



Tick-Borne Infections Council
of North Carolina, Inc.

NEWSLETTER 2021, Volume 4



Quote: - Where Asian long-horned ticks are now found in the US: As of early October 2020, the tick was known to be in northeastern states including Rhode Island, Connecticut, Delaware, New York, New Jersey, and Pennsylvania. Other states where the tick appears include Arkansas, Kentucky, Maryland, North Carolina, South Carolina, Ohio, Tennessee, Virginia, and West Virginia, according to the U.S. Centers for Disease Control and Prevention (CDC). From: <https://www.ecori.org/public-safety/2021/5/17/annual-tick-season-in-rhode-island-includes-arrival-of-new-invasive-species>

Highlights...

- Lyme disease bacteria found in brain on autopsy of person with dementia
- Mouse model establishes the central role of tick bites in the development of alpha gal (red meat allergy)
- Alpha-Gal Allergy as a Cause of Intestinal Symptoms
- Southern Tick-Associated Rash Illness: Florida's Lyme Disease Variant
- Effect of Vegetation on the Abundance of Tick Vectors
- Lyme disease spirochetes found in two of the largest parks in London
- Possums do not eat ticks!
- Lyme Neuroborreliosis: Mechanisms of *B. burgdorferi* Infection
- Spirochetes in the brain of a patient treated for Lyme years earlier
- Lyme Borreliosis and Associations With Mental Disorders and Suicide
- Symptom Clusters and Functional Impairment in Lyme patients
- Lone star tick moving north as temperatures rise
- Fatal Ehrlichiosis from an organ transplant

*Special notice:

COVID-19 vs. Tick-Borne Diseases: How to Tell the Difference

People are getting outside more due to the pandemic. The link below is to an article from New York but is pertinent to NC. We would add that here ticks are active all year, so even in the winter on a warmer day it is possible to contract a tick-borne infection (TBI).

Second, knowledge or evidence of a tick bite is not as easy as this article would imply. Many people that contract a TBI have no knowledge or evidence easy to see on their skin of a tick bite.

Third, respiratory symptoms in Covid may not always occur quickly so that even several weeks can go by with a person sick from a TBI, not Covid. Sometimes, respiratory symptoms with Covid may be minimal. There are cases now reported in the medical literature of late treatment for TBIs due to this confusion. We at TIC-NC are aware of several such cases. (Comments by the newsletter editor M. Herman-Giddens) <https://healthmatters.nyp.org/how-to-protect-yourself-from-ticks/>

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 Tick-borne Diseases”

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

From the CDC



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

- [Lyme Disease Surveillance Case Definition](#) (revised Jan 2017)
- [Lyme Disease Surveillance Case Report FormCdc-pdf PDF – 2 pages](#)] (for public health officials’ use)

Note: Surveillance case definitions establish uniform criteria for disease reporting and should not be used as the sole criteria for establishing clinical diagnoses, determining the standard of care necessary for a particular patient, setting guidelines for quality assurance, or providing standards for reimbursement.

Accessed and copied 14 September 2019.

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).

The State Vector-borne Diseases Working Group

There have been no state Vector-borne Diseases Working Group meetings this year.

Location:

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

Reports: None

State tick research and/or reports

The 2019 tick bone disease surveillance summaries are now complete. You can view them at the bottom of the NC DHHS Epi Section Facts & Figures page, under Vector-borne Diseases: <https://epi.dph.ncdhhs.gov/cd/diseases/vector.html>.

NC TBIs 2019 final, 2020 to November probable/confirmed

| NC EDSS Event Data – Cases Submitted to CDC | | | | | |
|---|---|--|---|--|--|
| Disease | Probable / Confirmed cases by year of report (2019) | Total preliminary confirmed and probable Events in NC EDSS Created between 1/1/2020 – 11/1/2020* | Total Events Reviewed and closed by NC DPH 1/1/2020 – 11/1/20 | Total Events Still Under Investigation by LHD 1/1/19 – 11/1/20 | Total Events created in NC EDSS 1/1/20 – 11/1/20 |
| Spotted Fever group rickettsiosis | 669P / 16C | 151P / 7C | 1394 | 243 | 1637 |
| Lyme disease | 243P / 91C | 125P / 83C | 473 | 302 | 775 |
| Ehrlichiosis | 150P / 6C | 74P / 10C | 310 | 114 | 424 |
| Anaplasmosis | 7P / 4C | 1P / 4C | 8 | 5 | 13 |
| Total Numbers | 1069P / 117C (1,186) | 351P / 104C (491) | 2,185 | 664 | 2,849 |

* Note 2020 data are preliminary

§§ TIC-NC Activities §§

Story By Frank Graff on PBS for which we were interviewed, August 2021.

<https://www.pbsnc.org/blogs/science/tick-are-everywhere-this-year/>?

Our grant!

Tick Safety for Outdoor Workers, TSOW

In July we received a **grant** from the North Carolina Department of Agricultural and Consumer Services, Structural Pest Control and Pesticides Division, Pesticide Environmental Trust Fund to carry out a project with migrant workers in the state. The project will end in the Fall of 2022.

TIC-NC Talks and Materials Distributed

Brochures/booklets:

NC Dept of Agriculture, Pest Control & Pesticides Division- hundreds will be distributed to county fairs and other suitable places
Hot Springs, NC

Talks:

Rotary Club, Pittsboro via Zoom

Grant: see details in this section

Chatham County Public Health Department and the Tick-borne Infections Council of North Carolina, Inc are partnering to conduct a pilot intervention to help keep outdoor workers safer from tick bites and tick-borne infections. This initiative will focus on agriculture and other outdoor workers including migrant workers in Chatham County and other nearby counties. Team leaders, field bosses, and first aid workers will be supplied with teaching materials, kits with materials for safe removal of biting ticks, and printed material about tick safety and symptoms of disease in Spanish for workers.

Special edition of *The Journal of Medical Entomology*

All papers in the collection have been made freely available to read and download through May 1, 2022.

Special Collection: The Rise of Ticks and Tick-Borne Diseases

Charles B. Beard, Lars Eisen, Rebecca Eisen, William Reisen

The *Journal of Medical Entomology* is pleased to publish a special collection of forum articles on the rise of ticks and tick-borne diseases in the United States. The articles were written by

leaders in the field and highlight key accomplishments, significant information gaps, insights into trends and drivers, and identification of high priority needs.

The Rise of Ticks and Tick-borne Diseases in the United States – Introduction

Charles B. Beard, Lars Eisen, Rebecca J. Eisen

Journal of Medical Entomology, tjab064, <https://doi.org/10.1093/jme/tjab064>

Ticks and tick-borne diseases have been recognized as threats to the health of humans and domestic animals for more than a century in the United States. However, as outlined in the following series of papers, the nature of this threat has evolved over time in response to changes in the natural environment, tick and wild animal populations, and human land use...

Tick and Tick-borne Pathogen Surveillance as a Public Health Tool in the United States

Rebecca J Eisen, Christopher D Paddock

Journal of Medical Entomology, tjaa087, <https://doi.org/10.1093/jme/tjaa087>

In recent decades, tick-borne disease (TBD) cases and established populations of medically important ticks have been reported over expanding geographic areas, and an increasing number of tick-borne bacteria, viruses, and protozoans have been recognized as human pathogens, collectively contributing to an increasing burden of TBDs in the United States...

A Survey of Tick Surveillance and Control Practices in the United States

Emily M Mader, Claudia Ganser, Annie Geiger, Laura C Harrington, Janet Foley, Rebecca L Smith, Nohra Mateus-Pinilla, Pete D Teel, Rebecca J Eisen

Journal of Medical Entomology, tjaa094, <https://doi.org/10.1093/jme/tjaa094>

Prevention and diagnosis of tick-borne diseases are improved by access to current and accurate information on where medically important ticks and their associated human and veterinary pathogens are present, their local abundance or prevalence, and when ticks are actively seeking hosts. The true extent of tick and tick-borne pathogen expansion is poorly defined, in part because of a lack of nationally standardized tick surveillance...

The Family Borreliaceae, a Diverse Group in Two Genera of Tick-Borne Spirochetes of Mammals, Birds, and Reptiles

Alan G. Barbour, Radhey S. Gupta

Journal of Medical Entomology, tjab055, <https://doi.org/10.1093/jme/tjab055>

Spirochetes of the family *Borreliaceae* are, with one exception, tick-borne pathogens of a variety of vertebrates. The family at present comprises two genera: *Borrelia*, which includes the agents of relapsing fever, avian spirochetosis, and bovine borreliosis, and *Borreliella*, which includes the agents of Lyme disease and was formerly known as "*Borrelia burgdorferi sensu lato* complex"...

Discovery and Surveillance of Tick-Borne Pathogens

Rafal Tokarz, W Ian Lipkin

Journal of Medical Entomology, tjaa269, <https://doi.org/10.1093/jme/tjaa269>

Within the past 30 yr molecular assays have largely supplanted classical methods for detection of tick-borne agents. Enhancements provided by molecular assays, including speed, throughput, sensitivity, and specificity, have resulted in a rapid increase in the number of newly characterized tick-borne agents.

Possible Effects of Climate Change on Ixodid Ticks and the Pathogens They Transmit: Predictions and Observations

Nicholas H Ogden, C Ben Beard, Howard S Ginsberg, Jean I Tsao

Journal of Medical Entomology, tjaa220, <https://doi.org/10.1093/jme/tjaa220>

The global climate has been changing over the last century due to greenhouse gas emissions and will continue to change over this century, accelerating without effective global efforts to reduce emissions. Ticks and tick-borne diseases (TTBDs) are inherently climate-sensitive due to the sensitivity of tick lifecycles to climate...

Impact of Land Use Changes and Habitat Fragmentation on the Eco-epidemiology of Tick-Borne Diseases

Maria A Diuk-Wasser, Meredith C VanAcker, Maria P Fernandez

Journal of Medical Entomology, tjaa209, <https://doi.org/10.1093/jme/tjaa209>

In this forum paper, we focus on how land use changes have shaped the eco-epidemiology of *Ixodes scapularis*-borne pathogens, in particular the Lyme disease spirochete *Borrelia burgdorferis* sensu stricto in the eastern United States. We use this as a model system, addressing other tick-borne disease systems as needed to illustrate patterns or processes...

The Contribution of Wildlife Hosts to the Rise of Ticks and Tick-Borne Diseases in North America

Jean I Tsao, Sarah A Hamer, Seungeun Han, Jennifer L Sidge, Graham J Hickling

Journal of Medical Entomology, tjab047, <https://doi.org/10.1093/jme/tjab047>

Wildlife vertebrate hosts are integral to enzootic cycles of tick-borne pathogens, and in some cases have played key roles in the recent rise of ticks and tick-borne diseases in North America. In this forum article, we highlight roles that wildlife hosts play in the maintenance and transmission of zoonotic, companion animal, livestock and wildlife tick-borne pathogens.

Barriers to Effective Tick Management and Tick-Bite Prevention in the United States (Acari: Ixodidae)

Lars Eisen, Kirby C Stafford, III

Journal of Medical Entomology, tjaa079, <https://doi.org/10.1093/jme/tjaa079>

Development of tick control tools have focused primarily on the blacklegged tick, *Ixodes scapularis* Say. Application of acaricides or entomopathogenic fungal agents to kill host-seeking ticks or ticks on rodents can suppress *I. scapularis* abundance in residential landscapes, but evidence is lacking for impact on human tick bites or tick-borne disease...

Southern Tick-Associated Rash Illness: Florida's Lyme Disease Variant

Southern tick-associated rash illness (STARI) is an emerging zoonotic disease causing an annular rash with central clearing that is almost identical to erythema migrans seen in Lyme disease. It is spread by *Amblyomma americanum* tick bite. Although it is still debatable, this zoonotic disease is thought to be caused by *Borrelia lonestari* spirochete. At this time, there is no approved diagnostic modality nor approved treatment for such an illness. Here we describe a rare case of STARI in a 63-year-old female and shed light on the differences between STARI and Lyme disease. Abdelmaseih R, et al. (May 28, 2021) *Cureus* 13(5): e15306.

doi:10.7759/cureus.15306. <https://www.cureus.com/articles/60781-southern-tick-associated-rash-illness-floridas-lyme-disease-variant/metrics>

Mouse model establishes the central role of tick bites in the development of alpha gal (red meat allergy)

Tick salivary gland extract induces alpha-gal syndrome in alpha-gal deficient mice

Alpha-gal syndrome (AGS) is characterized by delayed hypersensitivity to non-primate mammalian meat in people having specific immunoglobulin E (sIgE) to the oligosaccharide galactose-alpha-1,3-galactose. AGS has been linked to tick bites from *Amblyomma americanum* (*Aa*) in the U.S. A small animal model of meat allergy is needed to study the mechanism of alpha-gal sensitization, the effector phase leading to delayed allergic responses and potential therapeutics to treat AGS.

Eight- to ten-weeks old mice with a targeted inactivation of alpha-1,3-galactosyltransferase (AGKO) were injected intradermally with 50 µg of *Aa* tick salivary gland extract (TSGE) on days 0, 7, 21, 28, 42, and 49. Total IgE and alpha-gal sIgE were quantitated on Day 56 by enzyme-linked immunosorbent assay. Mice were challenged orally with 400 mg of cooked pork kidney homogenate or pork fat. Reaction severity was assessed by measuring a drop in core body temperature and scoring allergic signs.

Compared to control animals, mice treated with TSGE had 190-fold higher total IgE on Day 56 (0.60 ± 0.12 ng/ml vs. 113.2 ± 24.77 ng/ml; $p < 0.001$). Alpha-gal sIgE was also produced in AGKO mice following TSGE sensitization (undetected vs. 158.4 ± 72.43 pg/ml). Further, sensitized mice displayed moderate clinical allergic signs along with a drop in core body temperature of $\geq 2^{\circ}\text{C}$ as an objective measure of a systemic allergic reaction. Interestingly, female mice had higher total IgE responses to TSGE treatment but male mice had larger declines in mean body temperature.

TSGE-sensitized AGKO mice generate sIgE to alpha-gal and demonstrate characteristic allergic responses to pork fat and pork kidney. In keeping with the AGS responses documented in humans, mice reacted more rapidly to organ meat than to high fat pork challenge. This mouse model establishes the central role of tick bites in the development of AGS and provides a small animal model to mechanistically study mammalian meat allergy. Choudhary S et al. *Immunity, Inflammation, and Disease*, May 2021, <https://doi.org/10.1002/iid3.457>.

Possoms do not eat ticks!

Are Virginia opossums really ecological traps for ticks? Groundtruthing laboratory observations

Virginia opossums (*Didelphis virginiana*) are a common synanthrope in North America and serve as host to many species of ectoparasites. Research on captive Virginia opossums estimated that opossums eat, on average, 5500 larval ticks (Ixodidae family) per week. To investigate this apparent preference exhibited by opossums for ingesting ticks, we comprehensively analyzed stomach contents of 32 Virginia opossums from central Illinois. Using a dissecting microscope, we searched the contents exhaustively for ticks and tick body parts, without sieving or pre-rinsing the stomach contents.

We did not locate any ticks or tick parts in the stomach contents of Virginia opossums. We also performed a vigorous literature search for corroborating evidence of tick ingestion. Our search revealed 23 manuscripts that describe diet analyses of Virginia opossums, 19 of which were conducted on stomach or digestive tract contents and four of which were scat-based analyses. None of the studies identified ticks in their analyses of diet items.

We conclude that ticks are not a preferred diet item for Virginia opossums. Considering that wildlife unconditioned to laboratory conditions may exhibit non-typical behaviors, we recommend that lab-based studies of wildlife behavior be groundtruthed with studies based in natural conditions. Hennessy C & Hild K. *Ticks and Tick-borne Diseases*, <https://doi.org/10.1016/j.tbd.2021.101780>.

Climate change and Lyme disease cases

Climate, Environment, and Public Health in Western North Carolina

The frequency and severity of extreme weather events are expected to increase in the context of a changing climate. Populations across the globe are vulnerable and already experiencing the health effects of a changing climate. Western North Carolina (WNC) is no exception. The last decade was the warmest ever on record. This past year, 2019, broke historical records in North Carolina, and temperature anomalies in WNC largely drove this pattern.

The indirect and direct effects of climate on human health are complicated and modulated by underlying social vulnerabilities that enhance the severity and sensitivity of population exposure

to climate hazards. In this paper, we discuss the complex pathways through which climate hazards impact health in WNC and the on-going efforts among the academic and public health community to address these emerging climate-related health threats.

Specifically, we highlight the changing patterns in (1) temperature-related disease, (2) vector-borne disease, (3) natural hazards, (4) mental health impacts and the (5) built environment. Lastly, we identify important research needs and partnerships required to motivate effective and meaningful engagement with the public and policymakers around the regional impacts of climate change on human health, potential solutions, and co-benefits of resilience planning in WNC. Sugg et al. <https://ihhs.appstate.edu/about/institute-journal>.

The Epidemiology of Human Ehrlichiosis in Texas, 2008-2017

Tick-borne diseases in the United States, including ehrlichiosis, represent a growing public health problem. The purpose of this study was to examine the contemporary epidemiology of human ehrlichiosis in Texas by analyzing cases reported to the Texas Department of State Health Services.

In Texas, 101 cases of ehrlichiosis were reported during 2008-2017. We observed geographic grouping of cases as well as an increasing trend of reported cases occurring annually from 2009 to 2017. Notably, 27 cases occurred in 2008 in south Texas with unique patient characteristics in that they were younger, less likely to be hospitalized, and presented with disease earlier in the year than typically seen.

Our findings highlight the importance of disease awareness and prevention of tick bites as well as further investigation into transmission risk and future disease patterns. Erikson T, et al. Tick and Tick-borne Diseases, <https://doi.org/10.1016/j.ttbdis.2021.101788>.

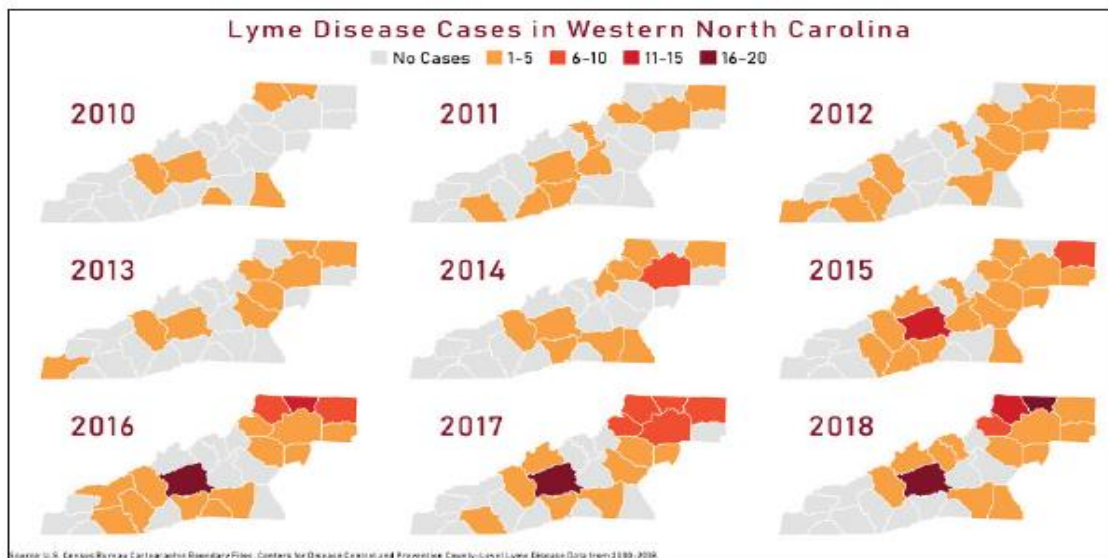


Figure 2. The 2010-8 Lyme disease cases in WNC.

Donor-derived ehrlichiosis: two clusters following solid organ transplantation

Ehrlichiosis has been infrequently described as transmissible through organ transplantation. Two donor derived clusters of ehrlichiosis are described here. During the summer of 2020, two cases of ehrlichiosis were reported to the Organ Procurement and Transplantation Network (OPTN) and the Centers for Disease Control and Prevention (CDC) for investigation. Additional transplant centers were contacted to investigate similar illness in other recipients and samples were sent to CDC.

Two kidney recipients from a common donor developed fatal ehrlichiosis-induced hemophagocytic lymphocytic histiocytosis (HLH). Two kidney recipients and a liver recipient from another common donor developed ehrlichiosis. All three were successfully treated.

Clinicians should consider donor-derived ehrlichiosis when evaluating recipients with fever early after transplantation after more common causes are ruled out, especially if the donor has epidemiological risk factors for infection. Suspected cases should be reported to the organ procurement organization (OPO) and the OPTN for further investigation by public health authorities. Saha et al. *Clinical Infectious Diseases*, ciab667, doi.org/10.1093/cid/ciab667

Lone star tick is not picky about habitat

Effect of Vegetation on the Abundance of Tick Vectors in the Northeastern United States: A Review of the Literature

Tick-borne illnesses have been on the rise in the United States, with reported cases up sharply in the past two decades. In this literature review, we synthesize the available research on the relationship between vegetation and tick abundance for four tick species in the northeastern United States that are of potential medical importance to humans.

The **blacklegged tick** (*Ixodes scapularis*) (Say; Acari: Ixodidae) is found to be positively associated with closed canopy forests and dense vegetation thickets, and negatively associated with open canopy environments, such as grasslands or old agricultural fields.

The **American dog tick** (*Dermacentor variabilis*) (Say; Acari: Ixodidae) has little habitat overlap with *I. scapularis*, with abundance highest in grasses and open-canopy fields.

The **lone star tick** (*Amblyomma americanum*) (Linnaeus; Acari: Ixodidae) is a habitat generalist without consistent associations with particular types of vegetation.

The habitat associations of the recently introduced **Asian long-horned tick** (*Haemaphysalis longicornis*) (Neumann; Acari: Ixodidae) in the northeastern United States, and in other regions where it has invaded, are still unknown, although based on studies in its native range, it is likely to be found in grasslands and open-canopy habitats. Mathison et al. *Journal of Medical Entomology*, tjab098, <https://doi.org/10.1093/jme/tjab098>.

▣▣ National Section ▣▣

Symptom Clusters and Functional Impairment in Individuals Treated for Lyme Borreliosis

Persistent fatigue, pain, and neurocognitive impairment are common in individuals following treatment for Lyme borreliosis (LB). Poor sleep, depression, visual disturbance, and sensory neuropathies have also been reported. The cause of these symptoms is unclear, and widely accepted effective treatment strategies are lacking.

This was a retrospective chart review of individuals with a history of treatment of LB referred to The Dean Center for Tick-Borne Illness at Spaulding Rehabilitation Hospital (Boston) between 2015 and 2018 ($n = 270$) because of persistent symptoms. Symptoms and functional impairment were collected using the General Symptom Questionnaire-30 (GSQ-30), and the Sheehan Disability Scale. Clinical tests were conducted to evaluate for tick-borne co-infections and to rule out medical disorders that could mimic LB symptomatology. Exploratory factor analysis was performed to identify symptom clusters.

Five symptom clusters were identified. Each cluster was assigned a name to reflect the possible underlying etiology and was based on the majority of the symptoms in the cluster: the neuropathy symptom cluster, sleep-fatigue symptom cluster, migraine symptom cluster, cognitive symptom cluster, and mood symptom cluster. Symptom severity for each symptom cluster was positively associated with global functional impairment ($p < 0.001$).

Identifying the interrelationship between symptoms in post-treatment LB in a cluster can aid in the identification of the etiological basis of these symptoms and could lead to more effective symptom management strategies. Zubcevic N et al. *Front. Med*, 21 August 2020

| <https://doi.org/10.3389/fmed.2020.00464>.

Recent Progress in Lyme Disease and Remaining Challenges

Lyme disease (also known as Lyme borreliosis) is the most common vector-borne disease in the United States with an estimated 476,000 cases per year. While historically, the long-term impact of Lyme disease on patients has been controversial, mounting evidence supports the idea that a substantial number of patients experience persistent symptoms following treatment.

The research community has largely lacked the necessary funding to properly advance the scientific and clinical understanding of the disease, or to develop and evaluate innovative approaches for prevention, diagnosis, and treatment. Given the many outstanding questions

raised into the diagnosis, clinical presentation and treatment of Lyme disease, and the underlying molecular mechanisms that trigger persistent disease, there is an urgent need for more support.

This **review article** summarizes progress over the past 5 years in our understanding of Lyme and tick-borne diseases in the United States and highlights remaining challenges. *Front. Med.*, 18 August 2021. Entire paper free of charge: <https://www.frontiersin.org/articles/10.3389/fmed.2021.666554/full>

Lone Star Tick Able to Survive Winters in the Northeast as Temperatures Rise

The lone star tick is an aggressive tick species found in the Southeast and Midwest areas of the U.S. that can transmit bacteria and viruses to humans and animals. A warming climate and changing land use patterns have led to the lone star tick moving into the Northeast USA. This infographic summarizes results of NEVBD-supported research into the ability of this tick to survive harsh winters in Connecticut and Maine. Information based on the manuscript by Linske et al. 2020. [Infographic \[PDF\] \(480.5Kb\)](#). Northeast Regional Center for Excellence in Vector-borne Diseases is supported through Cooperative Agreement Number 1U01CK000509-01 between the Centers for Disease Control and Prevention (CDC) and Cornell University. 7.21.2021. <https://ecommons.cornell.edu/handle/1813/104201>

§§ International & General Section §§

Lyme disease bacteria found in brain on autopsy of person with dementia consistent with Lewy body dementia

Detecting *Borrelia* Spirochetes: A Case Study With Validation Among Autopsy Specimens

The complex etiology of neurodegenerative disease has prompted studies on multiple mechanisms including genetic predisposition, brain biochemistry, immunological responses, and microbial insult. In particular, Lyme disease is often associated with neurocognitive impairment with variable manifestations between patients. We sought to develop methods to reliably detect *Borrelia burgdorferi*, the spirochete bacteria responsible for Lyme disease, in autopsy specimens of patients with a history of neurocognitive disease.

In this report, we describe the use of multiple molecular detection techniques for this pathogen and its application to a case study of a Lyme disease patient. The patient had a history of Lyme

disease, was treated with antibiotics, and years later developed chronic symptoms including dementia. The patient's pathology and clinical case description was consistent with Lewy body dementia. *B. burgdorferi* was identified by PCR in several CNS tissues and by immunofluorescent staining in the spinal cord. These studies offer proof of the principle that persistent infection with the Lyme disease spirochete may have lingering consequences on the CNS. Gadila SK, et al. Front. Neurol., 10 May 2021 | <https://doi.org/10.3389/fneur.2021.628045>.

Sexual Transmission of Lyme Borreliosis? The Question That Calls for an Answer

Transmission of the causative agents of numerous infectious diseases might be potentially conducted by various routes if this is supported by the genetics of the pathogen. Various transmission modes occur in related pathogens, reflecting a complex process that is specific for each particular host–pathogen system that relies on and is affected by pathogen and host genetics and ecology, ensuring the epidemiological spread of the pathogen.

The recent dramatic rise in diagnosed cases of Lyme borreliosis might be due to several factors: the shifting of the distributional range of tick vectors caused by climate change; dispersal of infected ticks due to host animal migration; recent urbanization; an increasing overlap of humans' habitat with wildlife reservoirs and the environment of tick vectors of *Borrelia*; improvements in disease diagnosis; or establishment of adequate surveillance. The involvement of other bloodsucking arthropod vectors and/or other routes of transmission (human-to-human) of the causative agent of Lyme borreliosis, the spirochetes from the *Borrelia burgdorferi* sensu lato complex, has been speculated to be contributing to increased disease burden. It does not matter how controversial the idea of vector-free spirochete transmission might seem in the beginning.

As long as evidence of sexual transmission of *Borrelia burgdorferi* both between vertebrate hosts and between tick vectors exists, this question must be addressed. In order to confirm or refute the existence of this phenomenon, which could have important implications for Lyme borreliosis epidemiology, the need of extensive research is obvious and required. Rudenko N and Golovchenko M. May 2021, Trop. Med. Infect. Dis. 2021, 6, 87. <https://www.mdpi.com/2414-6366/6/2/87>

Alpha-Gal Allergy as a Cause of Intestinal Symptoms in a Gastroenterology Community Practice.

Immunoglobulin E (IgE) to galactose- α -1,3-galactose (alpha-gal) is a recently appreciated cause of allergic reactions to mammalian meat and dairy. In eastern North America Lone Star tick bites are the dominant mode of sensitization. Classically the alpha-gal syndrome manifests with urticaria, gastrointestinal symptoms, and/or anaphylaxis, but increasingly there are reports of isolated gastrointestinal symptoms without other common allergic manifestations. The objective of this retrospective study was to determine the frequency of IgE to alpha-gal in patients presenting with unexplained gastrointestinal symptoms to a community gastroenterology

practice, and to evaluate the symptom response to the removal of mammalian products from the diet in alpha-gal-positive individuals.

An electronic medical record database was used to identify patients with alpha-gal IgE laboratory testing performed within the past 4 years. These charts were reviewed for alpha-gal test results, abdominal pain, diarrhea, nausea and vomiting, hives, bronchospasm, diagnosis of irritable bowel syndrome, postprandial exacerbation of symptoms, meat exacerbation of symptoms, patient recall of tick bite, other simultaneous gastrointestinal tract diagnoses, and clinical improvement with mammalian food product avoidance.

From: *Sustainable Health*

Volume 1 of The Journal of the Blue Cross NC Institute for Health & Human Services, the Beaver College of Health Sciences & Appalachian State University
March 2021, Vol. 01, Appalachian State University

A total of 1112 adult patients underwent alpha-gal IgE testing and 359 (32.3%) were positive. Gastrointestinal symptoms were similar in those positive and negative for alpha-gal seroreactivity. Of the 359 alpha-gal-positive patients, 122 had follow-up data available and 82.0% of these improved on a diet free of mammalian products. Few patients reported hives (3.9%) or bronchospasm (2.2%). Serum alpha-gal IgE titers ranged from 0.1 to >100 kU/L, with an average of 3.43 kU/L and a median of 0.94 kU/L.

Clinicians practicing in the region of the Lone Star tick habitat need to be aware that patients with IgE to alpha-gal can manifest with isolated abdominal pain and diarrhea, and these patients respond well to dietary exclusion of mammalian products. Richard N, Richard R. Southern Medical Journal, Feb 2021, 114(3):169-173, DOI: [10.14423/smj.0000000000001223](https://doi.org/10.14423/smj.0000000000001223) PMID: 33655311

Detection of *Babesia odocoilei* in Humans with Babesiosis Symptoms

Abstract: Human babesiosis is a life-threatening infectious disease that causes societal and economic impact worldwide. Several species of *Babesia* cause babesiosis in terrestrial vertebrates, including humans.

A one-day clinic was held in Ontario, Canada, to see if a red blood cell parasite, which is present in blacklegged ticks, *Ixodes scapularis*, is present in humans. Based on PCR testing and DNA sequencing of the 18S rRNA gene, we unveiled *B. odocoilei* in two of 19 participants. DNA amplicons from these two patients are almost identical matches with the type strains of *B. odocoilei* in GenBank. In addition, the same two human subjects had the hallmark symptoms of human babesiosis, including night sweats, chills, fevers, and profound fatigue. Based on symptoms and molecular identification, we provide substantive evidence that *B. odocoilei* is pathogenic to humans. Dataset reveals that *B. odocoilei* serologically cross-reacts with *Babesia duncani*.

Clinicians must realize that there are more than two *Babesia* spp. in North America that cause human babesiosis. This discovery signifies the first report of *B. odocoilei* causing human babesiosis. Scott J et al. *Diagnostics* 2021, 11, 947. June 2021, <https://www.mdpi.com/2075-4418/11/6/947>

Lyme disease spirochetes found in two of the largest parks in London

***Ixodes ricinus* and *Borrelia burgdorferi* sensu lato in the Royal Parks of London, UK**

Assessing the risk of tick-borne disease in areas with high visitor numbers is important from a public health perspective. Evidence suggests that tick presence, density, infection prevalence and the density of infected ticks can vary between habitats within urban green space, suggesting that the risk of Lyme borreliosis transmission can also vary. This study assessed nymph density, *Borrelia* prevalence and the density of infected nymphs across a range of habitat types in nine parks in London which receive millions of visitors each year.

Ixodes ricinus were found in only two of the nine locations sampled, and here they were found in all types of habitat surveyed. Established *I. ricinus* populations were identified in the two largest parks, both of which had resident free-roaming deer populations. Highest densities of nymphs (15.68 per 100 m²) and infected nymphs (1.22 per 100 m²) were associated with woodland and under canopy habitats in Richmond Park, but ticks infected with *Borrelia* were found across all habitat types surveyed. Nymphs infected with *Borrelia* (7.9%) were only reported from Richmond Park, where *Borrelia burgdorferi* sensu stricto and *Borrelia afzelii* were identified as the dominant genospecies.

Areas with short grass appeared to be less suitable for ticks and maintaining short grass in high footfall areas could be a good strategy for reducing the risk of Lyme borreliosis transmission to humans in such settings. In areas where this would create conflict with existing practices which aim to improve and/or meet historic landscape, biodiversity and public access goals, promoting public health awareness of tick-borne disease risks could also be utilised. Hansford, KM, et al. *Exp Appl Acarol* (2021). <https://link.springer.com/article/10.1007%2Fs10493-021-00633-3>

Case report on an emerging tick-borne pathogen with no common name

Case report: first symptomatic *Candidatus Neoehrlichia mikurensis* infection in Slovenia

Candidatus Neoehrlichia mikurensis (CNM) is an emerging tick-borne pathogen and usually causes symptomatic infection only in immunocompromised patients. Apart from one described case found in the literature where cultivation was successful, all cases so far were diagnosed by using broad-range 16S rDNA PCR.

Our patient presented with a prolonged febrile state of unknown origin. Clinical presentation, extensive medical workup and classic microbiologic testing were non-conclusive. Several infectious agents and other causes for the febrile state were excluded. In the end, a broad-range

16S rDNA PCR was to be performed to confirm the diagnosis of CNM infection. Treatment was successful with doxycycline.

Due to the obscurity of the pathogen, diagnostic workup in CNM is prolonged and challenging. More awareness is needed about this emerging infectious disease in countries with high prevalence of tick-borne diseases as standard microbiological methods are not successful in confirming the diagnosis. Lenart, M. *BMC Infect Dis* **21**, 579 (2021). <https://doi.org/10.1186/s12879-021-06297-z>

Lyme Neuroborreliosis: Mechanisms of *B. burgdorferi* Infection of the Nervous System

Lyme borreliosis is the most prevalent tick-borne disease in the United States, infecting ~476,000 people annually. *Borrelia* spp. spirochetal bacteria are the causative agents of Lyme disease in humans and are transmitted by *Ixodes* spp ticks. Clinical manifestations vary depending on which *Borrelia* genospecies infects the patient and may be a consequence of distinct organotropism between species. In the US, *B. burgdorferi* sensu stricto is the most commonly reported genospecies and infection can manifest as mild to severe symptoms.

Different genotypes of *B. burgdorferi* sensu stricto may be responsible for causing varying degrees of clinical manifestations. While the majority of Lyme borreliosis-infected patients fully recover with antibiotic treatment, approximately 15% of infected individuals experience long-term neurological and psychological symptoms that are unresponsive to antibiotics. Currently, long-term antibiotic treatment remains the only FDA-approved option for those suffering from these chronic effects.

Here, we discuss the current knowledge pertaining to *B. burgdorferi* sensu stricto infection in the central nervous system (CNS), termed Lyme neuroborreliosis (LNB), within North America and specifically the United States. We explore the molecular mechanisms of spirochete entry into the brain and the role *B. burgdorferi* sensu stricto genotypes play in CNS infectivity. Understanding infectivity can provide therapeutic targets for LNB treatment and offer public health understanding of the *B. burgdorferi* sensu stricto genotypes that cause long-lasting symptoms. Ford L and Tufts D. *Brain Sci.* 2021, *11*(6), 789; <https://doi.org/10.3390/brainsci11060789>.

Spirochetes in the brain of a patient treated for Lyme years earlier Detecting *Borrelia* Spirochetes: A Case Study With Validation Among Autopsy Specimens

The complex etiology of neurodegenerative disease has prompted studies on multiple mechanisms including genetic predisposition, brain biochemistry, immunological responses, and microbial insult. In particular, Lyme disease is often associated with neurocognitive impairment with variable manifestations between patients.

We sought to develop methods to reliably detect *Borrelia burgdorferi*, the spirochete bacteria responsible for Lyme disease, in autopsy specimens of patients with a history of neurocognitive disease. In this report, we describe the use of multiple molecular detection techniques for this pathogen and its application to a case study of a Lyme disease patient.

The patient had a history of Lyme disease, was treated with antibiotics, and years later developed chronic symptoms including dementia. The patient's pathology and clinical case description was consistent with Lewy body dementia. *B. burgdorferi* was identified by PCR in several CNS tissues and by immunofluorescent staining in the spinal cord. These studies offer proof of the principle that persistent infection with the Lyme disease spirochete may have lingering consequences on the CNS. Gadila et al. Front. Neurol., 10 May 2021 | <https://doi.org/10.3389/fneur.2021.628045>.

Lyme Borreliosis and Associations With Mental Disorders and Suicidal Behavior: A Nationwide Danish Cohort Study

Lyme borreliosis is a tick-borne infectious disease that may confer an increased risk of mental disorders, but previous studies have been hampered by methodological limitations, including small sample sizes. The authors used a nationwide retrospective cohort study design to examine rates of mental disorders following Lyme borreliosis.

Using Denmark's National Patient Register and the Psychiatric Central Research Register, and including all persons living in Denmark from 1994 through 2016 (N=6,945,837), the authors assessed the risk of mental disorders and suicidal behaviors among all individuals diagnosed with Lyme borreliosis in inpatient and outpatient hospital contacts (N=12,156). Incidence rate ratios (IRRs) were calculated by Poisson regression analyses.

Individuals with Lyme borreliosis had higher rates of any mental disorder (IRR=1.28, 95% CI=1.20, 1.37), of affective disorders (IRR=1.42, 95% CI=1.27, 1.59), of suicide attempts (IRR=2.01, 95% CI=1.58, 2.55), and of death by suicide (IRR=1.75, 95% CI=1.18, 2.58) compared with those without Lyme borreliosis. The 6-month interval after diagnosis was associated with the highest rate of any mental disorder (IRR=1.96, 95% CI=1.53, 2.52), and the first 3 years after diagnosis was associated with the highest rate of suicide (IRR=2.41, 95% CI=1.25, 4.62). Having more than one episode of Lyme borreliosis was associated with increased incidence rate ratios for mental disorders, affective disorders, and suicide attempts, but not for death by suicide.

Individuals diagnosed with Lyme borreliosis in the hospital setting had an increased risk of mental disorders, affective disorders, suicide attempts, and suicide. Although the absolute population risk is low, clinicians should be aware of potential psychiatric sequelae of this global disease. Fallon et al. The American Journal of Psychiatry, <https://doi.org/10.1176/appi.ajp.2021.20091347>.

Leeches used to get blood samples for tick studies among zoo animals

Detection of Antibodies against Tick-Borne Encephalitis Virus in Zoo Animals Using Non-Invasive Blood Sampling with Medicinal Leeches (*Hirudo medicinalis*)

P Kvapil, M Kastelic, N Jež, K Sedlák, N Kašpárková... - Pathogens, 2021

New idea! Of course, we wondered how the leeches were recovered before the “until the leeches spontaneously fell off the animals or were manually retrieved after achievement of sufficient enlargement. The individual leech was emptied, and blood volume was measured using a syringe with a varying volume (5, 10, or 20 mL) and a 22 G needle based on the size of the leeches... . In our case, medicinal leeches were able to draw up to 20 mL of blood in about 8 to 55 min.”

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