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CLINICAL-EPIDEMIOLOGICAL AND DIAGNOSTIC FEATURES OF NEUROBORRELIOSIS IN UKRAINE AND WORLDWIDE: A CURRENT PERSPECTIVE

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Lyme disease is a zoonotic infection caused by Borrelia burgdorferi sensu lato, transmitted through Ixodes tick bites. The infection has three stages. The early localized stage is marked by erythema migrans. The early disseminated stage involves the nervous system, heart, and skin. The late stage produces chronic musculoskeletal and neurological issues. Incidence is highest in Western Europe, the United States, and some regions of Ukraine, with recent increases in reported cases.

Neuroborreliosis develops in 10–15 % of patients, usually 2–6 weeks after infection. Symptoms include meningitis, radiculopathies, facial palsy, and other neurological signs. Differences in clinical presentation correspond to the regional distribution of Borrelia genotypes. Diagnosis requires serological tests, cerebrospinal fluid analysis, and molecular methods. Standard treatment is antibiotic therapy with doxycycline or ceftriaxone for 14–21 days.

Post-treatment Lyme disease syndrome affects 10–20 % of patients, presenting with persistent fatigue and cognitive deficits in the absence of active infection. Management focuses on rehabilitation, including physiotherapy and psychosocial interventions, to mitigate neurological impairments and improve functional outcomes.

Prevention is essential to reduce disease incidence. Key strategies include personal protective measures, epidemiological monitoring, and ongoing vaccine development. These measures are particularly important in high-risk settings, such as among military personnel and populations in areas with limited access to healthcare.

Key words: *borreliosis (Lyme disease), neuroborreliosis, diagnosis, epidemiology, post-treatment Lyme disease syndrome, prevention, Good health and well-being.*

Lyme disease (Lyme borreliosis) is an infectious disease caused by bacteria of the genus *Borrelia* (primarily *Borrelia burgdorferi* sensu lato), transmitted to humans through the bites of infected *Ixodes* ticks (*Ixodes* spp.) [1, 2].

The disease has a systemic nature and can affect the skin, joints, nervous system, and heart. Its course is often staged, with characteristic clinical phases: early localized stage – usually presenting with erythema migrans (skin redness at the site of the bite, about 60 % of cases); early disseminated stage – spread of the pathogen throughout the body, with possible involvement of the nervous system, heart, and skin; late stage – chronic damage to the musculoskeletal system (arthritis) and nervous system (neuroborreliosis), which is characterized by meningitis, radiculitis, neuropathies, and other manifestations. The prevalence increases with delayed diagnosis and treatment initiation [3–5].

Aim to summarize current clinical, epidemiological, and diagnostic features of neuroborreliosis in Ukraine and worldwide, assess the relevance of the problem, and define key directions for improving diagnosis, treatment, and prevention.

For the preparation of this review, a systematic analysis was conducted of scientific publications, official reports, and recommendations of international organizations (EUCALB, CDC, ECDC) from 2010 to 2025. Information sources included the databases PubMed, Scopus, and Web of Science, as well as open-access resources of scientific publishers. The selection of publications was based on the keywords: Lyme borreliosis, neuroborreliosis, diagnosis, epidemiology, post-treatment Lyme disease syndrome, prevention. Special attention was given to studies focusing on clinical symptoms, diagnostic methods, therapy, and epidemiology of neuroborreliosis in Ukraine and in regions with similar endemic conditions. Both original studies and systematic reviews/meta-analyses were analyzed.

Epidemiological Features of Lyme Disease

Lyme disease (LD) is one of the most widespread natural focal tick-borne zoonoses in the Northern Hemisphere. The European Centre for Disease Prevention and Control (ECDC) estimates that more than 200,000–300,000 cases occur each year in Europe, although the

true incidence is likely much higher due to underdiagnosis, particularly of mild or atypical presentations [6].

Countries with the highest incidence include Germany, Austria, the Czech Republic, Slovenia, the Baltic states, and Scandinavian countries. European strains of *Borrelia burgdorferi* sensu lato (particularly *B. afzelii*, *B. garinii*) cause a broader spectrum of clinical manifestations, complicating timely diagnosis [7].

The average incidence of LD in Western Europe is approximately 22 cases per 100,000 population per year, although distribution is highly uneven. In the Baltic states, Scandinavia, as well as Switzerland, Slovenia, and Austria, the rate exceeds 100 per 100,000 population [8]. In the Netherlands, during the period 2015–2019, incidence ranged from 111–131 per 100,000, and in certain regions even exceeded 357 [4]. Ukraine remains at a lower average level (14/100,000 in 2023), but there is a trend toward increasing incidence after 2015 and 2022. In Sumy region, the incidence reached 10.6 per 100,000 population (2019), which significantly exceeds the Ukrainian average [2].

In the United Kingdom (England and Wales), laboratory-confirmed incidence increased from 1.6 in 2013 to 2.77 in 2018, with an additional 1,000–2,000 clinically diagnosed cases each year [9]. Primary care data confirm an increase to nearly 1.95 per 100,000 population in 2016 [10]. Among the regions of Scotland, the incidence rate is about 15 per 100,000 population [11] (Table 1).

Table 1

Incidence in the United Kingdom (England and Wales), 2013–2021

Year	Laboratory-confirmed cases	Incidence per 100,000 population
2013	936	1.64
2014	856	1.49
2015	1 060	1.83
2016	1 134	1.94
2017	1 584	2.70
2018	1 636	2.77
2019	1 639	2.76
2020	1 262	2.11
2021	1 156	1.94

Note. These data do not include cases treated solely on clinical grounds (without laboratory confirmation), which are often assessed separately in addition (approximately 1,000–2,000 annually).

In the United States, about 35,000 confirmed cases are reported annually, but the CDC estimates the actual incidence at over 476,000 cases each year, taking into account underdiagnosis [9]. Approximately 63,000 cases meet CDC criteria [12, 13]. The primary pathogen is *B. burgdorferi* s.s., and the clinical manifestations of neuroborreliosis (LNB) differ somewhat.

According to CDC data, the incidence of LD is about 7–8 cases per 100,000 population, but in high-endemic areas (New England, Maine) it reaches 30–90 per 100,000 [5, 14, 15].

Despite the decline in the number of economic studies in Europe, recent data indicate: in Belgium in 2019, the annual cost of LD was about €5.6 million, of which 50 % were direct medical expenses and 46 % productivity losses; in late-stage disease (neuro/disseminated), costs are significantly higher (~€5,148 per patient vs. ~€193 in early-stage disease). In the Netherlands, costs were estimated at ~€20 million/year; in Germany, up to €80 million/year, with a large share of indirect costs (23–48 %) [16].

In the USA, total economic losses include substantial costs for treatment, diagnosis, and loss of work capacity, including losses due to diagnostic delays and the prolonged post-treatment Lyme disease syndrome (PTLDS), observed in 5–10 % of patients and often accompanied by chronic pain, fatigue, and neurological symptoms [12].

According to official data from the Ministry of Health of Ukraine, LD incidence has risen sharply over the past two decades–from isolated cases in the 2000s to over 3,000–5,000 officially registered cases annually by 2021. Endemic areas remain Vinnytsia, Volyn, Zhytomyr, Kyiv, Lviv, Sumy, and Cherkasy regions [2, 17].

The COVID-19 pandemic, and since 2022, the full-scale war in Ukraine, have significantly complicated epidemiological surveillance, diagnosis, and treatment of LD. Infection risk is increased among military personnel, volunteers, internally displaced persons, and residents of frontline and de-occupied territories, who often remain in forested or steppe areas that are natural habitats for ticks.

Armed Forces personnel remain in field conditions for extended periods without access to personal protective measures against ticks (repellents, daily checks, uniform treatment, etc.). A significant proportion of patients cannot seek medical care after a tick bite or when symptoms appear, due to the lack of medical facilities, unstable logistics, or active hostilities. Diagnostic challenges include the absence of ELISA laboratories and immunoblot testing in territories under active fighting or temporary occupation (parts of Donetsk, Luhansk, Kherson, Zaporizhzhia, and Kharkiv regions) [18, 19].

All this occurs in Ukraine amid an overburdened healthcare system, with LD testing being a low priority. Disease symptoms (weakness, headache, muscle pain, fatigue) may be mistaken for combat stress, exhaustion, or

other conditions. Finally, the absence of a national screening or medical follow-up program for military and civilians after a tick bite exacerbates the problem.

Prevalence of Neuroborreliosis

Neuroborreliosis (LNB) is a serious complication of LD. The infection may manifest as aseptic meningitis, radiculopathies, mono- or polyneuritis, cranial neuropathies, and less commonly, encephalomyelitis [20, 21].

In Denmark, according to a national study (2015–2019), the annual incidence of laboratory-confirmed LNB was 2.8–3.4 per 100,000, peaking in summer months. The highest rates were recorded among children (5–14 years) and older adults (65–74 years) [20, 22]. In Germany, the average LD incidence was 33.9/100,000, with about 5–15 % of cases having neurological complications [23].

Since 2018, the EU has recommended that member states report LNB cases separately as a specific clinical manifestation of LD. In the UK, incidence is significantly lower, with the highest rates in Scotland. LNB remains under-researched: official data do not allow an accurate estimation of LNB incidence, although clinical cases are regularly reported [24].

Mechanisms of *Borrelia* entry into the CNS include paracellular, transcellular, and other pathways, causing both meningeal inflammation and direct neuronal damage with activation of autoimmune mechanisms (molecular mimicry) [25, 26].

European LNB most often presents as painful radiculopathy (70 %), meningitis, facial palsy (40 %), and in late forms: encephalitis, myelitis, vasculitis [8, 26]. In the USA, LNB is mostly limited to encephalopathy, reported by some patients but not yet clearly linked to *Borrelia* infection. Facial palsy is more common, often bilateral; radicular pain or encephalitis occur less frequently compared to Europe. CNS symptoms appear on average 2–6 weeks after infection (Table 2) [24–26, 28].

Table 2

Clinical features of LNB: regional comparison

Region	Incidence of LD per 100,000	Share of LNB	Main clinical manifestations
Europe	20–100+, Eastern European countries 20–40	10–15 %	Radiculopathy (70 %), meningitis, facial paralysis (40 %), encephalitis/myelitis (less common) [8]
UK	<20 (usually <5)	low	Often limited to mild forms, data is fragmentary
Ukraine	14 (2023), growth after 2015	25 %	Neurological signs are common, requiring attention to early diagnosis (CSF, serology) [18, 19]
USA	476,000 clinically confirmed	10–15 %	Facial paralysis prevails, meningitis is less common, late forms are an exception

Neuroborreliosis: clinical signs depending on form and localization

Three main forms of LNB are distinguished: PNS form (peripheral nerve involvement) – cranial nerves (often cranial nerve VII – facial nerve) and peripheral mono- or polyneuritic symptoms (in 5–10 % of cases); Extraparenchymal CNS form – inflammation of the meninges (lymphocytic meningitis) (about 10 %); Parenchymal CNS form – involvement of brain or spinal cord tissue – encephalitis or myelitis (7–14 %) [29].

By onset period, early and late stages are distinguished. Early LNB develops 2–18 weeks after infection, often PNS form, meningoradiculitis, facial palsy; late LNB – months/years after initial infection. It may manifest as chronic meningitis, encephalitis, myelitis, or polyneuropathy [21, 30–32].

PNS form (radiculitis and cranial nerves): radiculitis (meningoradiculitis / Bannwarth's syndrome) – in Europe occurs in 66–70 % of adults with LNB (Denmark 2015–2017). Facial palsy – detected in 41–43 % of cases in the same Danish cohort. Among children, up to 55 % of cases with neurological involvement are recorded [29, 33, 34]. Multiple mononeuritis is less common, presenting as isolated nerve manifestations and sensory disturbances [35].

Extraparenchymal CNS form (meningitis) – lymphocytic meningitis, in combination with radiculopathy in the form of Bannwarth's syndrome – a characteristic sign of early European LNB [33].

Parenchymal CNS form (encephalitis or myelitis) in Europe is very rare (<5–7 %) but documented; in the USA – ultra-rare (<0.1 %) [29, 34, 36] (Table 3).

In European countries, the most frequently recorded combination is radiculalgia (66–70 %) and facial palsy (41–43 %) – the classic Bannwarth's syndrome. In children: facial palsy (55 %), other cranial neuropathies, lymphocytic

meningitis (27 %) [29, 34]. According to observations in England, cases of facial palsy in the context of LD are increasing (3.5 % of LD cases present with Bell's palsy overall). Testing for LD is recommended in patients with Bell's palsy, especially in summer or after visits to high-risk areas [37] (Table 3).

For North America, facial palsy is the most common manifestation (5–15 %) of all LNB cases, often combined with mild meningitis (75 %). Radiculopathies are much less common (<10 %, possibly underestimated). The development of encephalitis or myelitis is extremely rare (<0.1 %) [29, 36] (Table 3).

In domestic publications, clear data on the frequency of different LNB forms are scarce, but based on the significant rate of neurological symptoms (25 % of LD cases have neurological signs), it can be assumed that PNS forms with facial palsy and radiculopathy are also common. Late diagnosis without proper CSF analysis is often observed [34, 38] (Table 3).

Post-treatment Lyme disease syndrome (PTLDS) occurs in about 10 % of patients (more often in the USA) after therapy and manifests as prolonged fatigue, cognitive impairment [35]. Persistent neurological manifestations are complications of late or incomplete treatment, presenting as motor disorders, cognitive changes, psychiatric disturbances, and even borrelial vasculitis or stroke [39].

The median time from symptom onset to hospitalization for adults in Europe is 21 days; for children, it is significantly shorter – 10 days – which improves prognosis [40, 41].

Table 3

Summary of neuroborreliosis signs by form

Form/Localization	Europe (adults and children)	UK	USA	Ukraine (limited data)
PNS form	Radicular pain – 66–70 %, facial paralysis – 41–55 %	Increasing Bell's palsy (3.5 %)	Facial paralysis 5–15 %, radiculitis <10 %	25 % of neurological cases, PNS forms, often late
Extraparenchymal CNS form (meningitis)	Combination with radiculopathy is typical	Limited data; diagnostic interest	Meningitis – 75 % of facial paralysis cases	Presumably frequent in combination with PNS forms
Parenchymal CNS form	Rare encephalitis/myelitis in 7–14 %	Very rare; poorly studied	<0.1 % ultra-rare	No reported cases

Main Diagnostic Strategies for Lyme Disease

Diagnosis of LD traditionally relies on a combination of clinical signs, serological tests, and cerebrospinal fluid (CSF) cytological examination. The most common global approach is two-tiered serology. In the USA, according to CDC recommendations, the first stage involves an ELISA test; if positive or equivocal, it is followed by a blot analysis: IgM is used for diagnosis within 30 days from symptom onset, and IgG after 30 days [33, 42].

The European strategy is similar but includes an additional verification of the antibody index in CSF (Antibody Index, AI) to confirm LNB [43]. In the United Kingdom, general European approaches are applied, with additional testing in certain cases, for example, Bell's palsy [33]. In Ukraine, ELISA and immunoblotting are used; however, EIA (enzyme immunoassay) / NPA (negative percent agreement between a new test and a reference method) standards have not been fully implemented, which reduces the uniformity of diagnostics.

In the analysis of CSF, the main diagnostic indicators in Europe include lymphocytic pleocytosis, increased protein levels, and a positive AI test, whereas in the United States, AI is applied less commonly [44]. PCR testing of CSF, especially assays aimed at ospA or 16S rRNA, shows high specificity but relatively low sensitivity (25–38 %), which is particularly evident during the early stages of the disease [43] (Table 4).

As for alternative methods, the introduction of algorithms relying on two EIA tests instead of immunoblotting deserves attention, as this approach allows automation and increases sensitivity at early disease stages. PCR combined with genotyping is another promising option, especially in children, since the parallel use of ospA and 16S rRNA markers may facilitate the identification of early LNB cases. Further studies are also exploring urinary antigen testing and the refinement of serological diagnostics [3, 33, 43].

Interpretation of the AI varies by region: in Europe, a positive AI is considered a key proof of confirmed LNB, whereas in the USA it is not included in the official diagnostic criteria. For PCR in CSF, a positive result directly confirms the presence of the pathogen; however, a negative result does not exclude the diagnosis due to sensitivity of <40 % [45–47].

Table 4

Diagnostic algorithms by region

Stage	USA (CDC)	Europe (EFNS/AWMF)	United Kingdom	Ukraine
Clinical + history	EM/facial palsy/ radiculitis + tick bite	CNS/PNS signs	Facial palsy, anamnesis	Neurology + tick bite initially
Serology	2-tier serology	2-tier serology + AI in CSF	2-tier serology	ELISA → immunoblotting
CSF	in neurological cases after positive ELISA	mandatory if LNB suspected	in seropositive cases + clinical signs	used, but rarely
PCR in CSF	optional, low sensitivity	for AI-negative acute cases	as indicated	limited use
Final interpretation	IgM/IgG immunoblotting	AI + pleocytosis	as in Europe	no standard algorithm

Serological tests (ELISA/EIA) become informative only 2–4 weeks after infection, and false-negative results are possible in the early stages. For immunoblotting in the USA, the positivity criteria require the presence of at least two of three specific proteins for IgM and five of ten for IgG [33].

Recent improvements include a two-tier algorithm with two EIA tests, which provides quantitative results and better early-stage diagnosis. Molecular methods, particularly PCR with genotyping, show considerable potential both before and during treatment, and have already been implemented in pediatric practice in Europe. In Germany, S3 guideline systems offer structured recommendations for diagnosis and treatment in both adults and children, contributing to the standardization of approaches [33, 34, 43, 48] (Table 5).

In Ukraine, a comprehensive algorithm is currently lacking. AI testing for CSF is almost never used, and PCR remains at an experimental stage with limited application. There are no national protocols for determining CSF AI, highlighting the need for modernization of diagnostic approaches [49].

Table 5

Comparison of specific features of neuroborreliosis diagnostic algorithms worldwide

Stage	Ukraine	USA (CDC)	Europe (EFNS/Germany)
Initial assessment	Symptoms + ELISA	Clinical evaluation + 2-tier serology	Clinical evaluation + AI + immunoblotting
Immunoblotting	Actively used	Standard 2-tier serology	Less frequently (not always)
AI in CSF	Mostly absent	Not used	Mandatory for LNB
PCR	Rarely available	Limited use	Used as needed
CSF analysis	Depends on clinician	Sometimes performed	Standard for suspected LNB

Note. AI (Antibody Index) – in Ukraine, it is not officially validated in most laboratories but is recommended for implementation following EFNS/NICE guidelines.

Approaches to Lyme Disease Therapy and Treatment Effectiveness

The EFNS and AWMF S3 guidelines (Germany, 2020) recommend doxycycline (200 mg/day orally), ceftriaxone (2 g/day intravenously), or cefotaxime/penicillin G as first-line antibiotics for LNB therapy. The duration of therapy is stage-dependent: in early LNB (symptoms for less than 6 months), treatment usually lasts 14 days, whereas in late LNB (symptoms persisting more than 6 months), it may be extended up to 21 days, which represents the maximum recommended course [48, 50]. Analysis of randomized controlled trials (RCTs) and non-randomized studies (NRS) in 2023 confirmed that doxycycline and β-lactam antibiotics are equally effective. Extending therapy beyond 21 days offers no additional benefit, and corticosteroids for facial palsy show no efficacy [51].

IDSA and AAN recommendations (USA, 2020) largely align with European approaches. Doxycycline or ceftriaxone is prescribed for 14–21 days depending on disease form and severity, consistent with EFNS guidelines [52].

According to the British Infection Association (BIA), doxycycline is prescribed for 14–21 days for facial palsy or uncomplicated meningitis. For complex meningitis or late LNB, intravenous ceftriaxone is preferred, with treatment up to 28 days. If β-lactams are contraindicated, oral amoxicillin or cefuroxime can be used [53].

In clinical practice in Ukraine, doxycycline (100 mg twice daily) is used, and in severe cases – ceftriaxone, cefotaxime, or penicillin G intravenously. Alternatives for allergies or first-line therapy failure include oral or IV amoxicillin, azithromycin or clarithromycin (less effective, mainly for mild cases), and oral cefuroxime axetil (sometimes to complete a parenteral course). Standard treatment duration is 14 days, occasionally extended to 21 days [49].

A 2023 systematic review and meta-analysis, including 2 RCTs and 5 NRS (2015–2023), confirmed that doxycycline and β-lactam antibiotics are equally effective. Extending therapy beyond 21 days provides no additional benefit, and corticosteroids for facial palsy do not improve outcomes [51, 52].

A retrospective study by Stupica et al. (2021, Central Europe) demonstrated that patients with confirmed LNB (based on intrathecal antibody synthesis combined with typical clinical presentation) had a better prognosis than those with probable LNB. Persistent neurological deficits were lower in the confirmed group. Comparative studies of oral versus intravenous antibiotics confirmed that oral doxycycline is non-inferior to IV ceftriaxone for typical peripheral (PNS) LNB forms, while ceftriaxone is recommended for central forms (CNS) – encephalitis and myelitis [53].

Prognosis after Treatment

In pediatric cohorts, including the Shved cohort, complete recovery occurs in 80–90 % of children within two months after therapy. Adults show significant improvement, but 10–20 % of late-stage cases retain persistent neurological symptoms. European and American sources estimate that about 10 % of patients develop PTLDS post-treatment, manifesting as fatigue and cognitive impairment, which is not corrected by additional antibiotic courses [35].

In Ukrainian practice, doxycycline and ceftriaxone remain the main treatments for LNB. Corticosteroids for facial palsy are not used due to lack of benefit. Antibiotic therapy typically lasts 14–21 days, with occasional extension. Prognosis for early LNB forms is generally favorable, although the lack of systematic data on intrathecal antibodies complicates precise assessment of treatment effectiveness.

Rehabilitation of Patients after Neuroborreliosis

Rehabilitation aims to restore neurological function, prevent symptom chronicity, and reduce PTLDS risk. Duration: 3 weeks to 6 months, with at least 2–3 sessions per week during the first 3 months [54–57] (Table 6).

Table 6

Main Directions of Rehabilitation

Direction	Methods	Comment
Neurological rehabilitation	Physiotherapy, kinesitherapy, electrostimulation	For radiculopathies, pareses
Speech therapy correction	Work with facial palsy	Often in children/adults with bulbar dysfunction
Psychotherapy / CBT	Individual sessions for depression, anxiety	Effective for cognitive complaints
Cognitive training	Neuropsychological exercises	For patients with memory/concentration disorders
Massage, osteopathy	For myofascial pain syndromes	Used in EU (Germany, Poland)

Post-Treatment Lyme Disease Syndrome (PTLDS)

According to the CDC (2021), post-treatment Lyme disease syndrome (PTLDS) is defined as the persistence of symptoms lasting longer than six months after adequate antibiotic therapy for Lyme disease (LD), in the absence of evidence for ongoing active infection. The most frequently reported manifestations are chronic fatigue (affecting more than 60 % of patients), cognitive impairment (30–50 %), recurrent headaches, musculoskeletal pain, and symptoms resembling fibromyalgia [58–60].

The prevalence of this condition varies by region: in the USA, it is observed in 10–15 % of patients after treatment for neuroborreliosis, in EU countries – 5–10 % (specifically in Germany and France). Ukraine lacks formal statistical data; however, (according to KMIS, 2023), unofficial estimates suggest that as many as 10 % of patients might be impacted [59, 60].Treatment approaches for PTLDS are based on international guidelines: repeated courses of antibiotics are not recommended. The main focus is on symptomatic treatment and provision of

psychosocial support aimed at improving patients' quality of life [61].

Prevention

Prevention includes a set of individual and population-level measures aimed at avoiding tick contact, prompt removal of ticks, and reducing the risk of infection after a tick bite.

Personal protection represents a cornerstone of primary prevention. Applying repellents to exposed skin and clothing, wearing tightly woven light-colored garments with long sleeves, performing routine body inspections after outdoor exposure, and removing ticks within 24 hours substantially lower the risk of infection. For military personnel operating in field or forested conditions, these measures should be an essential component of medical support [2, 6, 49].

Post-exposure antibiotic prophylaxis is indicated in the case of a bite from a potentially infected tick. The optimal approach is a single dose of doxycycline 200 mg orally (4.4 mg/kg for children over 8 years) no later than 72 hours after tick removal. According to multicenter randomized trials, this method provides approximately 87 % effectiveness in preventing Lyme disease [49, 61].

Vaccination is currently under redevelopment. The first registered vaccine, LYMErix (1998, USA), was withdrawn due to safety concerns. Ongoing clinical trials are evaluating the VLA15 vaccine (Valneva/Pfizer), which targets multiple OspA serovariants and is planned for introduction in Europe. In parallel, multivalent protein and DNA-based vaccines are under development, aiming to prevent Lyme disease and its neurological complications [62, 63].

Educational programs are a critical addition to medical measures. In EU countries, extensive awareness campaigns conducted through schools, media, and healthcare institutions have demonstrated effectiveness in lowering tick exposure and encouraging timely medical consultation [64, 65]. In Ukraine, these efforts remain mostly limited to local initiatives, highlighting the necessity to enhance the role of family physicians, medical volunteers, and community-driven programs.

Conflict situations increase infection risk, particularly for military personnel, internally displaced individuals, and residents in areas with limited access to laboratory diagnostics (ELISA, immunoblotting). The lack of a national prevention strategy for tick-borne infections highlights the urgent necessity to establish state policies in accordance with international standards and adapted to wartime conditions.

Conclusions

Lyme disease is a multisystem zoonotic infection posing a significant public health burden in temperate regions, including Ukraine, the European Union, the United Kingdom, and the United States. Neuroborreliosis develops in approximately 10–15 % of cases, usually 2–6 weeks after infection, and may involve the central and peripheral nervous systems, manifesting as aseptic meningitis, cranial neuropathies, radiculoneuritis, encephalopathy, cognitive deficits, myelitis, or ataxia.

Lyme disease presents with different clinical patterns depending on geographic location. In Europe, Borrelia garinii is the dominant species, often producing neurotropic manifestations, including meningitis and nerve root inflammation. In contrast, in the United States, B. burgdorferi sensu stricto is more frequently linked to joint involvement and meningoencephalitis. In Ukraine, several Borrelia genotypes, including B. afzelii and B. garinii, circulate simultaneously, resulting in a wider range of clinical manifestations.

Diagnosis relies on a sequential strategy. Initial ELISA testing is followed by confirmation using immunoblotting. Examination of cerebrospinal fluid commonly reveals lymphocytic pleocytosis, elevated protein levels, and an increased Borrelia-specific IgG index. CXCL13 has been recognized as a potential early biomarker for central nervous system involvement.

Early initiation of therapy ensures high treatment efficacy. Intravenous ceftriaxone is the preferred regimen, whereas oral doxycycline is appropriate for less severe cases. Extending or repeating antibiotic courses is not advised for patients who continue to experience symptoms following standard therapy. Post-treatment Lyme disease syndrome occurs in approximately 10–20 % of patients and is characterized by persistent fatigue, musculoskeletal discomfort, and cognitive deficits. Optimal management relies on a multidisciplinary approach, including cognitive-behavioral therapy, physical rehabilitation, and psychosocial support.

Rehabilitation is especially important for individuals with ongoing neurological impairments. Techniques such as physiotherapy, focused cognitive training, and vestibular exercises support functional recovery and enhance daily living activities. Preventive strategies remain essential to curb disease incidence. These include public health education, personal protective measures, epidemiological monitoring, and ecological management of ticks and reservoir hosts in endemic areas. Advances in vaccine research continue to offer potential for secondary prevention.

References

1. Burn, L., Vyse, A., Pilz, A., Tran, T. M. P., Fletcher, M. A., Angulo, F. J., Gessner, B. D., Moïsi, J. C., & Stark, J. H. (2023). Incidence of Lyme Borreliosis in Europe: A Systematic Review (2005-2020). *Vector borne and zoonotic diseases (Larchmont, N.Y.)*, *23*(4), 172–194. https://doi.org/10.1089/vbz.2022.0070.

2. Lyme disease | Public Health Center. (n.d.). *Public Health Center of Ukraine | Ministry of Health*. https://phc.org.ua/kontrol-zakhvoryuvan/inshi-infekciyni-zakhvoryuvannya/osoblivo-nebezpechni-infekcii/khvoroba-layma.

3. Guérin, M., Shawky, M., Zedan, A., Octave, S., Avalle, B., Maffucci, I., & Padiolleau-Lefèvre, S. (2023). Lyme borreliosis diagnosis: state of the art of improvements and innovations. *BMC microbiology*, *23*(1), 204. https://doi.org/10.1186/s12866-023-02935-5.

4. Stark, J. H., Pilz, A., Jodar, L., & Moïsi, J. C. (2023). The Epidemiology of Lyme Borreliosis in Europe: An Updated Review on a Growing Public Health Issue. *Vector-Borne and Zoonotic Diseases*, *23*(4), 139–141. https://doi.org/10.1089/vbz.2022.0068.

5. *Lyme disease in the UK: the continued rise of an emerging zoonotic infection. (n.d.).* Homepage | Microbiology Society. https://microbiologysociety.org/publication/past-issues/life-on-a-changing-planet/article/lyme-disease-in-the-uk-the-continued-rise-of-an-emerging-zoonotic-infection.html.

6. *Borreliosis (Lyme disease)*. (*n.d.*). European Centre for Disease Prevention and Control. https://www.ecdc.europa.eu/en/borreliosis-lyme-disease.

7. Mead P. (2022). Epidemiology of Lyme Disease. *Infectious disease clinics of North America*, *36*(3), 495–521. https://doi.org/10.1016/j.idc.2022.03.004.

8. Burn, L., Vyse, A., Pilz, A., Tran, T. M. P., Fletcher, M. A., Angulo, F. J., Gessner, B. D., Moïsi, J. C., & Stark, J. H. (2023). Incidence of Lyme Borreliosis in Europe: A Systematic Review (2005-2020). *Vector borne and zoonotic diseases (Larchmont, N.Y.)*, *23*(4), 172–194. https://doi.org/10.1089/vbz.2022.0070.

9. UK Health Security Agency. (2022, 14 April). *Lyme disease epidemiology and surveillance*. GOV.UK. https://www.gov.uk/government/publications/lyme-borreliosis-epidemiology.

10. Tulloch, J. S. P., Semper, A. E., Brooks, T. J. G., Russell, K., Halsby, K. D., Christley, R. M., Radford, A. D., Vivancos, R., & Warner, J. C. (2019). The demographics and geographic distribution of laboratory-confirmed Lyme disease cases in England and Wales (2013-2016): an ecological study. *BMJ open*, *9*(7), e028064. https://doi.org/10.1136/bmjopen-2018-028064.

11. Brellier, F., Pujades-Rodriguez, M., Powell, E., Mudie, K., Mattos Lacerda, E., Nacul, L., & Wing, K. (2022). Incidence of Lyme disease in the United Kingdom and association with fatigue: A population-based, historical cohort study. *PloS one*, *17*(3), e0265765. https://doi.org/10.1371/journal.pone.0265765.

12. CD-N, A. C. R. (2021, 15 May). *What You Need to Know About the Stages of Lyme Disease*. Verywell Health. https://www.verywellhealth.com/lyme-disease-stages-5176671.

13. Hurley, B. (2024, August 2). *Lyme disease: the 'yuppie virus' with dangerous false diagnoses*. The Times & The Sunday Times. https://www.thetimes.com/world/us-world/article/lyme-disease-symptoms-serena-williams-alexis-ohainan-dltvc9pcb.

14. Wigle, R. (2024, 17 July). *Alexis Ohanian has Lyme disease – everything you need to know about the serious illness*. New York Post. https://nypost.com/2024/07/17/health/alexis-ohanian-has-lyme-disease-everything-you-need-to-know/.

15. Berger, E. (2025, 2 July). *US north-east sees record tick season as climate crisis sparks arachnid boom*. the Guardian. https://www.theguardian.com/us-news/2025/jul/02/ticks-us-north-east.

16. Geebelen, L., Devleesschauwer, B., Lernout, T., Tersago, K., Parmentier, Y., Van Oyen, H., Speybroeck, N., & Beutels, P. (2022). Lyme borreliosis in Belgium: a cost-of-illness analysis. *BMC public health*, *22*(1), 2194. https://doi.org/10.1186/s12889-022-14380-6.

17. Lyme disease NICE | The National Institute for Health and Care Excellence | Clinical Immunology. Allergology. Infectology. (n.d.). *Clinical Immunology. Allergology. Infectology.* Retrieved from https://kiai.com.ua/ua/archive/2020/1(122)/pages-39-46/hvoroba-layma-nice-the-national-institute-for-health-and-care-excellence.

18. Zolotukhin, O., Tril, V., Volkova, A., & Konechnyi, Y. (2024). Lyme disease in Ukraine in 2000–2023. *Przeglad Epidemiologiczny*. https://doi.org/10.32394/pe/195666.

19. Poiasnyk, I. M. (2020). Diagnostic challenges in patients with suspected neuroborreliosis. *Zaporizhzhia Medical Journal, 22*(2). https://doi.org/10.

20. Taj, K., Sletgaard, A., Mens, H., Lebech, A. M., & Brandt, C. T. (2022). *Ugeskrift for laeger*, *184*(10), V03210248.

21. Ford, L., & Tufts, D. M. (2021). Lyme Neuroborreliosis: Mechanisms of *B. burgdorferi* Infection of the Nervous System. *Brain sciences*, *11*(6), 789. https://doi.org/10.3390/brainsci11060789.

22. Bodilsen, J., Larsen, L., Brandt, C. T., Wiese, L., Hansen, B. R., Andersen, C. Ø., Lüttichau, H. R., Helweg-Larsen, J., Storgaard, M., & Nielsen, H. (2021). Existing Data Sources for Clinical Epidemiology: The Danish Study Group of Infections of the Brain Database (DASGIB). *Clinical epidemiology*, *13*, 921–933. https://doi.org/10.2147/CLEP.S326461.

23. Akkurt, B. H., Kraehling, H., Nacul, N. G., Elsharkawy, M., Schmidt-Pogoda, A., Minnerup, J., Stracke, C. P., & Schwindt, W. (2023). Vasculitis and Ischemic Stroke in Lyme Neuroborreliosis-Interventional Management Approach and Literature Review. *Brain sciences*, *13*(10), 1388. https://doi.org/10.3390/brainsci13101388.

24. Blanchard, L., Jones-Diette, J., Lorenc, T., Sutcliffe, K., Sowden, A., & Thomas, J. (2022). Comparison of national surveillance systems for Lyme disease in humans in Europe and North America: a policy review. *BMC public health*, *22*(1), 1307. https://doi.org/10.1186/s12889-022-13669-w.

25. Crissinger, T., & Baldwin, K. (2022). Early Disseminated Lyme Disease: Cranial Neuropathy, Meningitis, and Polyradiculopathy. *Infectious disease clinics of North America*, *36*(3), 541–551. https://doi.org/10.1016/j.idc.2022.02.006.

26. Roos K. L. (2021). Neurologic Complications of Lyme Disease. *Continuum (Minneapolis, Minn.)*, *27*(4), 1040–1050. https://doi.org/10.1212/CON.0000000000001015.

27. Knudtzen, F. C., Eikeland, R., Bremell, D., Quist-Paulsen, E., Johansen, I. S., Solheim, A. M., & Skarphédinsson, S. (2022). Lyme neuroborreliosis with encephalitis; a systematic literature review and a Scandinavian cohort study. *Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases*, *28*(5), 649–656. https://doi.org/10.1016/j.cmi.2021.11.001.

28. Halperin J. J. (2022). Nervous System Lyme Disease-Facts and Fallacies. *Infectious disease clinics of North America*, *36*(3), 579–592. https://doi.org/10.1016/j.idc.2022.02.007.

29. Marques, A. R., Strle, F., & Wormser, G. P. (2021). Comparison of Lyme Disease in the United States and Europe. *Emerging infectious diseases*, *27*(8), 2017–2024. https://doi.org/10.3201/eid2708.204763.

30. Kozak, S., Kaminiów, K., Kozak, K., & Paprocka, J. (2021). Lyme Neuroborreliosis in Children. *Brain sciences*, *11*(6), 758. https://doi.org/10.3390/brainsci11060758.

31. Garkowski, A., Łebkowska, U., Kubas, B., Garkowska, E., Rutka, K., Gawarecka, E., & Zajkowska, J. (2020). Imaging of

Lyme Neuroborreliosis: A Pictorial Review. *Open forum infectious diseases*, *7*(10), ofaa370. https://doi.org/10.1093/ofid/ofaa370.

32. Bruinsma, R. A., Zomer, T. P., Skogman, B. H., van Hensbroek, M. B., & Hovius, J. W. (2023). Clinical manifestations of Lyme neuroborreliosis in children: a review. *European journal of pediatrics*, *182*(5), 1965–1976. https://doi.org/10.1007/s00431-023-04811-w.

33. *Comparison of Lyme Disease in the United States and Europe*. (n.d.). Emerging Infectious Diseases journal. https://wwwnc.cdc.gov/eid/article/27/8/20-4763_article.

34. Radzišauskienė, D., Urbonienė, J., Jasionis, A., Klimašauskienė, A., Malickaitė, R., Petrulionienė, A., Vitkauskaitė, M., & Kaubrys, G. (2023). Clinical and epidemiological features of Lyme neuroborreliosis in adults and factors associated with polyradiculitis, facial palsy and encephalitis or myelitis. *Scientific reports*, *13*(1), 19881. https://doi.org/10.1038/s41598-023-47312-4.

35. MD, J. M. &. D. S. (2020, 4 February). *How Lyme Disease Affects the Brain*. Verywell Health. https://www.verywellhealth.com/lyme-neuroborreliosis-4581590.

36. Marques, A., Okpali, G., Liepshutz, K., & Ortega-Villa, A. M. (2022). Characteristics and outcome of facial nerve palsy from Lyme neuroborreliosis in the United States. *Annals of clinical and translational neurology*, *9*(1), 41–49. https://doi.org/10.1002/acn3.51488.

37. Cooper, L., Branagan-Harris, M., Tuson, R., & Nduka, C. (2017). Lyme disease and Bell's palsy: an epidemiological study of diagnosis and risk in England. *The British journal of general practice : the journal of the Royal College of General Practitioners*, *67*(658), e329–e335. https://doi.org/10.3399/bjgp17X690497.

38. I. V. Lutai, A. S. Ivanova, & T. A. Husieva. (2021). Clinical and epidemiological features of Lyme borreliosis. *Eastern Ukrainian Medical Journal*, *9*(1), 80-86. https://doi.org/10.21272/eumj.2021;9(1):80-86.

39. *Neuroborreliosis*. (n.d.). Sutura. https://sutura.org.ua/unsorted/nejroborelioz/.

40. Nordberg, C. L., Bodilsen, J., Knudtzen, F. C., Storgaard, M., Brandt, C., Wiese, L., Hansen, B. R., Andersen, Å. B., Nielsen, H., Lebech, A. M., & DASGIB study group (2020). Lyme neuroborreliosis in adults: A nationwide prospective cohort study. *Ticks and tick-borne diseases*, *11*(4), 101411. https://doi.org/10.1016/j.ttbdis.2020.101411

41. van Samkar, A., Bruinsma, R. A., Vermeeren, Y. M., Wieberdink, R. G., van Bemmel, T., Reijer, P. M. d., van Kooten, B., & Zomer, T. P. (2023). Clinical characteristics of Lyme neuroborreliosis in Dutch children and adults. *European Journal of Pediatrics*. https://doi.org/10.1007/s00431-022-04749-5.

42. Nykytyuk, S. O., & Klymniuk, S. I. (2020). Lyme borreliosis in children. *Advances in Clinical and Experimental Medicine*, (1), 14–25. https://doi.org/10.11603/1811-2471.2020.v.i1.11064.

43. Barstad, B., Quarsten, H., Tveitnes, D., Noraas, S., Ask, I. S., Saeed, M., Bosse, F., Vigemyr, G., Huber, I., & Øymar, K. (2018). Direct Molecular Detection and Genotyping of Borrelia burgdorferi Sensu Lato in Cerebrospinal Fluid of Children with Lyme Neuroborreliosis. *Journal of Clinical Microbiology*, *56*(5). https://doi.org/10.1128/jcm.01868-17.

44. Basa, N. R. (2024). Clinical, epidemiological, and immunological features of Lyme borreliosis in children [Doctoral dissertation, Lviv Danylo Halytskyi National Medical University]. Lviv Danylo Halytskyi National Medical University.

45. Blanc, F., Jaulhac, B., Fleury, M., de Seze, J., de Martino, S. J., Remy, V., Blaison, G., Hansmann, Y., Christmann, D., & Tranchant, C. (2017). Relevance of the antibody index to diagnose Lyme neuroborreliosis among seropositive patients. *Neurology*, *69*(10), 953–958. https://doi.org/10.1212/01.wnl.0000269672.17807.e0.

46. Frahier, H., Klopfenstein, T., Brunel, A.-S., Chirouze, C., & Bouiller, K. (2024). Characteristics of patients consulted for suspected Lyme neuroborreliosis in an endemic area. *Ticks and Tick-borne Diseases*, *15*(5), 102353. https://doi.org/10.1016/j.ttbdis.2024.102353.

47. Stevenson, B., Krusenstjerna, A. C., Castro-Padovani, T. N., Savage, C. R., Jutras, B. L., & Saylor, T. C. (2022). The Consistent Tick-Vertebrate Infectious Cycle of the Lyme Disease Spirochete Enables Borrelia burgdorferi To Control Protein Expression by Monitoring Its Physiological Status. *Journal of bacteriology*, *204*(5), e0060621. https://doi.org/10.1128/jb.00606-21.

48. Rauer, S., Kastenbauer, S., Hofmann, H., Fingerle, V., Huppertz, H. I., Hunfeld, K. P., Krause, A., Ruf, B., Dersch, R., & Consensus group (2020). Guidelines for diagnosis and treatment in neurology - Lyme neuroborreliosis. *German medical science : GMS e-journal*, *18*, Doc03. https://doi.org/10.3205/000279.

49. Ministry of Health of Ukraine. (2024, September 21). *Order No. 1623 «On the Approval of the Medical Care Standard «Lyme Disease»»*. State Expert Center of the Ministry of Health of Ukraine. Retrieved from https://www.dec.gov.ua/mtd/hvoroba-lajma/.

50. Mygland, A., Ljøstad, U., Fingerle, V., Rupprecht, T., Schmutzhard, E., Steiner, I., & European Federation of Neurological Societies (2010). EFNS guidelines on the diagnosis and management of European Lyme neuroborreliosis. *European journal of neurology*, *17*(1), 8–e4. https://doi.org/10.1111/j.1468-1331.2009.02862.x.

51. Dersch, R., & Rauer, S. (2023). Efficacy and safety of pharmacological treatments for Lyme neuroborreliosis: An updated systematic review. *European journal of neurology*, *30*(12), 3780–3788. https://doi.org/10.1111/ene.16034.

52. Dersch, R., Freitag, M. H., Schmidt, S., Sommer, H., Rücker, G., Rauer, S., & Meerpohl, J. J. (2024). Efficacy and safety of pharmacological treatments for neuroborreliosis–protocol for a systematic review. *Systematic Reviews*, *3*(1). https://doi.org/10.1186/2046-4053-3-117.

53. Dersch, R., Toews, I., Sommer, H., Rauer, S., & Meerpohl, J. J. (2015). Methodological quality of guidelines for management of Lyme neuroborreliosis. *BMC neurology*, *15*, 242. https://doi.org/10.1186/s12883-015-0501-3.

54. Ogrinc, K., Lusa, L., Lotrič-Furlan, S., Bogovič, P., Stupica, D., Cerar, T., Ružić-Sabljić, E., & Strle, F. (2016). Course and Outcome of Early European Lyme Neuroborreliosis (Bannwarth Syndrome): Clinical and Laboratory Findings. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America*, *63*(3), 346–353. https://doi.org/10.1093/cid/ciw299

55. Myszkowska-Torz, A., Frydrychowicz, M., Tomaszewski, M., Figlerowicz, M., Mania, A., & Mazur-Melewska, K. (2023). Neuroborreliosis and Post-Treatment Lyme Disease Syndrome: Focus on Children. *Life (Basel, Switzerland)*, *13*(4), 900. https://doi.org/10.3390/life13040900

56. Nemeth, J., Bernasconi, E., Heininger, U., Abbas, M., Nadal, D., Strahm, C., Erb, S., Zimmerli, S., Furrer, H., Delaloye, J., Kuntzer, T., Altpeter, E., Sturzenegger, M., Weber, R., & for, t. (2016). Update of the Swiss guidelines on post-treatment Lyme disease syndrome. *Swiss Medical Weekly*. https://doi.org/10.4414/smw.2016.14353

57. Kopcha, V. S., Korodiuk, V. I., Radetska, L. V., & Kadubets, O. Y. (2018). Challenges in the diagnosis of neuroborreliosis. *Infectious Diseases,* (1). https://doi.org/10.11603/1681-2727.2018.1.8681

58. *Chronic Symptoms and Lyme Disease*. (n.d.). Lyme Disease. https://www.cdc.gov/lyme/signs-symptoms/chronic-symptoms-and-lyme-disease.html.

59. Talbot, N. C., Spillers, N. J., Luther, P., Flanagan, C., Soileau, L. G., Ahmadzadeh, S., Viswanath, O., Varrassi, G., Shekoohi, S., Cornett, E. M., Kaye, A. M., & Kaye, A. D. (2023). Lyme Disease and Post-treatment Lyme Disease Syndrome: Current and Developing Treatment Options. *Cureus*, *15*(8), e43112. https://doi.org/10.7759/cureus.43112.

60. Maksimyan, S., Syed, M. S., & Soti, V. (2021). Post-Treatment Lyme Disease Syndrome: Need for Diagnosis and Treatment. *Cureus*, *13*(10), e18703. https://doi.org/10.7759/cureus.18703.

61. *Lyme Disease*. IDSA Home. https://www.idsociety.org/practice-guideline/lyme-disease/.

62. Gomes-Solecki, M., Arnaboldi, P. M., Backenson, P. B., Benach, J. L., Cooper, C. L., Dattwyler, R. J., Diuk-Wasser, M., Fikrig, E., Hovius, J. W., Laegreid, W., Lundberg, U., Marconi, R. T., Marques, A. R., Molloy, P., Narasimhan, S., Pal, U., Pedra, J. H. F., Plotkin, S., Rock, D. L., Rosa, P., … Schutzer, S. E. (2020). Protective Immunity and New Vaccines for Lyme Disease. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America*, *70*(8), 1768–1773. https://doi.org/10.1093/cid/ciz872.

63. Nayak, A., Schüler, W., Seidel, S., Gomez, I., Meinke, A., Comstedt, P., & Lundberg, U. (2020). Broadly Protective Multivalent OspA Vaccine against Lyme Borreliosis, Developed Based on Surface Shaping of the C-Terminal Fragment. *Infection and immunity*, *88*(4), e00917-19. https://doi.org/10.1128/IAI.00917-19.

64. Eisen, L., & Dolan, M. C. (2016). Evidence for Personal Protective Measures to Reduce Human Contact With Blacklegged Ticks and for Environmentally Based Control Methods to Suppress Host-Seeking Blacklegged Ticks and Reduce Infection with Lyme Disease Spirochetes in Tick Vectors and Rodent Reservoirs. *Journal of medical entomology*, *53*(5), 1063–1092. https://doi.org/10.1093/jme/tjw103.

65. Colby, E., Gould, L. H., Tan, Y., Pilz, A., Brestrich, G., Moisi, J. C., & Stark, J. H. (2025). Factors influencing Lyme borreliosis risk perception in Europe: a cross-sectional multi-country survey study. *BMC Public Health*, *25*(1). https://doi.org/10.1186/s12889-025-23722-z.

КЛІНІКО-ЕПІДЕМІОЛОГІЧНІ ТА ДІАГНОСТИЧНІ ОСОБЛИВОСТІ НЕЙРОБОРЕЛІОЗУ В УКРАЇНІ ТА СВІТІ: СУЧАСНИЙ ПОГЛЯД

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РЕЗЮМЕ. Лайм-бореліоз – системне зоонозне захворювання, що викликається бактеріями Borrelia burgdorferi sensu lato та передається через укуси кліщів роду Ixodes. Характерна поетапна клінічна картина включає ранню локалізовану стадію з мігруючою еритемою, ранню дисеміновану стадію із залученням нервової системи, серця та шкіри, а також пізню стадію з хронічними ураженнями опорно-рухового апарату і нервової системи. Поширеність Лайм-бореліозу значна у Північній півкулі з найвищими рівнями захворюваності у країнах Західної Європи, США та окремих регіонах України, де останнім часом відзначається зростання кількості випадків.

Нейробореліоз виникає у 10–15 % пацієнтів, переважно через 2–6 тижнів після інфікування, проявляючись менінгітом, радикулопатіями, лицьовим паралічем та іншими неврологічними симптомами. Відмінності у клінічних ознаках нейробореліозу зумовлені географічними особливостями циркуляції різних генотипів Borrelia. Діагностика поєднує серологічні методи, аналіз спинномозкової рідини та молекулярні дослідження, тоді як лікування базується на антибіотикотерапії (доксициклін, цефтріаксон) з тривалістю курсу 14–21 доба. Посттерапевтичний синдром Лайм-бореліозу, що виникає у 10–20 % пацієнтів, характеризується тривалою втомою та когнітивними порушеннями без ознак активної інфекції. Реабілітація, що включає фізіотерапію та психоемоційну підтримку, є невід'ємною частиною ведення хворих із неврологічними ускладненнями. Профілактика, що охоплює індивідуальні заходи захисту, епіднагляд та розробку вакцин, залишається ключовим фактором зменшення рівня захворюваності, особливо в умовах підвищеного ризику серед військових і населення у регіонах з обмеженим доступом до медичних послуг.

Ключові слова: *Лайм-бореліоз, нейробореліоз, діагностика, епідеміологія, посттерапевтичний синдром Лайма, профілактика, міцне здоров'я та благополуччя.*

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