Tick-Borne Infections Council of North Carolina, Inc.

NEWSLETTER 2017, Volume 3

Quote of the season: -

"Those among us who are unwilling to expose their ideas to the hazard of refutation do not take part in the scientific game."
— Karl R. Popper, The Logic of Scientific Discovery

Highlights…
Scroll down to see these features and more!

- **Chatham County's Dept of Public Health Tick Forum**
- **A 14-year history of tick bites and subsequent related illnesses in 2 people in central North Carolina**
- **In Connecticut, reducing dear density reduces ticks**
- **Reasons for caution with regard to potential new Lyme disease vaccines**
- **36% of Lyme disease ticks in one area of Ontario positive for the Lyme disease bacteria**
- **A million year old piece of amber contained a tick positive for pathogens**

State Vector-Borne Disease Working Group 2017 Meeting Schedule

Aug 4, 2017 October 20, 2017
(Check with us at info@tic-nc.org to confirm date as they occasionally make a last minute change.)

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

Links to Letters to Medical Providers from the State Department of Public Health on Lyme Disease and Rickettsial Diseases

These links are to the letters the state Department of Public Health issues every year to medical providers on Lyme disease and the Rickettsial diseases such as RMSF: http://tic-nc.org/publications/

Disease	Total cases by year of report 2014 Preliminary Confirmed + Probable (Confirmed/Probable/Suspected)*	2015 Final (Probable/Confirmed/Suspected)*	2016 Preliminary (Probable/Confirmed)
Lyme disease	170 (27/143/86)	192/38/46	277/33
Rickettsioses	496 (10/486/278)	454/5/130	475/6
Ehrlichioses	73 (11/62/31)	58/16/18	61/10
Anaplasmoses	12 (0/12/12)	15/4/3	14/1

*This is the year of report, not year of illness onset

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.

TIC-NC Talks and Materials Distributed

Brochures and English/Spanish brochures:
South Carolina Mosquito Control Association
El Centro Hispano Durham and Carrboro
Catholic Charities Durham
Day Laborers Center – Carrboro
Porch Program – Orange County
NC Farmworker Health Program
Piedmont Health
Wilmington, NC numerous locations
Shakori Hill's Spring Music Festival
William B Umstead State Park
Jordan Lake State Park
Eno River State Park
Hillsboro Hispanic Bakery and Tortilleria
El Restaurante Ixtapa
And more
Talks: South Carolina Mosquito Control Association
Booth: Hillsborough PORCH, booklets, Spanish-English brochure, tick removers, samples of repellents

In November 2016, Marcia E. Herman-Giddens, TIC-NC's Scientific Adviser, gave a presentation on ticks and tick-borne diseases encountered in South Carolina at the 44th Annual Meeting of the South Carolina Mosquito Control Association.. Dr. Bruce Harrison also spoke at the meeting.

44th Annual Meeting of the South Carolina Mosquito Control Association took place November 2-4, 2016 at Hickory Knob State Park in McCormick, SC.

Presenters

Dr. Chris Evans
Zika response in South Carolina;
SC Arbovirus Update

Dr. Bruce Harrison
Mosquito Ecology

Dr. Janet McAllister
Zika - The Threats of Resistance

Dr. Marcia Herman-Giddens
What's New With Ticks: It Just Keeps Getting Worse

More on the Chatham County Public Health Department Hosts Tick Forum', April 28, 2017

Tick forum panelists: Left to right- Bruce Harrison, Steve Seagle, Marcia Herman-Giddens, Ken Knight, and Graham Hickling

On Friday, April 28th, the Chatham County Public Health Department, with leadership from the Board of Health, hosted the 2017 Tick Forum to discuss issues around ticks and tick-borne illness in North Carolina, with a focus on Chatham County.

You may view the latest post at http://www.chathampublichealth.com/health-information/as-tick-activity-increases-chatham-county-public-health-department-hosts-tick-forum/

While it is not possible to prevent all cases of tick-borne illness, you can greatly reduce your risk by following the basic control measures seen at both above and below links.

To learn more about ticks or to watch videos of the Tick Forum presentations, visit www.chathamnc.org/ticks.

אא North Carolina and Southeast Section אא

Paper on a 14-year history of tick bites and subsequent related illnesses in 2 people in central North Carolina

North Carolina Residents: Frequency of Tick Bites and Associated Illnesses, 2001-2014

Background Tick bites are a source of illness and disease agents that may lead to morbidity and occasional fatalities in North Carolina. Public health interest in tick-borne illness and disease has increased due to continuing discoveries of tick-borne diseases and their increasing geographic spread and disease incidence. There are no data published on lay individuals with cumulative tick bites and associated illnesses over a period of years.

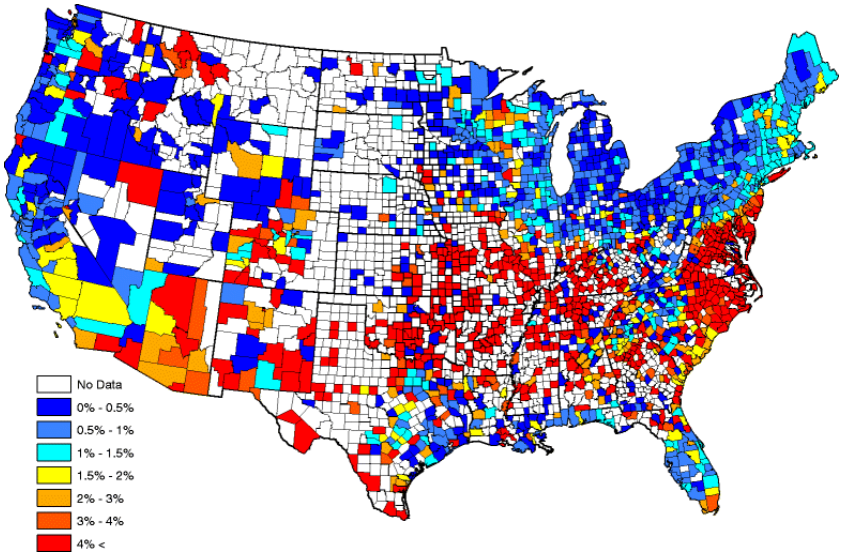
Methods We learned of a married couple living on a central North Carolina property who had used reasonable bite prevention methods, kept attached ticks after removal, and recorded dates and related illness records from 2001–2014. We obtained permission to analyze their records. Ticks were identified by an entomologist.

Results The male subject had a total of 219 bites from identifiable ticks comprising 213 *Amblyomma americanum*, 4 *Dermacentor variabili*s, and 2 *Ixodes scapularis*. He was treated for possible Rocky Mountain spotted fever once and presumed Southern Tick Associated Rash Illness once. The female subject had 193 bites comprising 168 *A. americanum*, 23 *D. variabilis*, and 2 *I. scapularis*. She was treated for 4 episodes of presumed Southern Tick Associated Rash Illness and one possible case of a tick-borne infection. Several years of data were missing for both subjects.

Limitations This retrospective report relied on the subjects' own records for much of the data. The experience of these individuals cannot be generalized. Diagnoses of these tick-related illnesses are inexact due to lack of tests for the Southern Tick Associated Rash Illness and cross-reactivity in tests for spotted fever rickettsiosis.

Conclusions This report demonstrates that tick-associated illnesses, including episodes fitting the Center for Disease Control and Prevention's definition of the Southern Tick Associated Rash Illness, may be more common than realized. Use of personal tick protection measures for tick bite illness and disease prevention may not be sufficiently protective. Further subject-based research on tick and disease burden on selected populations would be informative, and could aid in planning appropriate actions to mitigate the effects of tick-borne disease in North Carolina. Herman-Giddens et al. NCMJ vol. 78, no. 3 ncmedicaljournal.com, pp.156-163.

North Carolina looks like a hot-spot for *Ehrlichia,* at least in dogs



County level raw prevalences for *Ehrlichia* antibodies reported in domestic dogs aggregated over 2011–2015

"The forecast presented herein can be an a priori alert to veterinarians regarding areas expected to see expansion of *Ehrlichia* beyond the accepted endemic range, or in some regions a dynamic change from historical average prevalence. Moreover, this forecast could potentially serve as a surveillance tool for human health and prove useful for forecasting other vector-borne diseases."
From: A Bayesian spatio-temporal model for forecasting the prevalence of antibodies to *Ehrlichia* species in domestic dogs within the contiguous United States. Liu et al. *Parasites & Vectors*201710:138 DOI: 10.1186/s13071-017-2068-x. Open access.

Kentucky Handout on Ticks

COOPERATIVE EXTENSION SERVICE Entfact-618 UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT, KY 40546

Significant increases in wildlife populations, expanded ranges of some tick species, development of housing in rural areas, and the popularity of hiking and ecotourism have increased the potential for people to encounter ticks. Awareness and use of preventive measures to reduce exposure while working outdoors or enjoying outdoor activities are keys to reducing tick bites. Use repellents and check yourself frequently for ticks while and after being in areas where they may be active.
PDF has maps and information on disease incidence in Kentucky.
https://entomology.ca.uky.edu/files/ef618.pdf

◘◘ National Section ◘◘

In a Connecticut study, reducing deer density to 5.1 deer per square kilometer resulted in a 76% reduction in ticks and 80% reduction in Lyme disease

The Relationship Between Deer Density, Tick Abundance, and Human Cases of Lyme Disease in a Residential Community

White-tailed deer (*Odocoileus virginianus* Zimmerman), serve as the primary host for the adult blacklegged tick (*Ixodes scapularis* Say), the vector for Lyme disease, human babesiosis, and human granulocytic anaplasmosis. Our objective was to evaluate the degree of association between deer density, tick abundance, and human cases of Lyme disease in one Connecticut community over a 13-yr period. We surveyed 90–98% of all permanent residents in the community six times from 1995 to 2008 to document resident's exposure to tick-related disease and frequency and abundance of deer observations. After hunts were initiated, number and frequency of deer observations in the community were greatly reduced as were resident-reported cases of Lyme disease. Number of resident-reported cases of Lyme disease per 100 households was strongly correlated to deer density in the community. Reducing deer density to 5.1 deer per square kilometer resulted in a 76% reduction in tick abundance, 70% reduction in the entomological risk index, and 80% reduction in resident-reported cases of Lyme disease in the community from before to after a hunt was initiated. Kilpatrick et al. J Med Entomol (2014) 51 (4): 777-784. . J Med Entomol (2014) 51 (4): 777-784. https://doi.org/10.1603/ME13232

Iowa House Bill 577 protecting Lyme disease treatment passed on March 23 2017

The bill states:
A person licensed by a board under this subtitle shall not be subject to discipline under this chapter or the board's enabling statute based solely on the licensee's recommendation or provision of a treatment method for Lyme disease or other tick-borne disease if the recommendation or provision of such treatment meets all the following criteria:

1. The treatment is provided after an examination is performed and informed consent is received from the patient.
2. The licensee identifies a medical reason for recommending or providing the treatment.
3. The treatment is provided after the licensee informs the patient about other recognized treatment options and describes to the patient the licensee's education, experience, and credentials regarding the treatment of Lyme disease or other tick-borne disease.
4. The licensee uses the licensee's own medical judgment based on a thorough review of all available clinical information and Lyme disease or other tick-borne disease literature to determine the best course of treatment for the individual patient.
5. The treatment will not, in the opinion of the licensee, result in the direct and proximate death of or serious bodily injury to the patient.

Despite opposition from the state's medical community, the bill passed both houses of the legislature unanimously.
According to Representative Sandy Salmon of Janesville, the state Board of Medicine has disciplined two doctors for prescribing antibiotics for more than 30 days as treatment for Lyme disease.
During House debate on the bill, she said, "This has had the effect of quashing the willingness of Iowa medical providers to treat and even diagnose Lyme disease."

Two papers showing reason for caution in developing and testing vaccines for Lyme disease

The immune system cannot generate immunological memory during infection with the Lyme disease agent *B. burgdorferi*

In vertebrates including humans, mice and dogs, the bacteria *Borrelia burgdorferi* (Bb) causes a chronic, non-resolving infection known as Lyme disease, which requires antibiotic treatment to clear the bacteria. Re-infections are common in endemic regions. Similarly, mice can be re-infected with the same strain of Bb, implying a lack of functional immune responses. The mechanisms underlying this lack of effective short and long-term immunity to Bb are unknown. Using a mouse model of Bb-infection we show that infection with Bb produces strong T-dependent and T-independent serum antibodies, characterized by the unusual continued presence of IgM. Remarkably, both T-dependent and T-independent antibodies disappear rapidly when infection is controlled by antibiotic treatment and Bb-specific memory B cells could not be recovered. Thus, maintenance of Bb-specific humoral responses requires ongoing infections. Histological and flow cytometric examination of germinal centers, birthplaces of long-term humoral immunity, demonstrate their induction within 2 weeks of a primary infection and the presence of germinal center follicular helper T and B cells. However, the apparent normal induction of germinal centers is followed by their rapid and global collapse in multiple lymphoid organs by day 45. To determine whether the lack of memory formation is due to the nature of the Bb-antigens or is a sign of Bb-infection-mediated immune suppression, we vaccinated mice with influenza virus during an ongoing Bb-infection. Remarkably, in Bb infected mice the early antibody response to this unrelated antigen was skewed towards increased IgM production compared to that in non-infected mice, and influenza specific IgG responses were strongly reduced. Together our data demonstrate that Bb infection suppresses the development of long-lived antibody production and immunological memory formation and indicates that Bb may achieve this by suppressing the function and/or causing the rapid and global collapse of germinal centers. Supported by NIH AI073911 and T32 AI060555. Elsner at al. *Cytokine* http://dx.doi.org/10.1016/j.cyto.2013.06.080, Volume 63; 2013: pp 261

Neurological complications of vaccination with outer surface protein A (OspA).

A wide range of neurological complications have been reported via the medical literature and the VAERS system after vaccination with recombinant outer surface protein A (OspA) of Borrelia. To explore this issue, 24 patients reporting neurological adverse events (AE) after vaccination with Lymerix, out of a group of 94 patients reporting adverse events after Lymerix vaccination, were examined for causation. Five reports of cerebral ischemia, two transient Ischemic attacks, five demyelinating events, two optic neuritis, two reports of transverse myelitis, and one non-specific demyelinating condition are evaluated in this paper. Caution is raised on not actively looking for neurologic AE, and for not considering causation when the incidence rate is too low to raise a calculable difference to natural occurence. Marks DH. *Int J Risk Saf Med.* 2011;23(2):89-96. doi: 10.3233/JRS-211-0527.

Authors seek to replace the conventional 2-tiered test for Lyme disease.

Performance is still not impressive and there may be conflicts of interest regarding patents for the C6 EIA

Evaluation of Modified 2-Tiered Serodiagnostic Testing Algorithms for Early Lyme Disease

Background.
The conventional 2-tiered serologic testing protocol for Lyme disease (LD), an enzyme immunoassay (EIA) followed by immunoglobulin M and immunoglobulin G Western blots, performs well in late-stage LD but is insensitive in patients with erythema migrans (EM), the most common manifestation of the illness. Western blots are also complex, difficult to interpret, and relatively expensive. In an effort to improve test performance and simplify testing in early LD, we evaluated several modified 2-tiered testing (MTTT) protocols, which use 2 assays designed as first-tier tests sequentially, without the need of Western blots.
Methods.
The MTTT protocols included (1) a whole-cell sonicate (WCS) EIA followed by a C6 EIA; (2) a WCS EIA followed by a VlsE chemiluminescence immunoassay (CLIA); and (3) a variable major protein-like sequence, expressed (VlsE) CLIA followed by a C6 EIA. Sensitivity was determined using serum from 55 patients with erythema migrans; specificity was determined using serum from 50 patients with other illnesses and 1227 healthy subjects.
Results.
Sensitivity of the various MTTT protocols in patients with acute erythema migrans ranged from 36% (95% confidence interval [CI], 25%–50%) to 54% (95% CI, 42%–67%), compared with 25% (95% CI, 16%–38%) using the conventional protocol (P = .003–0.3). Among control subjects, the 3 MTTT protocols were similarly specific (99.3%–99.5%) compared with conventional 2-tiered testing (99.5% specificity; P = .6–1.0).
Conclusions.
Although there were minor differences in sensitivity and specificity among MTTT protocols, each provides comparable or greater sensitivity in acute EM, and similar specificity compared with conventional 2-tiered testing, obviating the need for Western blots. Branda et al. Clin Infect Dis, Jan 2017. https://doi.org/10.1093/cid/cix043

Black-legged ticks can transmit new Borrelia within 24 hours, on mice, at least

Transmission of *Borrelia miyamotoi* sensu lato relapsing fever group spirochetes in relation to duration of attachment by *Ixodes scapularis* nymphs

Borrelia miyamotoi sensu lato relapsing fever group spirochetes are emerging as causative agents of human illness (*Borrelia miyamotoi* disease) in the United States. Host-seeking *Ixodes scapularis* ticks are naturally infected with these spirochetes in the eastern United States and experimentally capable of transmitting *B. miyamotoi*. However, the duration of time required from tick attachment to spirochete transmission has yet to be determined. We therefore conducted a study to assess spirochete transmission by single transovarially infected *I. scapularis* nymphs to outbred white mice at three time points post-attachment (24, 48, and 72 hours) and for a complete feed (> 72–96 hours). Based on detection of *B. miyamotoi* DNA from the blood of mice fed on by an infected nymph, the probability of spirochete transmission increased from 10% by 24 hours of attachment (evidence of infection in 3/30 mice) to 31% by 48 hours (11/35 mice), 63% by 72 hours (22/35 mice), and 73% for a complete feed (22/30 mice). We conclude that (i) single *I. scapularis* nymphs effectively transmit *B. miyamotoi* relapsing fever group spirochetes while feeding, (ii)

transmission can occur within the first 24 hours of nymphal attachment, and (iii) the probability of transmission increases with the duration of nymphal attachment. Beuner at al. *Ticks and Tick-borne Diseases*, http://www.sciencedirect.com/science/article/pii/S1877959X17300869

American dog tick and Gulf Coast tick may transmit some Rickettsia from adults to eggs but not commonly

Comparative vertical transmission of *Rickettsia* by *Dermacentor variabilis* and *Amblyomma maculatum*

The geographical overlap of multiple *Rickettsia* and tick species coincides with the molecular detection of a variety of rickettsial agents in what may be novel tick hosts. However, little is known concerning transmissibility of rickettsial species by various tick hosts. To examine the vertical transmission potential between select tick and rickettsial species, two sympatric species of ticks, *Dermacentor variabilis* and *Amblyomma maculatum,* were exposed to five different rickettsial species, including *Rickettsia rickettsii*, *Rickettsia parkeri*, *Rickettsia montanensis*, *Rickettsia amblyommatis*, or flea-borne *Rickettsia felis*. Fitness-related metrics including engorgement weight, egg production index, nutrient index, and egg hatch percentage were then assessed. Subsamples of egg clutches and unfed larvae, nymphs, and adults for each cohort were assessed for transovarial and transstadial transmission of rickettsiae by qPCR. Rickettsial exposure had a minimal fitness effect in *D. variabilis* and transovarial transmission was observed for all groups except *R. rickettsii*. In contrast, rickettsial exposure negatively influenced *A. maculatum* fitness and transovarial transmission of rickettsiae was demonstrated only for *R. amblyommatis*- and *R. parkeri*-exposed ticks. Sustained maintenance of rickettsiae via transstadial transmission was diminished from F_1 larvae to F_1 adults in both tick species. The findings of this study suggest transovarial transmission specificity may not be tick species dependent, and sustained vertical transmission is not common. Harris et al. Ticks and Tick-borne Diseases. doi. org/10.1016/j.ttbdis.2017.04.003

Lone stars the most common tick on Missouri bears

Community composition of Ixodid ticks parasitizing American black bears in Missouri, USA

Bears (Ursidae) have extensive home ranges and may move long distances, thereby potentially serving as hosts to, and vectors of, large numbers of ticks. We assessed the composition of the parasitizing tick community on American black bears (*Ursus americanus*) to discern hard tick species capable of successfully feeding, which is a necessary step for tick reproduction.
We counted ticks from free-ranging, live-trapped, or road-killed black bears in southern Missouri, USA, during 2015, and collected a subset of engorged ticks (n = 967). All bears (n = 17) were infected with ticks (n = 6,993), with a mean intensity of 411 ticks/bear, of which 14% were engorged females. The infracommunity size of engorged ticks was 57 ticks/bear. From these engorged ticks, we identified 5 species: *Amblyomma americanum, A. maculatum, Dermacentor variabilis, D. albipictus,* and *Ixodes scapularis. Amblyomma americanum* was the most common species, collected on all surveyed bears, and represented 58.2% of engorged ticks, whereas *D. albipictus* and *A. maculatum* were the least common species, collected from only 3 and 4 bears, respectively, and representing 4.7% and 2.4% of engorged ticks, respectively. Our data suggest that individual black bears have the potential to host large numbers of ticks to engorgement, and may be important vectors for tick dispersal and for the maintenance of tick populations.
Al-Warid et al. Ursus 27(2):61-66. 2017 doi: http://dx.doi.org/10.2192/URSU-D-16-00008.1

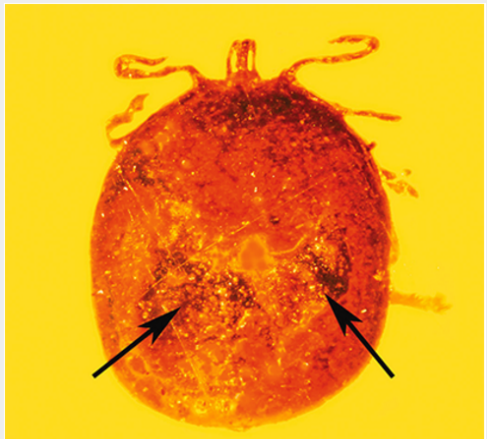
36% of black-legged ticks in the Grand River Valley, Ontario, Canada are positive for Lyme disease bacteria. Songs birds drop infected ticks during spring migration.

Detection of Lyme Disease Bacterium, *Borrelia burgdorferi* sensu lato, in Blacklegged Ticks Collected in the Grand River Valley, Ontario, Canada

We document the presence of blacklegged ticks, *Ixodes scapularis*, in the Grand River valley, Centre Wellington, Ontario. Overall, 15 (36%) of 42 *I. scapularis* adults collected from 41 mammalian hosts (dogs, cats, humans) were positive for the Lyme disease bacterium, *Borrelia burgdorferi* sensu lato (s.l.). Using real-time PCR testing and DNA sequencing of the flagellin (*fla*) gene, we determined that *Borrelia* amplicons extracted from *I. scapularis* adults belonged to *B. burgdorferi* sensu stricto (s.s.), which is pathogenic to humans and certain domestic animals. Based on the distribution of *I. scapularis* adults within the river basin, it appears likely that migratory birds provide an annual influx of *I. scapularis* immatures during northward spring migration. Health-care providers need to be aware that local residents can present with Lyme disease symptoms anytime during the year. Scott et al. *Int J Med Sci* 2017; 14(2):150-158. doi:10.7150/ijms.17763. Available from http://www.medsci.org/v14p0150.htm

Fossilized Tick Carrying Pathogens in Mammalian Blood Cells Discovered in 15-Million-Year-Old Amber

Ticks have been pathogen-carrying parasites for a very, very long time. A new discovery in a specimen of fossilized amber, roughly 15 million to 20 million years old, reveals a tick encased adjacent to mammalian blood cells infected with microbes resembling those in the order Piroplasmida. Entire article at: entomologytoday.org/2017/03/30/fossilized-tick-carrying-pathogens-in-mammalian-blood-cells-discovered-in-15-million-year-old-amber/



An engorged nymphal tick of the genus *Amblyomma* was discovered in fossilized amber with mammalian blood cells in and around the tick. The arrows in the picture identify two breaks in the tick's body wall, presumed to have resulted from a monkey grooming the tick off of a companion. (Photo credit: George Poinar, Ph.D.)

A nice summary of emerging tick-borne infections

From chapter in *Emergence of New Tickborne Infections*: **Emerging Zoonoses**, by I. W. Fong. **Part of the series Emerging Infectious Diseases of the 21st Century pp 81-100. Date: 08 February 2017**

Abstract:
Several tickborne infectious diseases such as Lyme borreliosis, ehrlichiosis, anaplasmosis, babesiosis, and others have been expanding to new endemic regions in the world for over a decade. Moreover, new pathogens transmitted by ticks have recently been recognized in animals and humans from diverse regions of the globe, widely separated in distance. These include new phleboviruses of the *Bunyaviridae* family, exemplified by severe fever with thrombocytopenia syndrome virus [SFTSV] recognized in China in 2010, and the Heartland virus, a closely related but distinct virus, presenting with similar clinical features and discovered in Missouri in 2012. Other newly recognized tickborne infections include a novel spirochete of the relapsing fever group, *Borrelia miyamotoi*, first reported to cause human infection in Russia in 2011 and subsequently discovered to cause clinical disease in the Netherlands, Japan, and the United States, with transmission by the black-legged deer tick *Ixodes scapularis*. In Europe a new tickborne disease, neoehrlichiosis caused by *Candidatus neoehrlichia mikurensis* belonging to the *Anaplasmataceae* family, has been described recently. Furthermore, new tickborne rickettsial infections continue to be recognized in Europe such as tickborne lymphadenopathy identified in 1997 and caused by *Rickettsia slovaca*. Novel tickborne infectious diseases will continue to emerge worldwide for the foreseeable future and be a challenge to the health of human populations. Innovative methods of prevention for a broad variety of tick-transmitted diseases are needed, and one approach is to develop a universal tick vaccine that can be given to animal hosts or humans.

Bell's palsy, one of the possible effects of Lyme disease, increased 42% per year from 2011 to 2015 in England

Lyme disease and Bell's palsy: an epidemiological study of diagnosis and risk in England

Background Lyme disease is caused by a tick-borne spirochaete of the *Borrelia* species. It is associated with facial palsy, is increasingly common in England, and may be misdiagnosed as Bell's palsy.
Aim To produce an accurate map of Lyme disease diagnosis in England and to identify patients at risk of developing associated facial nerve palsy, to enable prevention, early diagnosis, and effective treatment.
Design and setting Hospital episode statistics (HES) data in England from the Health and Social Care Information Centre were interrogated from April 2011 to March 2015 for International Classification of Diseases 10th revision (ICD-10) codes A69.2 (Lyme disease) and G51.0 (Bell's palsy) in isolation, and as a combination.
Method Patients' age, sex, postcode, month of diagnosis, and socioeconomic groups as defined according to the English Indices of Deprivation (2004) were also collected.
Results Lyme disease hospital diagnosis increased by 42% per year from 2011 to 2015 in England. Higher incidence areas, largely rural, were mapped. A trend towards socioeconomic privilege and the months of July to September was observed. Facial palsy in combination with Lyme disease is also increasing, particularly in younger patients, with a mean age of 41.7 years, compared with 59.6 years for Bell's palsy and 45.9 years for Lyme disease ($P = 0.05$, analysis of variance [ANOVA]).
Conclusion Healthcare practitioners should have a high index of suspicion for Lyme disease following travel in the areas shown, particularly in the summer months. The authors suggest that patients

presenting with facial palsy should be tested for Lyme disease. Cooper et al. Br J Gen Pract 11 April 2017; bjgp17X690497. **DOI:** https://doi.org/10.3399/bjgp17X690497

A case of Lyme disease in a cancer patient with a negative blood test

Seronegative lyme neuroborreliosis in a patient using rituximab.

A 66-year-old woman presented with severe shooting pains throughout her back and legs, followed by progressive deafness, weight loss and headache. She had a history of marginal zone B-cell lymphoma stage IV-B, for which she was successfully treated with immunochemotherapy and rituximab maintenance therapy. A relapse was suspected, but chemotherapy was not administered, since, despite elaborate investigations, malignancy could not be proven. Because of a history of tick bites she was tested for antibodies against *Borrelia burgdorferi* in serum and cerebrospinal fluid (CSF), which were negative. However, a *B burgdorferi* PCR on CSF came back positive. The patient was treated for seronegative Lyme neuroborreliosis with ceftriaxone intravenously and dramatically improved. This case presentation demonstrates that, in immunocompromised patients, it is important not to solely rely on antibody testing and to use additional diagnostic tests to avoid missing or delaying the diagnosis. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3604215/

Review Article on How Lyme Disease and Related Diseases Evade Immune Responses

There Is a Method to the Madness: Strategies to Study Host Complement Evasion by Lyme Disease and Relapsing Fever Spirochetes

Lyme disease and relapsing fever are caused by various *Borrelia* species. Lyme disease *borreliae*, the most common vector-borne pathogens in both the U.S. and Europe, are transmitted by *Ixodes* ticks and disseminate from the site of tick bites to tissues leading to erythema migrans skin rash, arthritis, carditis, and neuroborreliosis. Relapsing fever *borreliae*, carried by ticks and lice, trigger reoccurring fever episodes. Following transmission, spirochetes survive in the blood to induce bacteremia at the early stages of infection, which is thought to promote evasion of the host complement system. The complement system acts as an important innate immune defense mechanism in humans and vertebrates. Upon activation, the cleaved complement components form complexes on the pathogen surface to eventually promote bacteriolysis. The complement system is negatively modulated by a number of functionally diverse regulators to avoid tissue damage. To evade and inhibit the complement system, spirochetes are capable of binding complement components and regulators. Complement inhibition results in bacterial survival in serum (serum resistance) and is thought to promote bloodstream survival, which facilitates spirochete dissemination and disease manifestations. In this review, we discuss current methodologies to elucidate the mechanisms of *Borrelia* spp. that promote serum resistance and bloodstream survival, as well as novel methods to study factors responsible for bloodstream survival of Lyme disease *borreliae* that can be applied to relapsing fever *borreliae*. Understanding the mechanisms these pathogens utilize to evade the complement system will ultimately aid in the development of novel therapeutic strategies and disease prevention to improve human health. **Marcinkiewicz et al.** Front. Microbiol., 02 March 2017. http://journal.frontiersin.org/article/10.3389/fmicb.2017.00328/full

Poor Little Hedgehogs and Urban Dwellers

Melting pot of tick-borne zoonoses: the European hedgehog contributes to the maintenance of various tick-borne diseases in natural cycles urban and suburban areas

European hedgehogs (*Erinaceus europaeus*) are urban dwellers and host both *Ixodes ricinus* and *Ixodes hexagonus*. These ticks transmit several zoonotic pathogens like *Borrelia burgdorferi* (*sensu lato*), *Anaplasma phagocytophilum*, *Rickettsia helvetica*, *Borrelia miyamotoi* and "*Candidatus* Neoehrlichia mikurensis". It is unclear to what extent hedgehogs in (sub) urban areas contribute to the presence of infected ticks in these areas… Both *Ixodes hexagonus* ($n = 1132$) and *Ixodes ricinus* ($n = 73$) of all life stages were found on the 54 investigated hedgehogs. *Borrelia miyamotoi*, *A. phagocytophilum*, *R. helvetica* and *B. burgdorferi* genospecies (*Borrelia afzelii*, *Borrelia bavariensis* and *Borrelia spielmanii*) were detected in both *I. hexagonus* and *I. ricinus*. *Anaplasma phagocytophilum*, *R. helvetica*, *B. afzelii*, *B. bavariensis* and *B. spielmanii* were found significantly more in engorged ticks in comparison to questing *I. ricinus*.

European hedgehogs seem to contribute to the spread and transmission of tick-borne pathogens in urban areas. The relatively high prevalence of *B. bavariensis*, *B. spielmanii*, *B. afzelii*, *A. phagocytophilum* and *R. helvetica* in engorged ticks suggests that hedgehogs contribute to their enzootic cycles in (sub) urban areas. The extent to which hedgehogs can independently maintain these agents in natural cycles, and the role of other hosts (rodents and birds) remain to be investigated. Jafari et al. *Parasites & Vectors* 201710:134 DOI: 10.1186/s13071-017-2065-0

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