA Psychiatry, 81*(7), 691–699.

Bataller, L., et al. (2024). Genetic susceptibility in post-infectious neuroimmune syndromes. *Frontiers in Immunology, 15*, 1342291.

Berrich, M., Kieda, C., Grillon, C., Monteil, M., Lamerant, N., Gavard, J., ... & Haddad, N. (2011). Differential effects of Bartonella henselae on human and feline macro-and micro-vascular endothelial cells. *PLoS One*, 6(5), e20204.

Brackett, M., Potts, J., Meihofer, A., Indorewala, Y., Ali, A., Lutes, S., Putnam, E., Schuelke, S., Abdool, A., Woldenberg, E., & Jacobs, R. J. (2024). Neuropsychiatric Manifestations and Cognitive Decline in Patients With Long-Standing Lyme Disease: A Scoping Review. *Cureus*, 16(4), e58308

Bransfield, R. C. (2018). Aggressiveness, violence, homicidality, homicide, and Lyme disease. *Neuropsychiatric Disease and Treatment, 14*, 693–713.

Bransfield, R. C., Mao, C., & Greenberg, R. (2023). Microbes and mental illness. *Healthcare, 12*(1), 83.

Breitschwerdt, E. B., et al. (2005). Bartonella-associated neuropsychiatric disease. *Journal of Neuroparasitology, 1*, 1–9.

Breitschwerdt, E. B., Mozayeni, B. R., & Bradley, J. M. (2020). Bartonella infections: Advances in diagnosis and treatment. *Current Infectious Disease Reports*, 22(7), 1–12.

Breitschwerdt, E. B., Maggi, R. G., Nicholson, W. L., Cherry, N. A., & Woods, C. W. (2012). Bartonella sp. bacteremia in patients with neurological and neurocognitive dysfunction. *Journal of Clinical Microbiology*, 50(9), 2856–2861.

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

Breitschwerdt, E. B., Maggi, R. G., & Kempf, V. A. J. (2019). Bartonellosis: One Health perspectives. *ILAR Journal, 60*(2), 150–162.

Breitschwerdt, E. B., Robbeille, C., Maggi, R. et al. (2026). Postmortem evidence of Babesia and Bartonella infections in chronically ill suicidal young people. *Parasites & Vectors.*

Breitschwerdt, E. B., et al. (2025). Bartonella infection in neuropsychiatric disease. *Parasites & Vectors, 18*, Article 23.

Brownstein, J. S., et al. (2005). Forest fragmentation predicts Lyme disease risk. *Oecologia, 146*(3), 469–475.

Burgdorfer, W., et al. (1982). Lyme disease—A tick-borne spirochetosis? *Science, 216*, 1317–1319.

Bush, L. M., et al. (2024). Neurobartonelloses. *Parasites & Vectors, 17*, 112.

Cabrera, B., Romero-Rebollar, C., Jiménez-Ángeles, L., Genis-Mendoza, A. D., Flores, J., Lanzagorta, N., Arroyo, M., de la Fuente-Sandoval, C., Santana, D., Medina-Bañuelos, V., Sacristán, E., & Nicolini, H. (2019). Neuroanatomical features and its usefulness in classification of patients with PANDAS. *CNS spectrums*, 24(5), 533–543.

Calaprice-Whitty, D., Tang, A., & Tona, J. (2023). Factors Associated with Symptom Persistence in PANS: Part I-Access to Care. *Journal of child and adolescent psychopharmacology,* 33(9), 356–364.

Cameron, D. J. (2026). *Medical dismissal and Lyme disease*. https://danielcameronmd.com

Carithers, H.A. (1985) Cat-Scratch Disease. *American Journal of Diseases of Children,* 139, 1124-1133.

Centers for Disease Control and Prevention. (2024). *Signs and symptoms of untreated Lyme disease*. https://www.cdc.gov/lyme/signs-symptoms

Centers for Disease Control and Prevention. (2025). *Lyme disease surveillance and data*. https://www.cdc.gov/lyme

Center for Lyme Action. (2026). *Lyme advocates increase federal funding for Lyme and tickborne conditions by $405M*. https://centerforlymeaction.org/lyme-advocates-increase-federal-funding-for-lyme-and-tickborne-conditions-by-405m/

Chain, J.L., Alvarez, K., Mascaro-Blanco, A., Reim, S., Bentley, R., Hommer, R., Grant, P., Leckman, J.F., Kawikova, I., Williams, K., Stoner, J.A., Swedo, S.E., Cunningham, M.W. (2020). Autoantibody Biomarkers for Basal Ganglia Encephalitis in Sydenham Chorea and Pediatric Autoimmune Neuropsychiatric Disorder Associated With Streptococcal Infections. Frontiers in Psychiatry 11:564.

Chan, L., Hart, L. G., & Goodman, D. C. (2006). Geographic access to health care. *Journal of Rural Health, 22*(2), 140–146.

Chang, K., Frankovich, J., Cooperstock, M., Cunningham, M. W., Latimer, M. E., Murphy, T. K., Pasternack, M., Thienemann, M., Williams, K., Walter, J., Swedo, S. E., & PANS Collaborative Consortium. (2015). Clinical evaluation of youth with pediatric acute-onset neuropsychiatric syndrome (PANS): recommendations from the 2013 PANS Consensus Conference. *Journal of child and adolescent psychopharmacology,* 25(1), 3–13.

Cheslock, M. A., & Embers, M. E. (2019). Human bartonellosis. *Tropical Medicine and Infectious Disease, 4*(2), 69.

Chomel, B. B., & Sun, B. (2011). Zoonotic Bartonella infections. *Clinical Microbiology Reviews, 24*(4), 785–806.

Clarke, J. D., et al. (2022). Host genetics and Lyme persistence. *Frontiers in Cellular and Infection Microbiology, 12*, 913442.

Cleveland Clinic. (2025). *Bartonellosis*. https://my.clevelandclinic.org

Columbia Business School. (n.d.). *The economic impact of mental illness*. https://business.columbia.edu/research-brief/economic-impact-mental-illness

Columbia University Irving Medical Center. (n.d.). *Columbia Lyme and tick-borne diseases research center*. https://www.columbia-lyme.org/

Cooperstock, M. S., Swedo, S. E., Pasternack, M. S., & Murphy, T. K. (2017). Clinical Management of Pediatric Acute-Onset Neuropsychiatric Syndrome: Part III-Treatment and Prevention of Infections. *Journal of child and adolescent psychopharmacology*, *27*(7), 594–606.

Cox, C. J., Zuccolo, A. J., Edwards, E. V., Mascaro-Blanco, A., Alvarez, K., Stoner, J., Chang, K., & Cunningham, M. W. (2015). Antineuronal antibodies in a heterogeneous group of youth and young adults with tics and obsessive-compulsive disorder. *Journal of child and adolescent psychopharmacology*, 25(1), 76–85.

Cunningham, M. W. (2019). Molecular mimicry, autoimmunity, and infection: The cross-reactive antigens of group A streptococci and their sequelae. *Microbiology Spectrum*, 7(4), 1–18.

Cunningham, M. W. (2016). Streptococcus and autoimmune disease. *Clinical Microbiology Reviews, 29*(2), 264–302.

Cunningham, J. L., Frankovich, J., Dubin, R. A., Pedrosa, E., Nur Baykara, R., Schlenk, N. C., Maqbool, S. B., Dolstra, H., Marino, J., Edinger, J., Shea, J. M., Laje, G., Swagemakers, S. M., Sinnadurai, S., Zhang, Z. D., Lin, J. R., Van Der Spek, P. J., Lachman, H. M. (2025). Ultrarare Variants in DNA Damage Repair and Mitochondrial Genes in Pediatric Acute-Onset Neuropsychiatric Syndrome and Acute Behavioral Regression in Neurodevelopmental Disorders. *Developmental neuroscience*, 1–19. Advance online publication.

Cutforth, T., DeMille, M. M.., Agalliu, I., Agalliu, D. (2016). CNS Autoimmune Disease after Streptococcus Pyogenes Infections: Animal Models, Cellular Mechanisms and Genetic Factors. *Future Neurology* 11(1), 63–76.

Davis, S. J. (2022). The enormous problem of medical gaslighting. *MOJ Addict Med Ther.* 7(1):4-5.

Dehio, C. (2001). Bartonella interactions with endothelial cells and erythrocytes. *Trends in microbiology*, 9(6), 279-285.

Delaney, S., et al. (2024). Bartonella bacteremia and psychosis. *Frontiers in Psychiatry, 15*, 1388442.

Demchick, B. B., et al. (2019). Family quality of life in PANDAS. *Journal of Occupational Therapy, Schools, & Early Intervention, 12*(2), 182–199.

Deninger, M., & O'Donnell, R. (2009). *Special education placement and costs*. Massachusetts DOE.

Department of Defense. (2019). *Tick-borne disease research program*. Congressionally Directed Medical Research Programs. https://cdmrp.army.mil/tbdrp/pbbks/tbdrp_programhighlight2019.pdf

Dileepan, T., et al. (2016). Group A Streptococcus intranasal infection promotes CNS infiltration by streptococcal-specific Th17 cells. The Journal of clinical investigation, 126(1), 303–317.

Diliberti, M. K., Chu, L., Rainey, L. R., DiNicola, S. E., Lake, R. J., & Schwartz, H. L. (2025). Chronic absenteeism still a struggle in 2024–2025: Selected findings from the American School District Panel and the American Youth Panel (Report No. RR-A956-34). *RAND Corporation.*

Doran, P. R. (2015). Sudden Behavioral Changes in the Classroom: What Educators Need to Know about PANDAS and PANS. *Beyond Behavior*, 24(1), 31-37.

Embers, M. E., Barthold, S. W., Borda, J. T., Bowers, L., Doyle, L., Hodzic, E., Jacobs, M. B., Hasenkampf, N. R., Martin, D. S., Narasimhan, S., Phillippi-Falkenstein, K. M., Purcell, J. E., Ratterree, M. S., & Philipp, M. T. (2012). Persistence of Borrelia burgdorferi in rhesus macaques following antibiotic treatment of disseminated infection. *PloS one*, 7(1), e29914.

Endres, D., et al. (2022). Immunological causes of obsessive-compulsive disorder. *Translational Psychiatry*.

Ericson, M. E., Mozayeni, B. R., Radovsky, L., & Bemis, L. T. (2024). Bartonella- and Borrelia-related neurologic disease. *Microorganisms*, 12(1), 209.

Fallon, B. A., & Nields, J. A. (1994). Lyme disease: A neuropsychiatric illness. *American Journal of Psychiatry, 151*(11), 1571–1583.

Fallon, B. A., Keilp, J. G., Prohovnik, I., Heertum, R. V., & Mann, J. J. (2008). Regional cerebral blood flow and cognitive deficits in chronic Lyme disease. *Journal of Neuropsychiatry and Clinical Neurosciences*, 20(3), 326–332.

Fallon, B. A., Kochevar, J. M., Gaito, A., & Nields, J. A. (1998). The underdiagnosis of neuropsychiatric Lyme disease. *Psychiatric Clinics of North America, 21*(3), 693–viii.

Fallon, B. A., et al. (2021). Lyme borreliosis and psychiatric outcomes. *American Journal of Psychiatry, 178*(10), 921–931.

Ford, A. C., et al. (2006). Helicobacter pylori eradication therapy. *BMJ, 332*, 1164–1168.

Foster, A., Cushing, A., Hoffmann, J., Nash, K., Lee, C., Michelson, K. (2026). Expenditures for Pediatric Behavioral Health Care Over Time and Estimated Family Financial Burden. *JAMA Pediatr*., 180(2):194–201.

Frank, R. G., et al. (2014). Mental health policy and politics. *Health Affairs, 33*(1), 22–28.

Frankovich, J., Swedo, S., Murphy, T., Dale, R. C., Agalliu, D., Williams, K., ... & PANS/PANDAS Consortium. (2017). Clinical management of pediatric acute-onset neuropsychiatric syndrome: part II—use of immunomodulatory therapies. *Journal of child and adolescent psychopharmacology*, 27(7), 574-593.

Frankovich, J., Leibold, C. M., Farmer, C., et al. (2018). The Burden of Caring for a Child or Adolescent With Pediatric Acute-Onset Neuropsychiatric Syndrome (PANS): An Observational Longitudinal Study. *The Journal of clinical psychiatry,* 80(1), 17m12091.

Frick, L. R., Rapanelli, M., Jindachomthong, K., Grant, P., Leckman, J. F., Swedo, S., Williams, K., & Pittenger, C. (2018). Differential binding of antibodies in PANDAS patients to cholinergic interneurons in the striatum. *Brain, behavior, and immunity,* 69, 304–311.

Gagliano, A., Galati, C., Ingrassia, M., et al. (2020). Pediatric acute-onset neuropsychiatric syndrome. *Journal of Child and Adolescent Psychopharmacology, 30*(8), 495–511.

Gagliano, A., Carta, A., Tanca, M. G., & Sotgiu, S. (2023). Pediatric acute-onset neuropsychiatric syndrome. *Neuropsychiatric Disease and Treatment, 19*, 1221–1250.

Garg, K., et al. (2025). Lyme disease diagnostic challenges. *Integrative Medicine, 24*(3), 10–27.

Giedd, J. N., Rapoport, J. L., Garvey, M. A., Perlmutter, S., & Swedo, S. E. (2000). MRI assessment of children with obsessive-compulsive disorder or tics associated with streptococcal infection. *American Journal of Psychiatry*, 157(2), 281–283.

Global Alliance for Vaccines and Immunization (n.d.). *When infection sparks obsession: PANDAS and PANS*. https://www.gavi.org/vaccineswork/when-infection-sparks-obsession-pandas-and-pans

Goren, R., et al. (2024). Frequency and impact of paediatric acute-onset neuropsychiatric syndrome (PANS/PANDAS) in Canada. *Paediatr Child Health.* 30(3):157-163.

Gould, L. H., Fee, R., White, J., et al. (2025). Risk factors for Lyme disease in the United States. *American Journal of Epidemiology, 194*(8), 2287–2294.

Grandinetti, R., et al. (2024). PANS/PANDAS consensus document. *Frontiers in Immunology, 15*, 1420663.

Greenberg R. (2025). Investigating the frequency of tick-borne infections in a case series of 37 youth diagnosed with pediatric bipolar disorder. F*rontiers in child and adolescent psychiatry*, 4, 1685016.

Gregory, C. J., Okaro, J. O., Reingold, A., et al. (2025). Invasive group A streptococcal infections in 10 U.S. states. *JAMA, 333*(17), 1498–1507.

Gromark, C., Hesselmark, E., Djupedal, I. G., Silverberg, M., Horne, A., Harris, R. A., Serlachius, E., & Mataix-Cols, D. (2022). A Two-to-Five Year Follow-Up of a Pediatric Acute-Onset Neuropsychiatric Syndrome Cohort. *Child psychiatry and human development*, 53(2), 354–364.

Halperin, J. J. (2014). Nervous system Lyme disease: Diagnosis and treatment. *Clinical Infectious Diseases*, 58(9), 1267–1272.

Han, V. X., Alshammery, S., Keating, B. A., Gloss, B. S., Hofer, M. J., Graham, M. E., ... & Dale, R. C. (2025). Epigenetic, ribosomal, and immune dysregulation in paediatric acute-onset neuropsychiatric syndrome. *Molecular Psychiatry*, 30(11), 5389-5404.

Haridass, D. (2025). *PANDAS diagnosis and management*. Rheumatology Advisor.

Health Resources and Services Administration. (2016). *Behavioral health workforce projections*.

Heylen, D., et al. (2019). Urban tick ecology. *Science of the Total Environment, 670*, 941–949.

Hirsch, A. G., et al. (2020). Lyme treatment delays. *Frontiers in Medicine, 7*, 560018.

Hodzic, E., Feng, S., Holden, K., Freet, K. J., & Barthold, S. W. (2008). Persistence of Borrelia burgdorferi following antibiotic treatment in mice. *Antimicrobial agents and chemotherapy*, 52(5), 1728–1736.

Institute of Medicine. (1989). A national network of cancer centers.

Jaspers-Fayer F, Han SHJ, Chan E, et al. Prevalence of Acute-Onset Subtypes in Pediatric Obsessive-Compulsive Disorder. *J Child Adolesc Psychopharmacol*. 2017;27(4):332-341.

Johns Hopkins University. (n.d.). Lyme Disease Research Center and Clinical Care Program. https://secure.jhu.edu/form/LymeDisease

Johnson, L. B., & Maloney, E. L. (2022). Access to care in Lyme disease. *Healthcare, 10*(10), 1882.

Johnson, L., et al. (2014). Chronic Lyme disease severity. *PeerJ, 2*, e322.

Johnson, M., Fernell, E., Preda, I., Wallin, L., Fasth, A., Gillberg, C., & Gillberg, C. (2019). Paediatric acute-onset neuropsychiatric syndrome in children and adolescents: an observational cohort study. *The Lancet. Child & adolescent health,* 3(3), 175–180.

JournalFeed. (2025). PANS/PANDAS AAP report summary.

Kaplan, R. F., et al. (1992). Cognitive dysfunction in Lyme disease. *Neurology, 42*(4), 698–703.

Kapphahn, C., Peet, B., Gao, J., Chan, A., Farhadian, B., Ma, M., Silverman, M., Tran, P., Schlenk, N., Thienemann, M. and Frankovich, J. (2025), Sudden Onset Disordered Eating Behaviors and Appetite Issues in a Local Clinical Cohort of Children With Pediatric Acute-Onset Neuropsychiatric Syndrome (PANS). *Int J Eat Disord*, 58: 1219-1232.

Karaca, Z., & Moore, B. J. (2020). Costs of emergency department visits for mental and substance use disorders in the United States, 2017 (HCUP Statistical Brief No. 257). *Agency for Healthcare Research and Quality.* https://hcup-us.ahrq.gov/reports/statbriefs/sb257-ED-Costs-Mental-Substance-Use-Disorders-2017.jsp

Keilp, J. G., et al. (2006). Neurocognitive performance in Lyme disease. *Psychiatry Research, 144*, 1–10.

Kempf, V. A. J., Volkmann, B., Schaller, M., Sander, C. A., Alitalo, K., Riess, T., & Autenrieth, I. B. (2001). Evidence of a leading role for VEGF in Bartonella henselae–induced endothelial cell proliferations. *Cellular Microbiology*, 3(9), 623–632.

Kohler, J. (1990). Lyme borreliosis in neurology and psychiatry. *Fortschritte der Medizin*, 108 10, 191-3, 197.

Köhler-Forsberg O, N Lydholm C, Hjorthøj C, Nordentoft M, Mors O, Benros ME. (2019). Efficacy of anti-inflammatory treatment on major depressive disorder or depressive symptoms: meta-analysis of clinical trials. *Acta Psychiatr Scand*, 139(5):404-419.

Krupp, L. B., Masur, D., Schwartz, J., Coyle, P. K., Langenbach, L. J., Fernquist, S. K., Jandorf, L., & Halperin, J. J. (1991). Cognitive functioning in late Lyme borreliosis. *Archives of neurology*, 48(11), 1125–1129.

Kyle, R. A., et al. (2016). Discovery of Helicobacter pylori. *Mayo Clinic Proceedings, 91*(5), e67–e68.

Lanska, D. J. (2010). Neurosyphilis history. *Journal of the History of the Neurosciences, 19*(4), 333–346.

Lantos, P. M., et al. (2014). Cat scratch disease. *Clinical Infectious Diseases, 58*(9), e87–e91.

LaRusso, M. D., & Abadía-Barrero, C. (2024). Developmental impacts of PANS/PANDAS and inadequate support for children and families. *Child Psychiatry & Human Development*, 1-11.

Lashnits, E., et al. (2021). Bartonella and schizophrenia. *Vector-Borne and Zoonotic Diseases, 21*(6), 413–421.

Leonardi, L., et al. (2024). PANS immunological features. *Children, 11*(9), 1043.

Lichty, J. A. (1941). Rheumatic fever. *American Journal of Diseases of Children, 62*, 92–100.

Ljøstad, U., Skarpaas, T., & Mygland, Å. (2008). Clinical usefulness of cerebrospinal fluid CXCL13 in the diagnosis of acute Lyme neuroborreliosis. *Journal of Neurology*, 255(10), 1497–1503.

Locke, S., et al. (2023). Babesiosis neurologic complications. *Emerging Infectious Diseases, 29*(6), 1127–1135.

Louisa Adelynn Johnson Fund for Complex Disease. (2026). State public policy: PANS and PANDAS.

Louveau, A., Smirnov, I., Keyes, T., et al. (2015). CNS lymphatic vessels. *Nature, 523*, 337–341.

LymeDisease.org. (2026). *Inside 2026 virtual advocacy day*. https://www.lymedisease.org/inside-2026-virtual-advocacy-day/

Ma, M., Masterson, E. E., Gao, J., et al. (2024). Development of Autoimmune Diseases Among Children With Pediatric Acute-Onset Neuropsychiatric Syndrome. *JAMA Netw Open.* 7(7)

Maggi, R. G., Mozayeni, B. R., Pultorak, E. L., Hegarty, B. C., Bradley, J. M., Correa, M., & Breitschwerdt, E. B. (2012). Bartonella spp. bacteremia and rheumatic symptoms in patients from Lyme disease-endemic region. *Emerging infectious diseases,* 18(5), 783–791.

Mandated Health Benefits Advisory Commission. (2026). *A study of New Jersey Senate Bill 598: Requires health insurance coverage for certain neurological diseases.* New Jersey Department of Banking and Insurance. https://www.nj.gov/dobi/division_insurance/mhbac/S598.pdf

Manvell, C., Ferris, K., Maggi, R., Breitschwerdt, E. B., & Lashnits, E. (2021). Prevalence of Vector-Borne Pathogens in Reproductive and Non-Reproductive Tissue Samples from Free-Roaming Domestic Cats in the South Atlantic USA. *Pathogens (Basel, Switzerland)*, 10(9), 1221.

Marques, A. (2024). Lyme disease symptoms. *Science Translational Medicine, 16*, eado2103.

Marra, C. M. (1995). Neurologic complications of Bartonella henselae infection. *Current Opinion in Neurology, 8*(3), 164–169.

Masterson, E. E., & Gavin, J. M. (2024). Baseline characteristics of children in the PANS registry. *BMJ Open, 14*(1), e072743.

Matera, M,. Biagioli, V,. Illiceto, MT,. et al. (2025). Pediatric acute-onset neuropsychiatric syndromes and the gut-oral-brain axis: a narrative review of emerging microbiome-immune interactions and therapeutic perspectives. *Front. Immunol.* 16:1726630.

McCormick, D. W., et al. (2023). Bartonella infections in the United States. Emerging Infectious Diseases, 29(3), 467–475.

Mead, P.S. (2015) Epidemiology of Lyme Disease. *Infectious Disease Clinics of North America*, 29, 187-210.

Mechanic, D. (2014). Behavioral health care gaps. *Health Affairs, 33*(8), 1416–1424.

Mount Sinai Health System. (2024). *Mount Sinai opens center for complex conditions including Lyme disease and long COVID*. https://www.mountsinai.org/about/newsroom/2024/mount-sinai-opens-state-of-the-art-center-for-patients-with-complex-conditions-including-lyme-disease-and-long-covid

National Academies of Sciences, Engineering, and Medicine. (2025). *Lyme chronic illness report*.

National Institute of Mental Health. (2025). *PANS and PANDAS: Questions and answers*. https://www.nimh.nih.gov/health/publications/pandas

National Institutes of Health. (2019). *RCDC funding estimates*. https://report.nih.gov

National Institutes of Health RePORTER. (n.d.). https://reporter.nih.gov

National Resident Matching Program. (2025). *Results and data*.

Nuttall, P. A. (2022). Climate change and ticks. *Biologia, 77*, 1503–1512.

O'Dor, S. L., et al. (2022). PANS treatment barriers. *Journal of Child and Adolescent Psychopharmacology, 32*, 476–487.

Office of the Assistant Secretary for Health. (2023). Kay Hagan Tick Act implementation.

Ogden, N. H., et al. (2021). Climate change and ixodid ticks. *Journal of Medical Entomology*, 58(4), 1536–1545.

Ogrzewalska, M., et al. (2011). Tick ecology. *EcoHealth, 8*(3), 320–331.

Orlovska, S., et al. (2017). Infection and mental disorders. *JAMA Psychiatry, 74*(7), 740–746.

Pachner, A. R. (1988). Neurologic Lyme disease. *Seminars in Neurology, 8*(4), 312–321.

PANS PANDAS UK. (2020). 2020 parents survey. https://74b3576c-2926-474a-b4f3-782e8562d0b8.filesusr.com/ugd/5769d0_e553e22f948b4d9381343beb3466529c.pdf

Penna, P. (2023). Legislative testimony on PANS/PANDAS.

Platt, M. P., Agalliu, D., & Cutforth, T. (2017). Hello from the Other Side: How Autoantibodies Circumvent the Blood-Brain Barrier in Autoimmune Encephalitis. *Frontiers in immunology*, 8, 442.

Platt, M. P., Bolding, K. A., Wayne, C. R., Chaudhry, S., Cutforth, T., Franks, K. M., & Agalliu, D. (2020). Th17 lymphocytes drive vascular and neuronal deficits in a mouse model of postinfectious autoimmune encephalitis. *Proceedings of the National Academy of Sciences of the United States of America,* 117(12), 6708–6716.

Prato, A., Gulisano, M., Scerbo, M., Barone, R., Vicario, C. M., & Rizzo, R. (2021). Diagnostic Approach to Pediatric Autoimmune Neuropsychiatric Disorders Associated With Streptococcal Infections (PANDAS): A Narrative Review of Literature Data. *Frontiers in pediatrics*, 9, 746639.

Project Lyme. (2022). *Lyme legislation review*.

Raoult, D., & Roux, V. (1999). The body louse as a vector of reemerging human diseases. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America*, 29(4), 888–911.

Reik, L., et al. (1979). Neurologic Lyme disease. *Medicine, 58*(4), 281–294.

Rich, S. N., et al. (2024). Zoonotic disease knowledge. *Zoonoses and Public Health, 71*(6), 642–652.

Rupprecht, T. A., Koedel, U., Fingerle, V., & Pfister, H. W. (2008). The pathogenesis of Lyme neuroborreliosis: From infection to inflammation. *Molecular Medicine*, 14(3–4), 205–212.

SAMHSA. (2022). National Survey on Drug Use and Health.

Santoro, J. D., Frankovich, J., & Bhargava, S. (2018). Sleep disturbances in chronic PANS. *Journal of Clinical Sleep Medicine, 14*(7), 1187–1192.

Schaller, J. L., & Stevens, M. R. (2007). Bartonella and psychiatric illness. *Medical Hypotheses, 68*, 449–457.

Senate help Spach, D. H., & Koehler, J. E. (1998). Bartonella infections. *Infectious Disease Clinics of North America, 12*(1), 137–155.

Sigra, S., Hesselmark, E., & Bejerot, S. (2018). Treatment of PANDAS and PANS: a systematic review. *Neuroscience and biobehavioral reviews,* 86, 51–65.

Simon, J. A., Marrotte, R. R., Desrosiers, N., Fiset, J., Gaitan, J., Gonzalez, A., Koffi, J. K., Lapointe, F.-J., Leighton, P. A., Lindsay, L. R., Logan, T., & Millien, V. (2014). Climate change and habitat fragmentation drive the occurrence of Borrelia burgdorferi, the agent of Lyme disease, at the northern limit of its distribution. Evolutionary Applications, 7(7), 750–764.

Steere, A. C., Broderick, T. F., & Malawista, S. E. (1978). Erythema chronicum migrans and Lyme arthritis: epidemiologic evidence for a tick vector. *American journal of epidemiology*, 108(4), 312–321.

Steere A. C. (2024). Lyme Arthritis: A 50-Year Journey. *The Journal of infectious diseases*, *230*(Supplement_1), S1–S10.

Strausz, S., Abner, E., Blacker, G. et al. (2024). SCGB1D2 inhibits growth of Borrelia burgdorferi and affects susceptibility to Lyme disease. *Nat Commun*, 15, 2041.

Sun, Y. Q. et al. (2025). Projecting lyme disease risk in the United States: A machine learning approach integrating environmental, socioeconomic and vector factors. *One health (Amsterdam, Netherlands)*, 21, 101111.

Swedo, S. E., et al. (1998). PANDAS first cases. *American Journal of Psychiatry, 155*, 264–271.

Swedo, S. E., et al. (2012). PANS criteria. *Pediatrics & Therapeutics, 2*, 113.

Swedo, S. E., Frankovich, J., & Murphy, T. K. (2017). PANS treatment. *Journal of Child and Adolescent Psychopharmacology, 27*, 562–565.

Swedo, S. E., Seidlitz, J., Kovacevic, M., Latimer, M. E., Hommer, R., Lougee, L., & Grant, P. (2015). Clinical presentation of pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections in research and community settings. *Journal of child and adolescent psychopharmacology,* 25(1), 26–30.

Swedo, S. E., Leonard, H. L., Garvey, M., Mittleman, B., Allen, A. J., Perlmutter, S., ... Dubbert, B. K. (1998). Pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections. *American Journal of Psychiatry*, 155(2), 264–271.

Tang, A. W., et al. (2021). PANS treatment barriers. *Families, Systems, & Health, 39*, 477–485.

Talbot, B., et al. (2019). Tick density. *Scientific Reports, 9*, 16652.

Thienemann, M., Murphy, T., Leckman, J., Shaw, R., Williams, K., Kapphahn, C., ... Frankovich, J. (2017). Clinical management of pediatric acute-onset neuropsychiatric syndrome: Part I. *Journal of Child and Adolescent Psychopharmacology*, 27(7), 566–573.

Thienemann, M., Park, M., Chan, A., & Frankovich, J. (2021). Medication tolerance in PANS. *Journal of Psychiatric Research, 135*, 270–278.

Tick-Borne Disease Working Group. (2022). *Report to Congress*.

Tona, J., & Posner, T. (2011). Pediatric autoimmune neuropsychiatric disorders. *OT Practice*.

Tona, J. T., Ash, J., Brown, E., et al. (2023). Caregiver burden in PANS. *Journal of Child and Adolescent Psychopharmacology, 33*(9), 378–386.

Touradji, P., et al. (2019). Cognitive Lyme deficits. *Applied Neuropsychology: Adult, 26*, 203–212.

Trifiletti, R. R., et al. (2022). Genetic PANS variants. *Journal of Neuroimmunology, 362*, 577763.

U.S. Senate, Committee on Health, Education, Labor, and Pensions. (2012). Lyme disease: A comprehensive approach to an evolving threat: Field hearing before the Committee on Health, Education, Labor, and Pensions, United States Senate, 112th Cong., 2nd sess. (S. Hrg. 112–632). U.S. Government Printing Office.

Vale, T. C., & Cardoso, F. (2015). Chorea history. *Tremor and Other Hyperkinetic Movements, 5*.

van de Beek, D., Brouwer, M. C., Thwaites, G. E., & Tunkel, A. R. (2016). Advances in treatment of bacterial meningitis. *The Lancet*, 388(10063), 3036–3047.

Vreeland, A., et al. (2023). Postinfectious OCD and PANS/PANDAS. *Developmental Neuroscience, 45*, 361–374.

Vrijmoeth, L., et al. (2024). Lyme genetics. *Frontiers in Genetics, 15*.

Wald, E. R., et al. (2023). PANS incidence. *Frontiers in Pediatrics, 11*.

Walensky, R. P., et al. (2015). Infectious disease workforce. *Clinical Infectious Diseases, 60*, 1824–1829.

Williams, K. A., & Swedo, S. E. (2015). Post-infectious autoimmune disorders: Sydenham's chorea, PANDAS and beyond. *Brain research,* 1617, 144–154.

Worsmer, S., et al. (2007). Lyme misdiagnosis. *Journal of Infection, 54*, 507–514.

Xu, J., et al. (2024). PANS antibodies. *Brain, Behavior, and Immunity, 122*, 241–255.

Yu, H., et al. (2026). Lyme disease costs. *JAMA Network Open, 9*, e2552518.

Zheng, J., et al. (2020). Association of Pediatric Acute-Onset Neuropsychiatric Syndrome With Microstructural Differences in Brain Regions Detected via Diffusion-Weighted Magnetic Resonance Imaging. *JAMA network open*, 3(5), e204063.

APPENDIX

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

Appendix A: Glossary

AAP – American Academy of Pediatrics

Alpha-gal Syndrome – Allergic reaction to red meat triggered by tick bites

Autoantibodies – Immune proteins that mistakenly target the body's own tissues

Autoimmunity – Immune response directed against the body's own cells or organs

Babesia – Tickborne parasite that infects red blood cells

Basal Ganglia – Brain structures involved in movement, behavior, and emotion regulation

Biomarkers – Measurable biological indicators of disease or physiological processes

Borrelia burgdorferi – A bacterium that causes Lyme disease

Bartonella – Genus of bacteria associated with multisystem and neuropsychiatric illness

Bartonellosis – Infection caused by Bartonella species

CaMKII – Calcium/calmodulin-dependent protein kinase II involved in neuronal signaling

CDC – Centers for Disease Control and Prevention

Central Nervous System (CNS) – Brain and spinal cord

CLA – Center for Lyme Action

CME – Continuing medical education

Cohort – A group of individuals followed in a research study over time

Cognitive Impairment – Deficits in memory, attention, or other thinking functions

Complement System – Part of the immune system that enhances pathogen clearance

Cytokines – Signaling proteins that regulate immune and inflammatory responses

Diagnostic Criteria – Standardized set of signs and symptoms used to define a condition

Dopamine Receptor Antibodies – Autoantibodies targeting dopamine signaling pathways

DSM-5-TR – Diagnostic and Statistical Manual of Mental Disorders, 5th Edition, Text Revision

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

EBV (Epstein-Barr Virus) – Common virus associated with infectious and immune-mediated conditions

Encephalitis – Inflammation of the brain

Endothelial Tropism – Tendency of a pathogen to infect blood vessel lining cells

Epidemiology – Study of disease patterns, causes, and distribution in populations

GAS (Group A Streptococcus) – Bacteria associated with PANDAS and other infections

HHS – U.S. Department of Health and Human Services

HRSA – Health Resources and Services Administration

ICD – International Classification of Diseases

Immune Dysregulation – Abnormal or imbalanced immune system activity

Immunocompetent – Having a normally functioning immune system

Inflammation – Biological response to injury or infection involving immune activation

IANC – Infection associated neuropsychiatric condition

IACI – Infection-associated chronic illness

Kynurenine Pathway – Metabolic pathway linked to immune activation and neuroinflammation

Lyme Disease (LD) – Tickborne infection caused by Borrelia burgdorferi

Lyme IACI / PTLD – Chronic or persistent illness following Lyme disease

Microbiome – Community of microorganisms living in the body

Microglial Priming – Heightened reactivity of brain immune cells

Mood Dysregulation – Abnormal or unstable emotional responses

Mycoplasma pneumoniae – Bacteria associated with respiratory and neuropsychiatric illness

NAPPA – National Alliance for PANS/PANDAS Action

NASEM – National Academies of Sciences, Engineering, and Medicine

Neuroinflammation – Inflammatory processes affecting the brain and nervous system

Neuropsychiatric – Relating to both neurological and psychiatric symptoms

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

Neuroretinitis – Inflammation of the retina and optic nerve

NIH – National Institutes of Health

NIMH – National Institute of Mental Health

OCD (Obsessive-Compulsive Disorder) – Condition characterized by intrusive thoughts and repetitive behaviors

Orthostatic Changes – Symptoms related to changes in position (e.g., standing) affecting blood pressure or heart rate

PANDAS – Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections

PANS – Pediatric Acute-onset Neuropsychiatric Syndrome

Pathogenesis – Biological mechanism through which a disease develops

Psychosis – Severe mental disturbance involving loss of contact with reality

SCFAs (Short-Chain Fatty Acids) – Metabolites produced by gut bacteria that influence immune and brain function

Seroprevalence – Level of a pathogen in a population as measured by blood tests

Stigma – Social disapproval associated with a condition or diagnosis

Surveillance – Systematic collection and analysis of health data

Th17 Cells – Immune cells involved in inflammation and autoimmune responses

Tickborne Disease – Illness transmitted through tick vectors

TBDWG – Tick-Borne Disease Working Group

Vector-borne Disease (VBD) – Disease transmitted by organisms such as ticks or mosquitoes

Appendix B: Enacted Tickborne Disease-Related State Legislation

State	Bill or Resolution	Status/Year	Description	Type of Policy
Alabama	Senate Joint Resolution 85	Proclaimed May 2024	Proclaims June 2024 as Tick-borne Disease and Illness Awareness Month	Awareness
California	AB 592	2005: Enacted	Protects doctors who prescribe long-term treatment	Provider protections
California	Assembly Concurrent Resolution No. 42	June 11, 2021: Chaptered by Secretary of State - Res. Chapter 46, Statutes of 2021.	Proclaims May to be the official month of Lyme disease awareness	Awareness
Colorado	Proclamation	Proclaimed May 201	Proclaims May to be the official month of Lyme disease awareness	Awareness
Connecticut	Section 38a-518h	Enacted in 2024	Lyme disease treatment must include a minimum of 30 days of intravenous antibiotics, 60 days of oral antibiotics, or a combination of both, with additional treatment if advised by a rheumatologist, infectious disease specialist, or neurologist.	Treatment
Connecticut	H.B. No. 5629	2015: File Number 456	Proclaim May as Lyme Disease Awareness Month.	Awareness
Delaware	DE General Assembly Lyme Awareness Month Resolution	Designated 2017	Recognize May as the official month of Lyme disease awareness	Awareness
Georgia	Senate Resolution 771	Signed March 2018	Recognize May 2018 as Lyme Disease Awareness Month.	Awareness
Illinois	HB 0889	2019: Enacted	Requires insurance policies to provide coverage for long-term antibiotic therapy for individuals diagnosed with tickborne diseases.	Insurance Coverage

Illinois	House Resolution 780	2022: Passed	Urge the federal government to allocate increased funding for research into a cure for Lyme disease and designate May 2022 as Lyme Disease Awareness Month in the State of Illinois.	Surveillance and Tracking
Illinois	HB 4515: Public Act 100-1137	2019: Enacted	Grant medical providers immunity from disciplinary action by the Department of Financial and Professional Regulation for administering experimental treatments for Lyme disease or other tickborne diseases.	Provider protections
Iowa	Iowa Code 147.56	2017: Enacted	Protects physicians who prescribe long-term antibiotics for Lyme disease, ensuring they can provide necessary treatment without fear of disciplinary action.	Provider protections
Kansas	Senate Bill 28	(Passed) 14, 2024: Motion to override line item veto prevailed; Line item veto 112a,116a overridden	This bill allocates $140,000 for Lyme disease prevention and research. Any remaining funds in the Lyme disease prevention and research account after June 30, 2024, will be reappropriated for the 2025 fiscal year.	Surveillance and Tracking
Kentucky	RS Chapter 304, Subtitle 17A,	Effective January 1, 2021	This legislation mandates that all health benefit plans issued or renewed after the effective date of the act must cover long-term antibiotic therapy for Lyme disease, provided that the therapy is deemed medically necessary and ordered by a licensed physician who has thoroughly evaluated the person's symptoms, diagnostic results, and response to treatment. Coverage may be subject to cost-sharing provisions such as copayments, deductibles, and coinsurance, which must be no less favorable than those for other ongoing medications covered by the plan.	Insurance Coverage
Maine	3282-B	2015: enacted	Allows licensed physicians to prescribe long-term antibiotics for Lyme disease treatment without facing disciplinary action.	Provider protections
Maine	LD 597	2009: Enacted	Directs the Maine Center for Disease Control and Prevention to include on its publicly accessible website information about different alternatives for the treatment of Lyme disease.	Education and Prevention

Maryland	Senate Bill 926	Passed May 10, 2016	Require notifying patients of testing issues, outlining that it is still possible to have Lyme disease even with a negative test.	Treatment
Michigan	House Resolution No. 238	Enacted 2024	Proclaims May as National Lyme Disease Awareness Month.	Awareness
Minnesota	62A.265 Revision of CHAPTER 465-H.F.No. 219	2024: Enacted	Every health plan, including those offering the coverage specified in section 62A.011, subdivision 3, clause (10), must cover treatment for diagnosed Lyme disease. No health plan listed in subdivision 1 may impose a special deductible, co-payment, waiting period, or any other special restriction on Lyme disease treatment that is not applied to nonpreventive treatments in general.	Insurance Coverage
New Hampshire	House Bill 1639	Passed on July 30 2020	Requires insurance coverage for long-term antibiotic therapy for tickborne illness.	Insurance Coverage
New Hampshire	Revision: Section 415:18-ee	Effective 2021	Each insurer issuing or renewing any policy of group or blanket accident or health insurance that provides benefits for medical or hospital expenses must offer coverage to certificate holders who are residents of this state for long-term antibiotic therapy for tickborne illnesses, when deemed medically necessary and ordered by a licensed infectious disease physician after thoroughly evaluating the patient's symptoms, diagnostic test results, or response to treatment. Benefits provided under this section cannot be subject to higher co-payments, deductibles, or coinsurance than those applied to similar benefits by the insurer.	Insurance Coverage
New Jersey	SB 400	Introduced on January 9 2024 - 25% progression	Mandate health insurance coverage for the treatment of tickborne diseases, including long-term antibiotic therapy.	Insurance Coverage
New York	Senate Bill S7854	2014: Signed	Safeguards doctors who prescribe long-term antibiotic therapy for Lyme disease from disciplinary action.	Provider protections
New York	Senate Bill S7242	2018: Signed by Governor	Relates to installing Lyme and tickborne disease warning signs at all state-managed parks	Awareness

New York	Senate Bill S4089	2022: Signed by Governor	Directs the commissioner of agriculture and markets to develop and conduct a public awareness campaign regarding Lyme disease and other tickborne diseases	Awareness
Ohio	Revised Code Section 4731.77	Effective: September 15, 2014	Physicians must provide patients with a written notice when ordering a Lyme disease test. The notice informs patients that test results may be inaccurate and that they should contact their healthcare provider if they continue to have symptoms.	Treatment
Ohio	Section 5.2237	Effective: September 12, 2008	The month of May is designated as "Ohio Lyme Disease Awareness Month" to increase public awareness of Lyme disease as a health concern.	Awareness
Pennsylvania	Senate Resolution No. 338	Adopted April 2016	Designating the month of May 2016 as “Lyme Disease Awareness Month” in Pennsylvania	Awareness
Rhode Island	R.I. Gen. Laws § 5-37.5-4	Enacted 2023	Protects physicians who prescribe long-term antibiotics for Lyme disease, ensuring they can provide necessary treatment without fear of disciplinary action.	Provider protections
Rhode Island	R.I. Gen. Laws § 5-37.5-5	Enacted 2023	Every individual or group hospital or medical-expense insurance policy or individual or group hospital or medical-services plan contract delivered, issued for delivery, or renewed in this state on or after January 1, 2004, shall provide for Lyme disease treatment as provided in chapters 18, 19, 20, and 41 of title 27	Insurance Coverage
Rhode Island	R.I. Gen. Laws § 5-37.5-6	Enacted 2023	Every physician, or his/her in-office designee, who orders a laboratory test for the presence of Lyme disease shall provide to the patient or his/her legal representative Lyme disease testing information disclosure.	Treatment
Tennessee	Proclamation	Proclaimed April 2018	Proclaims May 2018 as Lyme and Tick-Borne Disease Awareness Month	Awareness

Vermont	H. 123	2014: Enacted	Direct health care professionals to document the basis for a Lyme disease or other tickborne illness diagnosis in patients' medical records; to provide information to patients that assist in their understanding of the available Lyme disease tests, the meaning of Lyme disease test results, and any limitations to those test results; and to obtain patients' written informed consent prior to administering long-term treatment for Lyme disease or other tickborne illness.	Treatment
Virginia	HB 1933	2013: Enacted	Requires physicians to provide to each patient for whom a test for the presence of Lyme disease is ordered a written notice about Lyme disease, about testing for Lyme disease, and about the need for the patient to contact his physician with questions or concerns about Lyme disease. The bill also provides that licensees are immune from civil liability for providing such notice absent gross negligence or willful misconduct	Treatment
Virginia	HB 850	2022: Approved by Governor	Requires the Department of Conservation and Recreation to develop and post in each state park and interstate park signage addressing the appropriate steps a visitor can take to prevent tick bites, how to identify Lyme disease, and where to seek treatment.	Awareness
Washington	SB 5448	Effective July 2015	Requires a study of the effects long-term antibiotic therapy has on certain Lyme disease patients.	Surveillance and Tracking
West Virginia	§33-25A-8p.	Signed 2018	Requires all health insurance policies to cover Lyme disease treatment	Insurance Coverage
Wisconsin	254.52 Lyme disease; treatment, information and research.	2025:	Research Lyme disease in humans and, in consultation with other agencies, monitor its spread, investigate cases, review strategies from endemic states, and develop statewide recommendations. It will provide updated information for clinicians and health departments, distribute public awareness materials, and conduct research on Lyme disease prevalence.	Education and Prevention
Wisconsin	Senate Bill 298	Enacted March 3, 2020	Raise awareness about Lyme Disease through Department of Natural Resources	Awareness

Appendix C: PANS/PANDAS Related State Legislation

State	Statute Citation	Health Insurance Coverage Required	Specific Medicaid Provision[1]	Annual Awareness Day[2]	Advisory Council	Other
Arkansas[2]	A.C.A. § 23-79-1901 et seq.; §20-77-142		✓			Interdisciplinary panel to develop protocol for diagnosis and treatment
California	Health and Safety Code §1367.38; Insurance Code §10123.38	✓				
Colorado	C.R.S. 10-16-104 (27)	✓				
Connecticut	Conn. Gen. Stat. §10 - 29a (115); 2026 Public Act No. 26-33	✓		✓		
Delaware	Del. Code Chapter 33, Title 18 §3370B; Chapter 35, Title 18 §3571T; Chapter 52, Title 29 §5211; Chapter 5, Title 31 §527	✓				
Georgia	OCGA §§ 33-24-59.36; 45-18-4.2	✓				
Illinois	215 ILCS 5/356z.25; 20 ILCS 2310/2310-676	✓			✓	
Indiana	IC §§ 27-8-37-1et seq; 27-13-7-26; 5-10-8-24	✓				

© 2026 Center for Lyme Action and National Alliance for PANS/PANDAS Action

Kansas	KSA §75-6525					State employee health benefit coverage required in 2023[4]
Louisiana	LRS 22 §1028.6	✓				Specialty PANS/PANDAS vehicle license plate
Maryland	Insurance Code §15–855	✓				
Massachusetts	176G §4GG, 175 §47NN, 176B §4OO, 32A§17R, 176A §8OO, 111 §242, 6§15VVVV	✓		✓	✓	
Minnesota	Minn. Stat. Ann. §§ 62A.3097 , 256B.0625 Subd. 66	✓	✓			
Missouri	RSMo § 9.502			✓		
Nebraska	2026 LB 762 Slip Law	✓				
New Hampshire	RSA §417-E:1	✓				
New York	Public Health Ch. 45 Art. 2, Title 1 §207 (n)					Health care and wellness education and outreach
Oregon	ORS §§743A.315, 187.290	✓		✓		
Rhode Island	R.I. Gen. Laws § §27-41-95, 27-20-78, 27-19-82, 27-18-90	✓				
Tennessee	Tenn. Code Ann. §§15-2-148; 71-5-172		✓	✓		
Texas	Texas Health and Safety Code §119A.001 et seq.				✓	
Virginia	Code of Virginia §§32.1-73.9 et seq, 38.2-3418.22, 32.1-325(34)	✓	✓		✓	Includes PANS PANDAS treatment in future essential health benefits benchmark plan

Source: The Louisa Adelynn Johnson Fund for Complex Disease, https://tlajfundforcomplexdisease.com/
Updated August 2026

1. States with statutes that specifically refer to the state Medicaid program are checked. Other states may cover services for the diagnosis and treatment of PANS and PANDAS via regulatory measures such as Oregon, or the definition of health insurance plans utilized in the statute may encompass the Medicaid program.
2. States with statutes establishing an annual awareness day are checked. Other states have passed measures to declare awareness days in a particular year that are not part of the state statutes.
3. The Arkansas legislature currently funds a clinic annually in its appropriations bills. See 2025 SB 128 for FY 2026 funding of $175,000. In 2025 the Arkansas House recommended a measure, HB 1573, for further study in the Interim, which would modify the statute section concerning the development of the protocol.
4. State employee health benefit coverage may have been extended for additional plans years.

For a detailed description of state statutes, please visit https://policyconsult.com/resources

Center for Lyme Action

Center for Lyme Action
611 Pennsylvania Ave, SE
Suite 126
Washington, DC 20003