



Tick-Borne Infections Council
of North Carolina, Inc.

NEWSLETTER 2023, Volume 1



Quote: “Initiating treatment with psychotropics in patients with comorbid alpha-gal syndrome is complicated by the *ubiquity of mammalian products as inactive ingredients in medications*. Moreover, some common pharmaceutical ingredients can be sourced from animals or plants. For instance, stearic acid and lactic acid are generally alpha-gal positive if sourced from animals and alpha-gal negative if sourced from plants. Unfortunately, the **sourcing information for these ingredients is not readily available** in medication package inserts.” -- Narlesky MR, et al in *Initiating Psychotropic Treatment in a Patient With Alpha-Gal Syndrome*. *Cureus*, September 2022 (See entire abstract with access to article in the North Carolina and the South section below.)

Highlights...

- **Data links to the CDC**
- **Current and Future Strategies for the Diagnosis and Treatment of the Alpha-Gal Syndrome**
- **Ehrlichiosis in a Recent Liver Transplant Recipient**
- **Lyme Disease, NY State Public Health Department, & Climate Change**
- ***Borrelia burgdorferi* (Lyme) seropositivity in a small population of wild-caught eastern fence lizards**
- **Asian Longhorned Tick found in Caldwell County**
- **Histopathological Findings on a Tick-Bite Lesion**
- **Tick Species Composition, Collection Rates, and Phenology Provide Insights into Tick-Borne Disease Ecology in Virginia**

- **Neurological Pain, Psychological Symptoms, and Diagnostic Struggles among Patients with Tick-Borne Diseases**
- **American dog ticks along their expanding range edge in Ontario, Canada**
- **Study of American Dog Ticks Across the US**
- **Study of personal protection measures finds no intervention predominantly or consistently effective**
- **Lyme disease diagnoses increased 357 percent in rural areas over past 15 years according to insurance claims**
- **Clinician barriers to providing care for chronic Lyme patients**
- **Migrant farm workers in Texas and risk of tick-borne infections**
- **Risk of tick-borne pathogens in New York City (Staten Island)**
- **Almost half of southern Italians with a tick bite had a pathogen**
- **Catnip as a tick repellent**
- **Tularemia and biowarfare**
- **Brain abnormalities and clinical correlates in post treatment Lyme disease**
- **Tick-Borne Disease Exposure Risk in Acadia National Park, Mount Desert Island, Maine**

VBWG meeting dates for 2023: None announced.

Location:

Office of the Chief Medical Examiner Photo ID required.
 4312 District Drive
 Raleigh, NC 27607

Link to Notice to Medical Providers from the State Department of Public Health on Lyme Disease and Rickettsial Diseases: “Annual Update on Diagnosis and Surveillance for Tickborne Diseases”

The state has started issuing only one letter. Please see the homepage of our website to access. www.tic-nc.org.

To look at the (state) NCDHHS’s tick data, go to epi.dph.ncdhhs.gov/cd/diseases/ticks.html

Case data for Lyme disease from the CDC for North Carolina

The CDC:

NC had 344 cases of reported Lyme disease in 2019.

NC had 264 cases of reported Lyme disease in 2020.

<https://www.cdc.gov/lyme/datasurveillance/surveillance-data.html>

Links to access Lyme and other tick-borne infections data from the CDC.

<https://www.cdc.gov/lyme/datasurveillance/surveillance-data.html>

Annual incidence. <https://www.cdc.gov/lyme/datasurveillance/surveillance-data.html>

https://wonder.cdc.gov/nndss/nndss_annual_tables_menu.asp

<https://www.cdc.gov/lyme/datasurveillance/maps-recent.html>

As of November 1, 2022, 2019 is the latest year for which there is Lyme disease data.

CDC: “More recent case counts are not publicly available at this time.” (Accessed Nov 1, 2022.)



Where To Find CDC Case Definitions and their Statement that the Surveillance Case Definitions Are “not to be used as the sole criteria for establishing critical diagnosis”

Case Definition and Report Forms

The surveillance definition of Lyme disease was revised in January 2022.

See https://www.cste.org/resource/resmgr/ps/ps2021/21-ID-05_Lyme_Disease.pdf for the rationale behind the changes.

- ndc.services.cdc.gov/case-definitions/lyme-disease-2022/
- www.cdc.gov/lyme/resources/lymediseasecasereportform.pdf (for public health officials' use)
- **Note from the CDC:** *The categorical labels used here to stratify laboratory evidence are intended to support the standardization of case classifications for public health surveillance. The categorical labels should not be used to interpret the utility or validity of any laboratory test methodology.* Accessed and copied Nov 16, 2022 at <https://ndc.services.cdc.gov/case-definitions/lyme-disease-2022/>.

The surveillance definition of Rocky Mountain spotted fever/spotted fever rickettsiosis was revised in 2020.

- ndc.services.cdc.gov/case-definitions/spotted-fever-rickettsiosis-2020/

The [Southeast Regional Center of Excellence in Vector-Borne Disease](#) (SECVBD) will continue its vital work for another five years, thanks to renewed funding from the Centers for Disease Control and Prevention (CDC). Entomologist John Beier, Sc.D., a professor at the University of Miami Miller School of Medicine Department of Public Health Sciences, leads the Miller School's SECVBD efforts in collaboration with the Miami-Dade County Mosquito Control Division.

Based at the University of Florida, the SECVBD was established in 2016, performing its initial work as the Zika epidemic reached the U.S. The center now includes an interdisciplinary team of researchers — from institutions including the Miller School, the University of South Carolina, University of North Carolina at Chapel Hill, Florida International University, Old Dominion University, and Ponce Health Sciences University in Puerto Rico — who work with leaders of state public health and mosquito and tick control agencies in the Southeast.

<https://physician-news.umiamihealth.org/cdc-renews-funding-for-study-of-vector-borne-diseases/>

Heartland virus disease cases by state, as of January 2021

As of January 2021, more than 50 cases of Heartland virus disease have been reported from states in the Midwestern and Southern United States. Most people diagnosed with the disease became sick from May through September.

All residents of and visitors to areas where Heartland virus activity has been identified are at risk of Heartland virus infection, particularly people who engage in outdoor work and recreational activities.



Heartland virus is not currently a notifiable disease, but CDC asks that states report possible cases of Heartland virus on a voluntary basis.

<https://www.cdc.gov/heartland-virus/statistics/index.html>

CDC: Lyme disease case reporting for 2020 might be artificially reduced due to pandemic

Effects of COVID-19 Pandemic on Reported Lyme Disease, United States, 2020

Surveys indicate US residents spent more time outdoors in 2020 than in 2019, but fewer tick bite-related emergency department visits and Lyme disease laboratory tests were reported. Despite ongoing exposure, Lyme disease case reporting for 2020 might be artificially reduced due to coronavirus disease-associated changes in healthcare-seeking behavior. McCormick DW, et al. *Emerg Infect Dis.* 2021 Oct; 27(10): 2715-2717. doi: [10.3201/eid2710.210903](https://doi.org/10.3201/eid2710.210903).

State tick research and/or reports

The 2019 tick borne disease surveillance summaries are now complete. You can view them at the bottom of the NC DHHS Epi Section Facts & Figures page, under Vector.

<https://epi.dph.ncdhhs.gov/cd/vector/LymeSurveillanceSummary2020.pdf>

<https://epi.dph.ncdhhs.gov/cd/vector/SpottedFeverGroupRickettsiosisSurveillanceSummary2020.pdf>

Note: By the *former* CDC definition, six counties had confirmed cases of Lyme disease in two persons who had not traveled out of the county for 30 days after their tick exposure. **Therefore, these counties were endemic for Lyme disease by the former CDC definition: Wake, Guilford, Haywood, Alleghany, Buncombe, and Wilkes.**

Counties with one case of locally acquired Lyme disease were: Cleveland (2008), Wilson (2009), Pitt (2009), Carteret (2009), Gates (2011), Perquimans (2011), Rowan (2013), Union (2013), Caldwell (2013), Franklin (2014), Stanley (2014), Duplin 2014.

Report from the State or Vectorborne Disease Work Group meeting

None: no meetings.

State tick research and/or reports

The 2021 tick-borne disease surveillance summaries are now complete. You can view them at the bottom of the NC DHHS Epi Section Facts & Figures page, under Vector

epi.dph.ncdhhs.gov/cd/lyme/LymeSurveillanceSummary2021.pdf

TIC-NC Talks and Materials Distributed

Brochures/booklets:

Ashe County Public Library
New Bern

In packets for some alpha gal patients
Asheville: some for firefighters, reporters,
Trader Joe's, health care workers

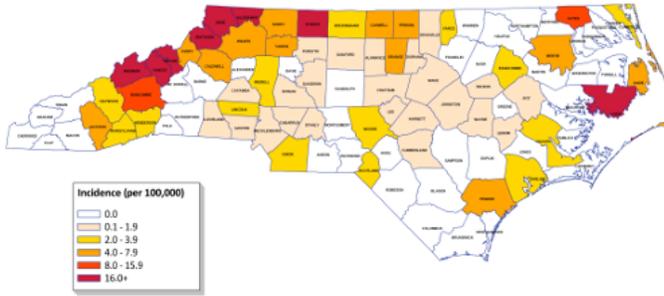
Interview: Spectrum News 1 Charlotte
spectrumlocalnews.com/nc/charlotte/news/2022/06/10/it-s-tick-season-in-north-carolina

Comment to author regarding misinformation on ticks sent to magazine (unpublished):

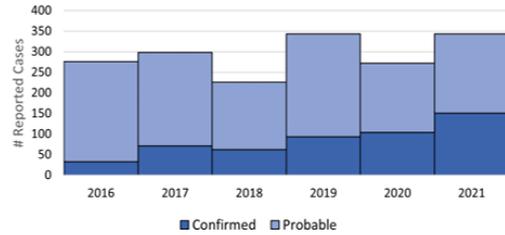
"Our State: Celebrating North Carolina"

Newspaper: Article mentioning TIC-NC in
Chatham News + Record

Confirmed and Probable Incidence of Lyme Disease Cases by County of Residence, NC, 2021



Confirmed and Probable Cases of Lyme Disease by Year, NC, 2016-2021; n= 1758



Note: Map is for 2021 only.

TIC-NC Activities

October at the North Carolina State Fair

Tyler Harran with the **NCDA Pesticides Division** distributed 1,000 of our booklets and talked to people at the Pesticides Division booth about our work and how to stay safer from tick-borne diseases and conditions. Thank you, Tyler!



Photo taken and sent by TIC-NC member who moved to Nova Scotia where there is a growing tick problem. Bre Giffin saw this in their local children's museum, Discovery Centre in Halifax, along with more information. Thanks for sharing this with us, Bre!



North Carolina and South

Initiating Psychotropic Treatment in a Patient with Alpha-Gal Syndrome

Alpha-gal syndrome, which is typically acquired by a tick bite, is an IgE-mediated immune response to galactose-alpha-1,3-galactose (alpha-gal), an oligosaccharide in most mammalian tissue. This report describes a 29-year-old Caucasian female with comorbid alpha-gal syndrome who presented to the inpatient psychiatric unit after an intentional overdose.

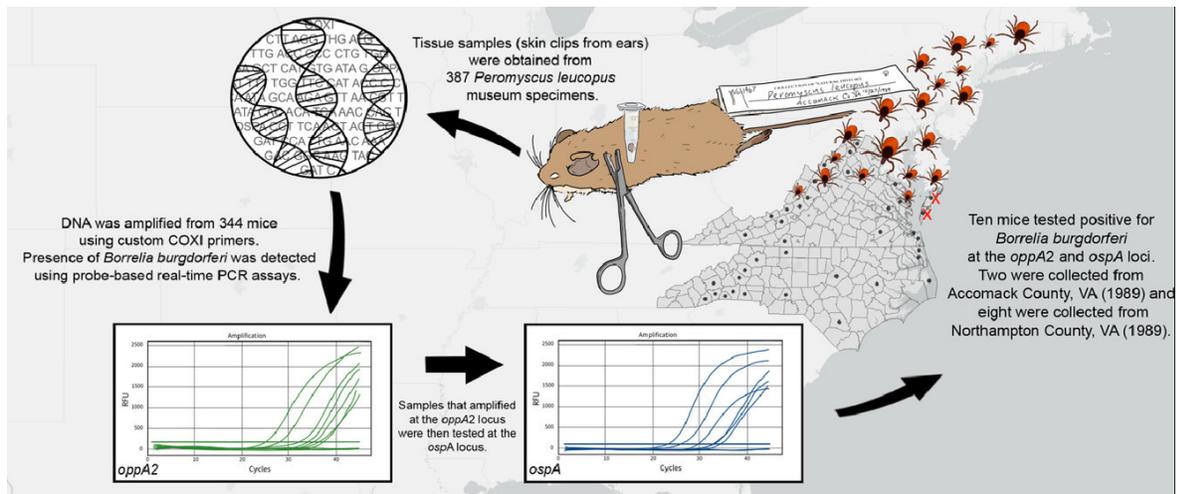
Because of the patient's alpha-gal syndrome, the treatment team worked with the hospital pharmacy to evaluate treatment options that did not contain mammalian products. After carefully reviewing the ingredients of suitable medications on formulary, the patient was started on a generic sertraline formulation that was free of mammalian derivatives. At the time of discharge, the patient reported significant symptom improvement and was free of symptoms suggesting an alpha-gal allergic reaction. This case illustrates the challenges of starting psychiatric medications in a patient with comorbid alpha-gal syndrome. Narlesky MR, et al. *Cureus* 14(8): e28443. doi:10.7759/cureus.28443. Open access.

Use of mammalian museum specimens to test hypotheses about the geographic expansion of Lyme disease in the southeastern United States

Lyme disease, caused primarily in North America by the bacterium *Borrelia burgdorferi sensu stricto*, is the most frequently reported vector-borne disease in North America and its geographic extent is increasing in all directions from foci in the northeastern and north central United States. Several southeastern states, including Virginia and North Carolina, have experienced large increases in Lyme disease incidence in the past two decades, with the biggest changes in incidence occurring in the western portion of each state.

We tested the hypothesis that *B. burgdorferi s.s.* was present in western Virginia and North Carolina *Peromyscus leucopus* populations prior to the recent emergence of Lyme disease. Specifically, we examined archived *P. leucopus* museum specimens, sampled between 1900 and 2000, for *B. burgdorferi s.s.* DNA. After confirming viability of DNA extracted from ear punch biopsies from *P. leucopus* study skins collected between 1945 and 2000 in 19 Virginia counties and 17 North Carolina counties, we used qPCR of two species-specific loci to test for the presence of *B. burgdorferi s.s.* DNA. Ten mice, all collected from the Eastern Shore of Virginia in 1989, tested positive for presence of *B. burgdorferi*; all the remaining 344 specimens were *B. burgdorferi*-negative.

Our results suggest that *B. burgdorferi s.s.* was not common in western Virginia or North Carolina prior to the emergence of Lyme disease cases in the past two decades. Rather, the emergence of Lyme disease in this region has likely been driven by the relatively recent expansion of *B. burgdorferi s.s.* in southward-moving ticks and reservoir hosts in the mountainous counties of these two states. Lever M, et al. *Ticks and Tick-borne Diseases*, doi.org/10.1016/j.ttbdis.2022.102018.



Article below has good description of the Ehrlichia species and symptoms

An Unusual Case of Ehrlichiosis Manifesting With Hyponatremia, Acute Encephalopathy, and Hemophagocytic Lymphohistiocytosis

Ehrlichiosis is a tick-borne infection that has become increasingly more common in the United States in recent years. We present a case of a patient who was found to have confusion, hyponatremia, and hemophagocytic lymphohistiocytosis after contracting *Ehrlichia chaffeensis* following a tick exposure. This unusual presentation emphasizes the need for increased awareness of the varied symptoms of this infection and the importance of obtaining a complete history from patients at risk of vector-borne diseases. Bolling T, et al. *Cureus* 14(7): e26943. doi:10.7759/cureus.26943.

Borrelia burgdorferi seropositivity found in a small population of wild-caught eastern fence lizards

Outer surface protein E (OspE) mediates *Borrelia burgdorferi* sensu stricto strain-specific complement evasion in the eastern fence lizard, *Sceloporus undulatus*

In North America, Lyme disease is primarily caused by the spirochetal bacterium *Borrelia burgdorferi* sensu stricto (*Bb*), which is transmitted between multiple vertebrate hosts and ixodid ticks, and is a model commonly used to study host-pathogen interactions. While *Bb* is consistently observed in its mammalian and avian reservoirs, the bacterium is rarely isolated from North American reptiles. Two closely related lizard species, the eastern fence lizard (*Sceloporus undulatus*) and the western fence lizard (*Sceloporus occidentalis*), are examples of reptiles parasitized by *Ixodes* ticks. Vertebrates are known to generate complement as an innate defense mechanism, which can be activated before *Bb* disseminate to distal tissues. Complement from western fence lizards has proven lethal against one *Bb* strain, implying the role of complement in making those lizards unable to serve as hosts to *Bb*. However, *Bb* DNA is

occasionally identified in distal tissues of field-collected eastern fence lizards, suggesting some *Bb* strains may overcome complement-mediated clearance in these lizards. These findings raise questions regarding the role of complement and its impact on *Bb* interactions with North American lizards.

In this study, we found *Bb* seropositivity in a small population of wild-caught eastern fence lizards and observed *Bb* strain-specific survivability in lizard sera. We also found that a *Bb* outer surface protein, OspE, from *Bb* strains viable in sera, promotes lizard serum survivability and binds to a complement inhibitor, factor H, from eastern fence lizards. Our data thus identify bacterial and host determinants of eastern fence lizard complement evasion, providing insights into the role of complement influencing *Bb* interactions with North American lizards.

Marcinkiewicz L, et al. *Ticks and Tick-borne Diseases*, doi.org/10.1016/j.ttbdis.2022.102081. *Open access*.

Current and Future Strategies for the Diagnosis and Treatment of the Alpha-Gal Syndrome (AGS)

This article has a thorough discussion of AGS and is free to access.

J Asthma Allergy. 2022;15:957-970, Vaz-Rodrigues R, Mazuecos L, de la Fuente J.

<https://www.dovepress.com/current-and-future-strategies-for-the-diagnosis-and-treatment-of-the-a-peer-reviewed-fulltext-article-JAA>

Another alpha-gal review that is comprehensive

The Meat of the Matter: Understanding and Managing Alpha-Gal Syndrome

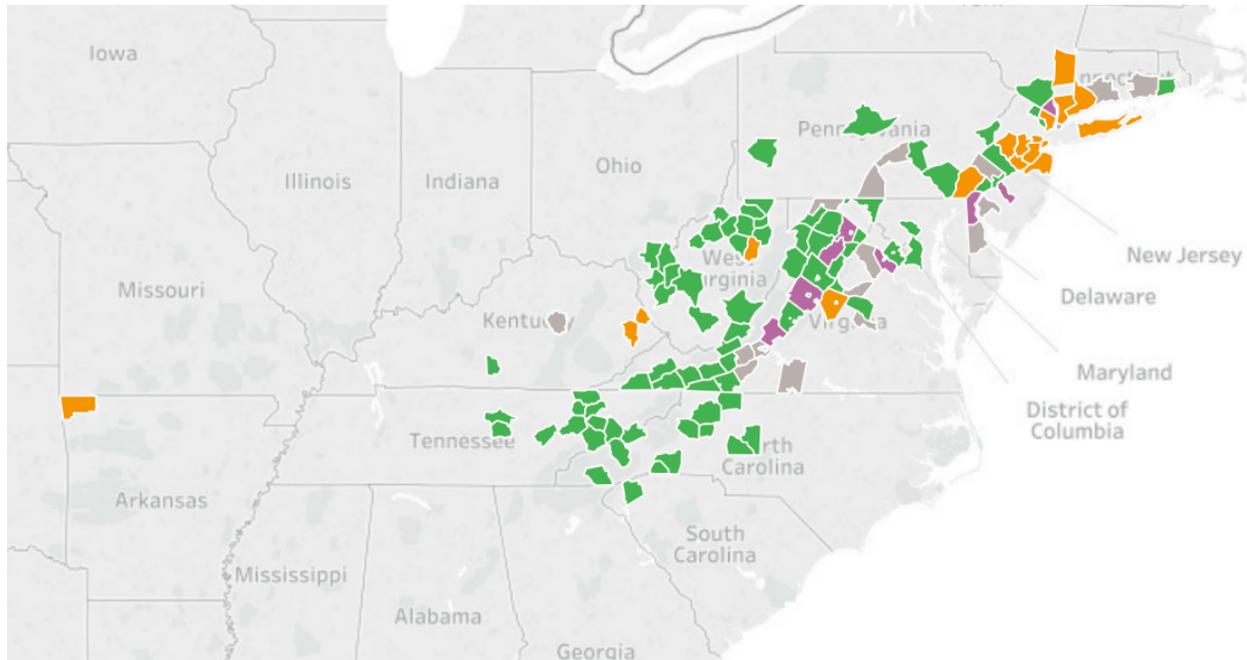
Alpha-gal syndrome is an unconventional food allergy, characterized by IgE-mediated hypersensitivity responses to the glycan galactose-alpha-1,3-galactose (alpha-gal) and not to a food-protein. In this review, we discuss how alpha-gal syndrome reframes our current conception of the mechanisms of pathogenesis of food allergy. The development of alpha-gal IgE is associated with tick bites though the possibility of other parasites promoting sensitization to alpha-gal remains... We review the foundation of management in alpha-gal syndrome, namely avoidance, but also discuss the use of antihistamines, mast cell stabilizers, and the emerging role of complementary and alternative therapies, biological products, and oral immunotherapy in the management of this condition. Alpha-gal syndrome influences the safety and tolerability of medications and medical devices containing or derived from mammalian products and impacts quality of life well beyond food choices. MacDougall J et al. *ImmunoTargets and Therapy* 2022;11 37–54. For entire paper see:

<https://www.dovepress.com/the-meat-of-the-matter-understanding-and-managing-alpha-gal-syndrome-peer-reviewed-fulltext-article-ITT#t0001>.

Asian Longhorned Tick found in Caldwell County

The Asian longhorned tick (*Haemaphysalis longicornis*) is native to China, Japan, and Korea. Unfortunately, this tick has been in the United States since 2010. Now it's in Caldwell County.

The NC Wildlife Commission collected this tick from a deer in the county. Currently, this tick is confirmed to be in 130 counties across 15 states. North Carolina has 11 confirmed counties, with Caldwell County being the newest county added to the list. Read more at: <https://caldwell.ces.ncsu.edu/2021/01/asian-longhorned-tick-found-in-caldwell-county/Nagy S & Lovejoy T>.



Tick Species Composition, Collection Rates, and Phenology Provide Insights into Tick-Borne Disease Ecology in Virginia

To better understand tick ecology in Virginia and the increasing Lyme disease incidence in western Virginia, a comparative phenological study was conducted in which monthly collections were performed at twelve sampling locations in southwestern Virginia (high Lyme disease incidence) and 18 equivalent sampling locations in southeastern Virginia (low Lyme disease incidence) for one year.

In western Virginia, we also explored the effect of elevation on collection rates of *Ixodes scapularis* Say (Acari: Ixodidae) and *Amblyomma americanum* (L.) (Acari: Ixodidae). In total, 35,438 ticks were collected (33,106 *A. americanum*; 2,052 *I. scapularis*; 134 *Ixodes affinis* Neumann [Acari: Ixodidae]; 84 *Dermacentor variabilis* [Say] [Acari: Ixodidae]; 49 *Dermacentor albipictus* [Packard] [Acari: Ixodidae]; 10 *Haemaphysalis leporispalustris* [Packard] [Acari: Ixodidae]; 2 *Ixodes brunneus* Koch [Acari: Ixodidae]; 1 *Haemaphysalis longicornis* Neumann [Acari: Ixodidae]).

Within southwestern Virginia, *Ixodes scapularis* collection rates were not influenced by elevation, unlike *A. americanum* which were collected more frequently at lower elevations (e.g., below 500 m). Notably, *I. scapularis* larvae and nymphs were commonly collected in

southwestern Virginia (indicating that they were questing on or above the leaf litter) but not in southeastern Virginia. Questing on or above the leaf litter is primarily associated with northern populations of *I. scapularis*.

These findings may support the hypothesis that *I. scapularis* from the northeastern United States are migrating into western Virginia and contributing to the higher incidence of Lyme disease in this region. This comparative phenological study underscores the value of these types of studies and the need for additional research to further understand the rapidly changing tick-borne disease dynamics in Virginia. Morris CN, et al. *Journal of Medical Entomology* 2022, <https://doi.org/10.1093/jme/tjac121>.

Genetic characterization of a novel *Ehrlichia chaffeensis* genotype from an *Amblyomma tenellum* tick from South Texas, USA

Ehrlichia chaffeensis is the causative agent of human monocytotropic ehrlichiosis (HME), a disease that ranges in severity from mild to fatal infection. *Ehrlichia chaffeensis* is maintained in a zoonotic cycle involving white-tailed deer (*Odocoileus virginianus*) as the main vertebrate reservoir and lone star ticks (*Amblyomma americanum*) as its principal vector. Through complete genomic analysis from human ehrlichial isolates and DNA sequences obtained from deer and tick specimens, nine strains of *E. chaffeensis* have been characterized. Few studies have examined the genetic diversity of *E. chaffeensis* in ticks, and some of these investigations have identified that the genetic sequences coincide with the circulating strains reported so far.

Here, we report the first evidence of *E. chaffeensis* DNA from an unfed *Amblyomma tenellum* (formerly *Amblyomma imitator*) collected in South Texas. We characterized the genetic variation of this *E. chaffeensis* genotype using conserved gene markers such as rRNA, dsb, and groEL. We also used gene targets useful to distinguish genotypes, such as the variable length PCR target gene (VLPT) and 120-kDa gene, encoding the tandem-repeat proteins TRP32 and TRP120, respectively. Our results suggest a novel *E. chaffeensis* genotype that exhibited greater variability than other genotypes of *E. chaffeensis* and highlights the role for *A. tenellum* as a potential vector of *E. chaffeensis*. Arroyave E, et al. *Ticks and Tick-borne Diseases*. <https://doi.org/10.1016/j.ttbdis.2022.101990>.

Migrant farm workers in Texas and risk of tick-borne infections

Tick-Borne Disease Risk and Exposure among Vulnerable Populations in Perceived Non-Endemic Regions

Migrant and seasonal workers in the United States, among others in rural agricultural communities, may be at an elevated risk for tick-borne diseases (TBDs). This research included a survey of over 250 such workers, both women and men, in 13 locations across five eco-systems in Texas, which is generally perceived as a non-endemic state.

Employing a modified Horowitz Multiple Systemic Infectious Disease Syndrome Questionnaire, a range of data was collected regarding living conditions, such as sleeping outside, along with queries about tick exposure, tick bite encounters, illnesses, and prior TBD diagnoses.

Findings revealed that 67% of the respondents who scored highest on symptom severity suggestive of a TBD reported sleeping outdoors (compared to 29% of the lowest scoring), with 78% of the likely-to-highly-likely group also recalling tick-bite encounters (compared to 20% of the lowest scoring). Approximately 28% of those who reported severe symptoms also indicated previous Lyme disease diagnoses. This research serves as an initial investigation into the living conditions associated with increased risk of TBDs among vulnerable populations. It underscores the need for further assessments of TBD risk relative to vulnerable populations even in perceived non-endemic regions and highlights the paucity of actionable data as a critical public health issue. Thomas K, et al. *Zoonotic Dis.* 2022, 2(3), 111-116; doi.org/10.3390/zoonoticdis2030011. Open access.

For a thorough discussion of tularemia see:

<https://www.gideononline.com/blogs/tularemia/>

By 1960, around 85% of all cases of tularemia in the south-central US were found to be associated with **tick** exposure. Rabbits were the main contributors to the spread of tularemia to humans... [Tularemia: Rabbit Fever as a Biological Weapon?](#)

National Section

A multimodal neuroimaging study of brain abnormalities and clinical correlates in post treatment Lyme disease

Lyme disease is the most common vector-borne infectious disease in the United States. Post-treatment Lyme disease (PTLD) is a condition affecting 10–20% of patients in which symptoms persist despite antibiotic treatment. Cognitive complaints are common among those with PTLD, suggesting that brain changes are associated with the course of the illness. However, there has been a paucity of evidence to explain the cognitive difficulties expressed by patients with PTLD.

This study administered a working memory task to a carefully screened group of 12 patients with well-characterized PTLD and 18 healthy controls while undergoing functional MRI (fMRI). A subset of 12 controls and all 12 PTLD participants also received diffusion tensor imaging (DTI) to measure white matter integrity. Clinical variables were also assessed and correlated with these multimodal MRI findings. On the working memory task, the patients with PTLD responded more slowly, but no less accurately, than did controls. FMRI activations were observed in expected regions by the controls, and to a lesser extent, by the PTLD participants. The PTLD

group also hypoactivated several regions relevant to the task. Conversely, novel regions were activated by the PTLD group that were not observed in controls, suggesting a compensatory mechanism. Notably, three activations were located in white matter of the frontal lobe. DTI measures applied to these three regions of interest revealed that higher axial diffusivity correlated with fewer cognitive and neurological symptoms.

Whole-brain DTI analyses revealed several frontal lobe regions in which higher axial diffusivity in the patients with PTLD correlated with longer duration of illness. Together, these results show that the brain is altered by PTLD, involving changes to white matter within the frontal lobe. Higher axial diffusivity may reflect white matter repair and healing over time, rather than pathology, and cognition appears to be dynamically affected throughout this repair process. Marvel CL. PloS, doi.org/10.1371/journal.pone.0271425.

An Evaluation of the Impact of Increased Lyme Disease Prevalence on New York State Public Health Department Action in the Face of Climate Change

Lyme disease is a zoonotic disease transmitted to humans from black-legged ticks (*Ixodes scapularis*) carrying the bacterium *Borrelia burgdorferi* that can cause serious complications if not detected and treated in a timely manner. While Lyme disease has only been present in the United States since 1970, it has quickly become endemic to the northeast United States. And since 1990, caseloads have dramatically risen and are estimated to be close to 400,000 cases a year.

The increase in incidence rates is attributable to climate change. As the planet warms, the number of tick vectors increases, vector mortality rates lessen, vector life cycles become shorter, and vector active seasons become longer. In New York State there has been a northward expansion of ticks and Lyme disease cases from hyperendemic areas (like the Hudson Valley) to emerging areas (like the Adirondacks.) Public health action has the potential to halt the spread of Lyme disease into areas where incidence is currently low.

This study aims to evaluate barriers to New York State county-level public health departments taking action to prevent and combat the spread of Lyme disease. Through a confidential survey, it was determined that financial and human resources are consistently the greatest barriers to county-level Lyme disease prevention activities. Data availability was found to be significantly more of a barrier in counties where Lyme disease is still emerging than in counties where Lyme disease is already hyperendemic.

To prevent counties where Lyme disease is emerging from becoming hyperendemic, it is imperative to establish robust and accurate data surveillance systems. Appropriate data systems would also be essential in preventing the spread of other tick-borne diseases in the face of climate change, such as anaplasmosis and babesiosis in New York State. Krevlin ZA, et al. Preprint. Research Square. doi.org/10.21203/rs.3.rs-1720313/v1.

Neurological Pain, Psychological Symptoms, and Diagnostic Struggles among Patients with Tick-Borne Diseases

Public health reports contain limited information regarding the psychological and neurological symptoms of tick-borne diseases (TBDs). Employing a mixed-method approach, this analysis triangulates three sources of symptomology and provides a comparison of official public health information, case reports, and medical literature, and the self-reported symptoms of patients with Lyme disease and other TBDs. Out of the fifteen neuropsychiatric symptoms reported in the medical literature for common TBDs, headaches and fatigue and/or malaise are the only two symptoms fully recognized by public health officials. Of TBDs, Lyme disease is the least recognized by public health officials for presenting with neuropsychiatric symptoms; only headaches and fatigue are recognized as overlapping symptoms of Lyme disease.

Comparisons from a patient symptoms survey indicate that self-reports of TBDs and the associated symptoms align with medical and case reports. Anxiety, depression, panic attacks, hallucinations, delusions, and pain—ranging from headaches to neck stiffness and arthritis—are common among patients who report a TBD diagnosis. Given the multitude of non-specific patient symptoms, and the number and range of neuropsychiatric presentations that do not align with public health guidance, this study indicates the need for a revised approach to TBD diagnosis and for improved communication from official public health sources regarding the wide range of associated symptoms. Maxwell SP, et al. *Healthcare* 10, doi.org/10.3390/healthcare10071178.

Lyme disease diagnoses increased 357 percent in rural areas over past 15 years, according to private insurance claims

From 2007 to 2021, claims with Lyme disease diagnoses rose 65 percent in urban areas, according to FAIR Health study.

Newswise — NEW YORK, NY—August 2, 2022—Lyme disease has experienced notable growth in the United States over the past 15 years and, as a result, has become an illness of increasing national concern. From 2007 to 2021, private insurance claim lines with Lyme disease diagnoses rose 357 percent in rural areas and 65 percent in urban areas. These and other findings on this tick-borne, bacterial illness were captured in an infographic just released by FAIR Health. The national, independent organization used its database of over 36 billion privately billed healthcare claims to conduct its 15-year analysis of Lyme disease; this analysis builds upon a [previous FAIR Health infographic](#) that studied 10 years of Lyme disease data. Click [here](#) for the infographic released today. For entire article see: <https://www.newswise.com/articles/lyme-disease-diagnoses-increased-357-percent-in-rural-areas-over-past-15-years-according-to-private-insurance-claims>.

Study of personal protection measures finds no intervention predominantly or consistently effective

Effectiveness of personal protection measures against Lyme disease: A review of epidemiologic studies from the United States

Lyme disease, the most commonly reported vector-borne disease in the United States, is caused by the bacteria *Borrelia burgdorferi* and is transmitted through the bite of an infected blacklegged tick. In the absence of a licensed vaccine, the prevention of Lyme disease relies heavily on limiting tick exposure. Methods for limiting tick exposure include personal protection measures such as repellent use, wearing protective clothing, avoiding areas where ticks may be present, bathing after exposure to tick habitat and performing regular tick checks. Public health officials typically recommend all these personal protection measures; however, there is limited evidence to promote one behavior or practice over another.

The focus of this article is to review available literature that examines the effectiveness of recommended personal protection measures to prevent Lyme and other *Ixodes*-transmitted diseases in humans. Articles included in this review were identified through Google Scholar and PubMed searches using specific search terms. We identified over 56,000 articles using Google Scholar and PubMed searches. Of those, 16 studies fit our criteria for inclusion and were reviewed in their entirety.

Among the personal protection measures evaluated, no intervention was predominantly or consistently effective across studies, demonstrating that, currently, there is no single best method for primary prevention of *Ixodes*-transmitted diseases in the United States. Frequently recommended practices such as tick checks, repellent use and protective clothing had mixed results across studies. Study design differences limited comparability among studies, and sample sizes for these studies may have been too small to detect statistically significant results even if a prevention method was effective. Though many of the reviewed personal protection measures are frequently recommended to the public, limited evidence demonstrates their ability to prevent tick-borne disease. Additional standardized studies are needed to evaluate personal protection measures. Schwartz AM, et al. Zoonoses and Public Health, doi.org/10.1111/zph.12984.

Study of American Dog Ticks Across the US

Influence of tick sex and geographic region on the microbiome of *Dermacentor variabilis* collected from dogs and cats across the United States

Highlights

- Francisellaceae most abundant bacterial family in *Dermacentor variabilis* microbiome.
- *Rickettsia* spp. identified in approximately one in five *Dermacentor variabilis*.
- Male *Dermacentor variabilis* exhibit higher levels of α diversity than females.

- Distinct community structure patterns in western and northeastern *Dermacentor variabilis*.
- Apparent co-occurrence patterns between specific bacterial genera.

As tick-borne diseases continue to increase across North America, current research strives to understand how the tick microbiome may affect pathogen acquisition, maintenance, and transmission...

Here, adult *D. variabilis* ticks ($n = 145$) were collected from dogs and cats from 32 states with specimens originating from all four regions of the United States (West, Midwest, South, and Northeast), and the tick microbiome was examined via V4-16S rRNA gene amplification and Illumina sequencing... Fifty genera represented the majority (>80%) of the sequences detected, with the genera *Allofrancisella* and *Francisella* being the most abundant. Further, 97%, 23%, and 5.5% of the ticks contained sequences belonging to *Francisella* spp., *Rickettsia* spp., and *Coxiella* spp., respectively. No *Ehrlichia* spp. or *Anaplasma* spp. were identified...

Collectively, these findings highlight the differences in bacterial diversity of *D. variabilis* across the US and supports the interpretation that tick sex and geographic region affects microbiome composition across a broad sampling distribution. Duncan KT, et al. Ticks and Tick-borne Diseases.

doi.org/10.1016/j.ttbdis.2022.102002.

Risk of tick-borne pathogen spillover into urban yards in New York City (Staten Island)

The incidence of tick-borne disease has increased dramatically in recent decades, with urban areas increasingly recognized as high-risk environments for exposure to infected ticks. Green spaces may play a key role in facilitating the invasion of ticks, hosts and pathogens into residential areas, particularly where they connect residential yards with larger natural areas (e.g. parks). However, the factors mediating tick distribution across heterogeneous urban landscapes remain poorly characterized.

Using generalized linear models in a multimodel inference framework, we determined the residential yard- and local landscape-level features associated with the presence of three tick species of current and growing public health importance in residential yards across Staten Island, a borough of New York City, in the state of New York, USA.

The amount and configuration of canopy cover immediately surrounding residential yards was found to strongly predict the presence of *Ixodes scapularis* and *Amblyomma americanum*, but not that of *Haemaphysalis longicornis*. Within yards, we found a protective effect of fencing against *I. scapularis* and *A. americanum*, but not against *H. longicornis*. For all species, the presence of log and brush piles strongly increased the odds of finding ticks in yards.

The results highlight a considerable risk of tick exposure in residential yards in Staten Island and identify both yard- and landscape-level features associated with their distribution. In particular, the significance of log and brush piles for all three species supports recommendations for yard management as a means of reducing contact with ticks. Gregory N, et al. *Parasites Vectors* **15**, 288 (2022). doi.org/10.1186/s13071-022-05416-2.

Access to Care in Lyme Disease: Clinician Barriers to Providing Care

Patients with persistent Lyme disease/chronic Lyme disease (PLD/CLD) encounter significant barriers to accessing medical care. Although this health inequity has been explored from the patient perspective, the obstacles clinicians encounter when providing care to this group of patients have not been examined. The primary goal of this study was to identify the challenges faced by clinicians who provide care for patients with PLD/CLD.

Clinicians who treat PLD/CLD were surveyed regarding their professional backgrounds, general challenges to providing care, supply and demand constraints, insurance restrictions, and regulatory and legal challenges. Clinicians treating patients with PLD/CLD have developed substantial clinical expertise but encounter multiple clinical, regulatory and financial impediments to providing care.

Clinician-encountered barriers may be powerful disincentives for providing care patients with PLD/CLD and make it difficult to retain and recruit clinicians who will care for the rapidly expanding PLD/CLD populations. Understanding these barriers and identifying potential solutions is essential to resolving the current supply/demand imbalance that makes it difficult for patients to receive the care they need to become well. Johnson B & Maloney EL. Healthcare 2022, 10, 1882. <https://doi.org/10.3390/healthcare10101882>. Open access.

Assessment of Physician Knowledge, Attitudes, and Practice for Lyme Disease in a Low-Incidence State

Lyme disease (LD), caused by the bacterium *Borrelia burgdorferi*, is transmitted to humans in California through the bite of infected blacklegged ticks (*Ixodes pacificus*). Overall, the incidence of LD in California is low: approximately 0.2 confirmed cases per 100,000 population. However, California's unique ecological diversity results in wide variation in local risk, including regions with local foci at elevated risk of human disease.

The diagnosis of LD can be challenging in California because the prior probability of infection for individual patients is generally low. Combined with nonspecific symptoms and complicated laboratory testing, California physicians need a high level of awareness of LD in California to recognize and diagnose LD efficiently. This research addresses an under-studied area of physicians' knowledge and practice of the testing and treatment of LD in a low-incidence state. We assessed knowledge and practices related to LD diagnosis using an electronic survey distributed to physicians practicing in California through mixed sampling methods.

Overall, responding physicians in California had a general awareness of Lyme disease and were knowledgeable regarding diagnosis and treatment. However, we found that physicians in California could benefit from further education to improve test-ordering practices, test interpretation, and awareness of California's disease ecology with elevated levels of focal

endemicity, to improve recognition, diagnosis, and treatment of LD in California patients. Brummitt SI, et al. *Journal of Medical Entomology*, <https://doi.org/10.1093/jme/tjac137>.

Patterns and Ecological Mechanisms of Tick-Borne Disease Exposure Risk in Acadia National Park, Mount Desert Island, Maine, United States

National parks are unique and significant vector-borne pathogen transmission settings, engaging over 300 million people in outdoor recreation per year. In this study, we integrated vector surveys and ecological habitat feature data in spatial models to characterize tick-borne disease exposure risk in Acadia National Park (ANP), Maine. To determine the broad-scale patterns of blacklegged tick *Ixodes scapularis* Say (Acari: Ixodidae) densities in ANP, we conducted host-seeking tick collections at 114 sites across the park over two years. Using these tick survey data and geospatial landscape feature data (i.e., land cover, elevation, forest patch size, and aspect) we developed a random forest model of nymphal tick density.

We found that host-seeking tick density varies significantly across the park and is particularly high in areas characterized by deciduous forest cover and relatively low elevation. To explore potential fine-scale ecological drivers of tick density spatial patterns, we quantified microclimate conditions, host activity, and vegetation characteristics at a subset of 19 sites.

We identified significant differences in microclimate conditions but not host activity or vegetation metrics across broad-scale landscape feature classes. Mean temperature and mean humidity were correlated to nymphal densities and therefore may provide a mechanistic link between landscape features and blacklegged tick densities.

Finally, we detected multiple tick-borne pathogens in both ticks and small mammals sampled in ANP, including *Borrelia burgdorferi*, *Babesia microti*, and *Anaplasma phagocytophilum*. Our findings demonstrate the value of using ecological metrics to estimate vector-borne disease exposure risk and provide insight into habitat characteristics that may drive tick-borne disease exposure risk. McBride SE et al. *Journal of Medical Entomology*, <https://doi.org/10.1093/jme/tjac152>.

Single Mowing Event Does Not Reduce Abundance of *Ixodes scapularis* (Acari: Ixodidae)

Nuisance and medically important ticks can be abundant in a variety of forested landscapes, including recreational parks. Strategies to reduce the abundance of host-seeking ticks in high-use areas within parks are limited. Mowing vegetation is a recommended method to control ticks, but few studies have evaluated the efficacy of this practice. The goal of this study was to determine if a single mowing event could reduce the abundance of host-seeking ticks on recreational trails. Ticks were collected by dragging trails at three recreational parks in northern Minnesota during June and July, 2021. A pre-intervention sample was taken followed by six consecutive weeks of tick sampling. We encountered a total of 3,456 ticks (2,459 *Ixodes scapularis* Say and 997 *Dermacentor variabilis* L.) during the 7-week study period.

There were no significant differences in the abundance of *I. scapularis* (adults) or *D. variabilis* (adults only) between control and mown trail sections. Mowing was a significant predictor of nymphal *I. scapularis* abundance but trended towards more ticks in mown sections compared to controls. These results suggest that a single mowing intervention during early June is likely to be ineffective as a strategy to reduce the risk of human contacts with ticks on trails. Lee X et al. *Journal of Medical Entomology*, doi.org/10.1093/jme/tjac164.

Ehrlichiosis in a Recent Liver Transplant Recipient Leading to Multiorgan Failure

Ehrlichia infection has a broad spectrum of diseases ranging from asymptomatic to fatal. While Ehrlichia often presents as a mild form of the disease in immunocompetent patients, immunosuppressed patients are at increased risk for a more virulent and potentially fatal infection. Our liver transplant patient presented with fever, persistent headaches, and negative Ehrlichia antibodies. Empiric antibiotic therapy was started and along with knowledge of prior tick infection, doxycycline was added. Subsequent positive PCR and observation of Ehrlichia chaffeensis in peripheral blood smear confirmed the diagnosis. The patient did recover from infection but not before it manifested in hepatic, renal, and pulmonary involvement. Therefore, a high level of suspicion is necessary for early detection and treatment initiation to prevent a devastating progression of the disease in immunosuppressed patients. Almajali F et al. *Case Reports in Transplantation*, Article ID 3062836, doi.org/10.1155/2022/3062836.

Diagnostic Histopathological Findings of a Tick-Bite Lesion without the Presence of an Insect Body

Tick bite is detected when the insect's body remains, and portions, such as the mouthparts, may be used to confirm the species and the potential for microbial infection. Moreover, a histopathological diagnostic standard for tick-borne illnesses has not yet been established. Thus, this study aimed to perform a histopathological examination of the lesion in a patient in whom a tick was not identified along with its bite. The patient was a 47-year-old man who presented with a lesion caused by a tick bite; the lesion was resected en bloc from the subcutaneous fat on the left side of the neck.

Histopathological findings showed necrosis and thickening of the epidermis, ulceration, a strong periodic acid-Schiff stain-positive substance over the epidermis, extravascular exposure of erythrocytes in the dermis, thrombi, sclerosis of collagenous fibers, pseudolymphoma with a predominance of T cells, and marked infiltration of basophils extending from the epidermis to the subdermal sebaceous layer. Tick-bite lesions may be detected histopathologically, even if the presence of the insect body is not confirmed, as in this case, if the injection of tick saliva and

local reaction of the salivary component are histologically evaluated. Takada T. Case Reports in Dermatology, 2022;14:157–163. doi.org/10.1159/000525009. Ed. note: Ticks are arachnids, not insects.

American dog ticks along their expanding range edge in Ontario, Canada

The American dog tick, *Dermacentor variabilis*, is a tick of public and veterinary health importance in North America. Using passive tick surveillance data, we document distribution changes for the American dog tick in Ontario, Canada, from 2010 through 2018. *Dermacentor variabilis* submissions from the public were geocoded and aggregated—from large to small administrative geographies—by health region, public health unit (PHU) and Forward Sortation Area (FSA)... Submission hot spots were in warmer, low elevation areas with poorly drained soils, compared to the province's low submission areas. *Dermacentor variabilis* is spreading in Ontario and continued research into their vector ecology is required to assess medicoveterinary health risks. Nelder MP, et al. . *Sci Rep* 12, 11063 (2022). <https://doi.org/10.1038/s41598-022-15009-9>.

Study of personal protection measures finds no intervention predominantly or consistently effective

Effectiveness of personal protection measures against Lyme disease: A review of epidemiologic studies from the United States

Lyme disease, the most commonly reported vector-borne disease in the United States, is caused by the bacteria *Borrelia burgdorferi* and is transmitted through the bite of an infected blacklegged tick. In the absence of a licensed vaccine, the prevention of Lyme disease relies heavily on limiting tick exposure. Methods for limiting tick exposure include personal protection measures such as repellent use, wearing protective clothing, avoiding areas where ticks may be present, bathing after exposure to tick habitat and performing regular tick checks. Public health officials typically recommend all these personal protection measures; however, there is limited evidence to promote one behaviour or practice over another.

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Among the personal protection measures evaluated, no intervention was predominantly or consistently effective across studies, demonstrating that, currently, there is no single best method for primary prevention of *Ixodes*-transmitted diseases in the United States. Frequently recommended practices such as tick checks, repellent use and protective clothing had mixed results across studies. Study design differences limited comparability among studies, and sample sizes for these studies may have been too small to detect statistically significant results even if a

prevention method was effective. Though many of the reviewed personal protection measures are frequently recommended to the public, limited evidence demonstrates their ability to prevent tick-borne disease. Additional standardized studies are needed to evaluate personal protection measures. Schwartz AM, et al. *Zoonoses and Public Health*, doi.org/10.1111/zph.12984.

The Current State of Knowledge on Baggio–Yoshinari Syndrome (Brazilian Lyme Disease-like Illness): Chronological Presentation of Historical and Scientific Events Observed over the Last 30 Years

Baggio–Yoshinari Syndrome (BYS) is an emerging Brazilian tick-borne infectious disease that clinically mimics Lyme Disease (LD) present in the Northern Hemisphere. LD is caused by spirochetes belonging to the *Borrelia burgdorferi* sensu lato complex and transmitted by Ixodid ticks of complex *Ixodes ricinus*. On the contrary, BYS is transmitted by hard Ixodid ticks of the genera *Amblyomma*, *Rhipicephalus* and *Dermacentor*. In 1992, the first cases of BYS were described in patients that developed EM rash, flu-like symptoms and arthritis after tick bite episodes.

Since these findings, research in BYS has been developing for more than 30 years and shows that its epidemiological, clinical and laboratorial features are different from LD. *Borrelia burgdorferi* was never isolated in Brazil. In addition, specific serologic tests have shown little positivity. Furthermore, peripheral blood analysis of patients using electron microscopy exhibited structures resembling spirochete-like microorganisms or the latent forms of spirochetes (L form or cell wall deficient bacteria).

For these reasons, Brazilian zoonosis was defined as an exotic and emerging Brazilian infectious disease, transmitted by ticks not belonging to the *Ixodes ricinus* complex, caused by latent spirochetes belonging to the *B. burgdorferi* sensu lato complex with atypical morphology. The Brazilian ecosystem, combined with its ticks and reservoir biodiversity, possibly contributed to the origin of this new zoonosis, which emerged as a result of the passage of *B. burgdorferi* through exotic vectors and reservoirs. Yoshinary NH, et al. *Pathogens* 2022, 11(8), 889; <https://doi.org/10.3390/pathogens11080889>. Open access.

Review article by European authors, who conclude” insufficient evidence for the persistence of viable and infectious spirochetes after adequate antibiotic treatment

Persistent *Borrelia burgdorferi* Sensu Lato Infection after Antibiotic Treatment: Systematic Overview and Appraisal of the Current Evidence from Experimental Animal Models

Lyme borreliosis is caused by spirochetes belonging to the *Borrelia burgdorferi sensu lato* group, which are transmitted by *Ixodes* tick species living in the temperate climate zones of the Northern Hemisphere. The clinical manifestations of Lyme borreliosis are diverse and treated with oral or intravenous antibiotics. In some patients, long-lasting and debilitating symptoms can

persist after the recommended antibiotic treatment. The etiology of such persisting symptoms is under debate, and one hypothesis entails persistent infection by a subset of spirochetes after antibiotic therapy.

Here, we review and appraise the experimental evidence from *in vivo* animal studies on the persistence of *B. burgdorferi sensu lato* infection after antibiotic treatment, focusing on the antimicrobial agents doxycycline and ceftriaxone. Our review indicates that some *in vivo* animal studies found sporadic positive cultures after antibiotic treatment. However, this culture positivity often seemed to be related to inadequate antibiotic treatment, and the few positive cultures in some studies could not be reproduced in other studies.

Overall, current results from animal studies provide insufficient evidence for the persistence of viable and infectious spirochetes after adequate antibiotic treatment. Borrelial nucleic acids, on the contrary, were frequently detected in these animal studies and may thus persist after antibiotic treatment. We put forward that research into the pathogenesis of persisting complaints after antibiotic treatment for Lyme borreliosis in humans should be a top priority, but future studies should most definitely also focus on explanations other than persistent *B. burgdorferi sensu lato* infection after antibiotic treatment. Verschoor YL, et al. *Clinical Microbiology Reviews*, doi.org/10.1128/cmr.00074-22.

Detection of Endosymbiont *Candidatus* Midichloria mitochondrii and Tickborne Pathogens in Humans Exposed to Tick Bites, Italy

During 2021, we collected blood and serum samples from 135 persons exposed to tick bites in southern Italy. We serologically and molecularly screened for zoonotic tickborne pathogens and only molecularly screened for *Candidatus* *Midichloria mitochondrii*.

Overall, 62 (45.9%) persons tested positive for tickborne pathogens. *Coxiella burnetii* was detected most frequently (27.4%), along with *Rickettsia* spp. (21.5%) and *Borrelia* spp. (10.4%). We detected *Candidatus* *M. mitochondrii* DNA in 46 (34.1%) participants who had statistically significant associations to tickborne pathogens ($p < 0.0001$). Phylogenetic analysis of *Candidatus* *M. mitochondrii* sequences revealed 5 clades and 8 human sequence types that correlated with vertebrates, *Ixodes* spp. ticks, and countries in Europe.

These data demonstrated a high circulation of tickborne pathogens and *Candidatus* *M. mitochondrii* DNA in persons participating in outdoor activities in southern Italy. Our study shows how coordinated surveillance among patients, clinicians, and veterinarians could inform a One Health approach for monitoring and controlling the circulation of tickborne pathogens. SgROI G, et al. *Emerging Infectious Diseases*, 28(9), 1824-1832. <https://doi.org/10.3201/eid2809.220329>.

Repellency of novel catnip (*Nepeta cataria*) cultivar extracts against *Ixodes scapularis* and *Haemaphysalis longicornis* (Acari: Ixodida: Ixodidae)

Tick bites are a major public health concern due to the vector role that many tick species have in transmitting human pathogens. Synthetic repellents such as N-diethyl-meta-toluamide (DEET) remain the standard for repellency. Still, there is a need for natural commercial alternatives with similar or better properties than DEET.

We evaluated the repellency of two extracts, CR3 and CR9, derived for newly developed catnip cultivars on two tick species, *Ixodes scapularis* and *Haemaphysalis longicornis*. Dose-response *in vitro* assays showed that CR3 and CR9 extracts have similar repellency properties to DEET. At a 20% concentration, both CR3 and CR9 extracts exhibited a repellency of 100%. Catnip extracts maintained their repellency properties for at least 8 h. In a two-choice assay, *I. scapularis*, but not *H. longicornis*, was more sensitive to CR3 than DEET. In addition, CR3 reduces the life span of *I. scapularis*, suggesting that it has an acaricidal effect on ticks.

In summary, CR3 and CR9 catnip extracts are promising tick repellents that should be further developed, alone or in combination with other tick repellents, and tested for their use as tick repellents for humans. González J et al. Ticks and tick-borne diseases, <https://doi.org/10.1016/j.ttbdis.2022.102046>.

***Borrelia burgdorferi*, the Lyme disease spirochete, possesses genetically-encoded responses to doxycycline, but not to amoxicillin.**

Some species of bacteria respond to antibiotic stresses by altering their transcription profiles, in order to produce proteins that provide protection against the antibiotic. Understanding these compensatory mechanisms allows for informed treatment strategies, and could lead to the development of improved therapeutics.

To this end, studies were performed to determine whether *Borrelia burgdorferi*, the spirochetal agent of Lyme disease, also exhibits genetically-encoded responses to the commonly prescribed antibiotics doxycycline and amoxicillin. After culturing for 24 h in a sublethal concentration of doxycycline, there were significant increases in a substantial number of transcripts for proteins that are involved with translation. In contrast, incubation with a sublethal concentration of amoxicillin did not lead to significant changes in levels of any bacterial transcript.

We conclude that *B. burgdorferi* has a mechanism(s) that detects translational inhibition by doxycycline and increases production of mRNAs for proteins involved with translation machinery in an attempt to compensate for that stress. Saylor TC, Casselli T, et al. (2022) PLoS ONE 17(9): e0274125. doi.org/10.1371/journal.pone.0274125.

Only half of the children in this Lyme study had EM rashes

Frequency of Tick-borne Coinfections in Children with Suspected Lyme Disease

We performed a prospective eight-center study of children 1 to 21 years of age presenting to a Pedi Lyme Net emergency department for evaluation for Lyme disease between June 2015 and December 2021. We defined a case of confirmed Lyme disease based on presence of erythema migrans (EM) lesion or positive two-tier serology in the appropriate clinical context. For this study, we selected Lyme cases with either a single EM lesion or neurologic Lyme disease (facial palsy and/or meningitis).

Of the 617 study patients, 306 (49.6%) had a single EM lesion or neurologic Lyme disease, 302 (48.9%) clinical mimics and 9 (1.5%) had a recent tick bite without evidence of infection. The median patient age was 10 years (interquartile range 6-14 years) and 370 (59.9%) were male.

A significant minority of children with suspected Lyme disease also had other tick-borne infections identified by multiplex HDPCR panel. Reliance on traditional diagnostic methods and clinical presentation may underdiagnose or misdiagnose these infections leading to ineffective antibiotic therapy. Further study is needed to identify children at highest risk of tick-borne co-infections to guide clinical decision-making. Nigrovic LE, et al. *Annals of Emergency Medicine*, <https://doi.org/10.1016/j.annemergmed.2022.08.027>.

The Impact of Telemedicine in the Diagnosis of Erythema Migrans during the COVID Pandemic: A Comparison with In-Person Diagnosis in the Pre-COVID Era

Erythema migrans (EM) is the hallmark manifestation of the Lyme borreliosis (LB), and therefore its presence and recognition are sufficient to make a diagnosis and to start proper antibiotic treatment to attempt to eradicate the infection.

In this study we compared the clinical data of 439 patients who presented an EM either according to the diagnostic modality through physical assessment or through telemedicine. Our data clearly show that telemedicine for EM diagnosis is useful as it enables prompt administration of appropriate antibiotic therapy, which is critical to avoid complications, especially for neurologic and articular entities. Therefore, telemedicine is a tool that could be adopted for the diagnosis of Lyme disease both by specialized centers but also by general practitioners. Trevisan G, et al.. *Pathogens* 2022, 11, 1122. <https://doi.org/10.3390/pathogens11101122>.



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