



TICK BORNE DISEASES IN ONTARIO: PREVALENCE, PREVENTION AND PATHOLOGY

SARAH KEATING MD FRCPC
JANUARY 9, 2025

Outline

- Definition of Lyme disease
- Prevalence
- Ticks
- The Lyme bacterium
- Manifestations of Lyme
- Tick borne disease and mental illness
- Coinfections
- Pathology of Lyme
- Prevention
- Diagnosis and treatment

LYME DISEASE DEFINITION

- Caused by a gram negative spirochetal bacterium, *Borrelia burgdorferi*
- Vector - blacklegged ticks (*Ixodes scapularis*)
- Lyme sufferers often are unaware of a tick bite
- Ticks often carry other pathogens
- These infections are difficult to diagnose and to treat

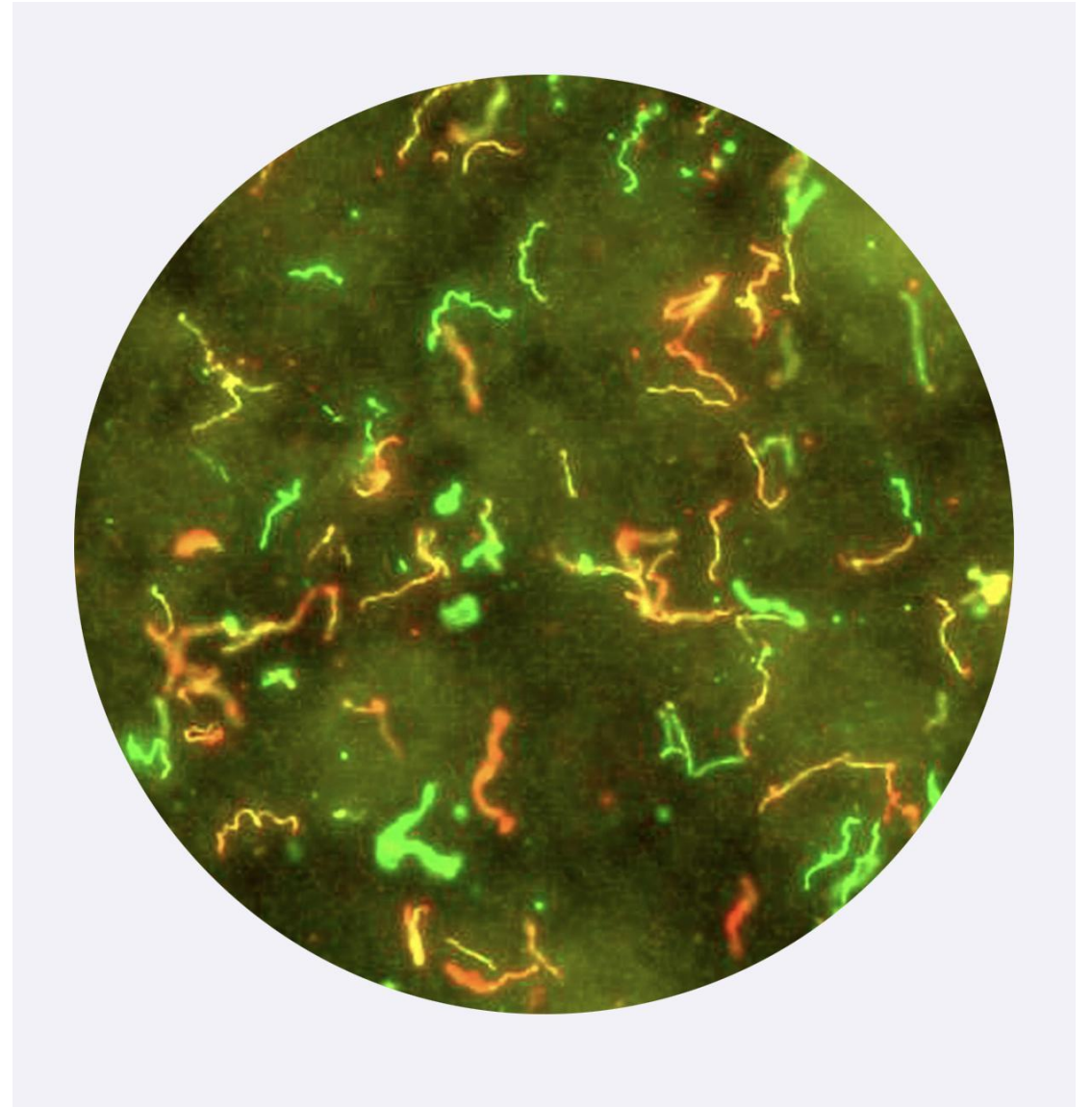
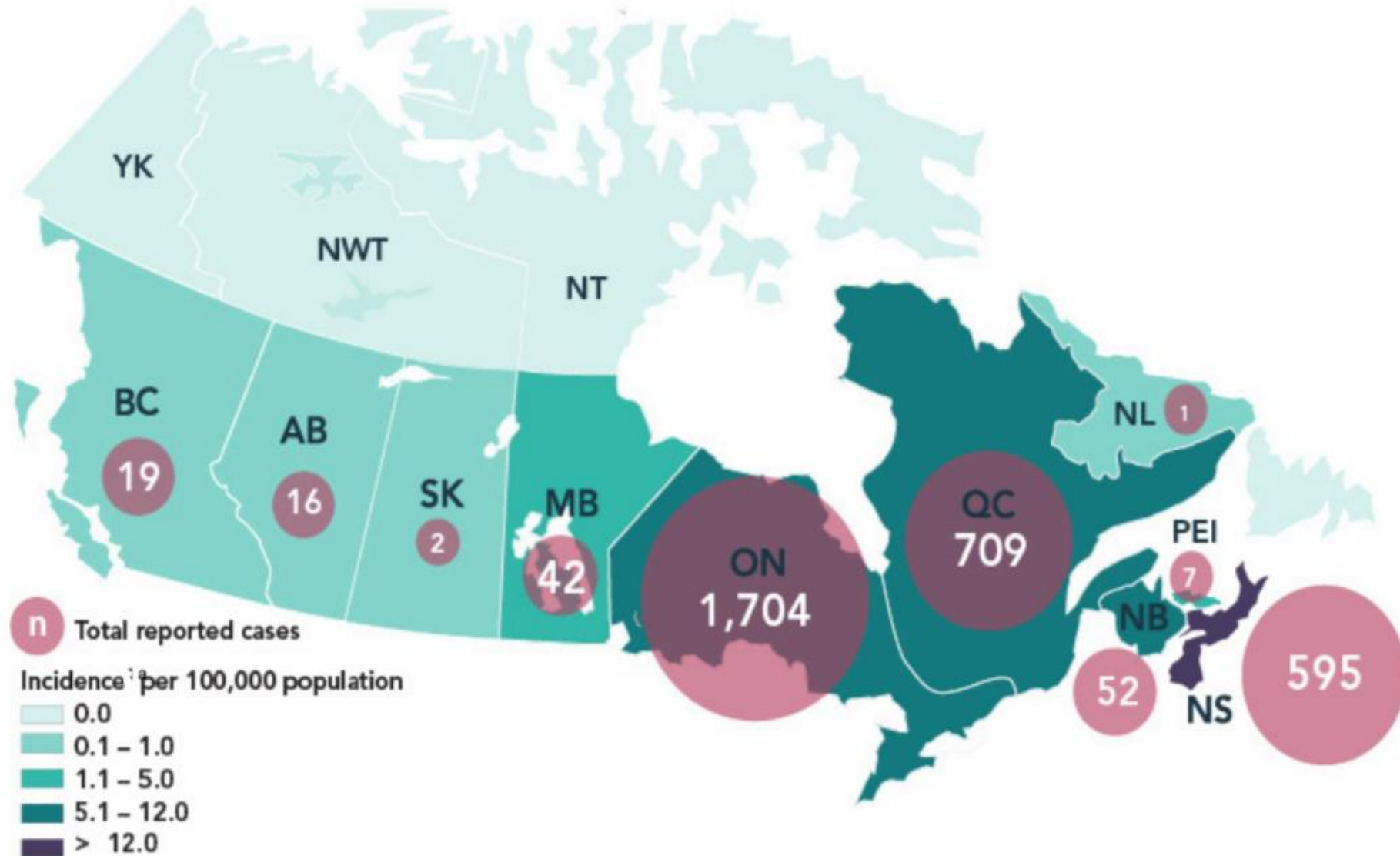
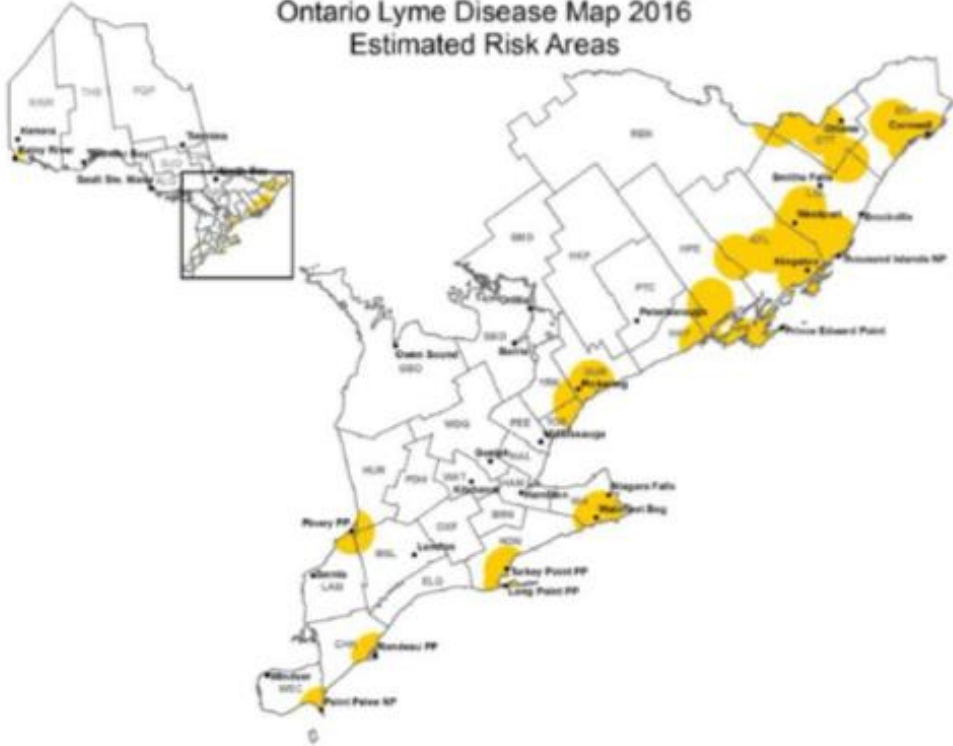


Figure 3. Geographic distribution of all reported Lyme disease cases, 2021

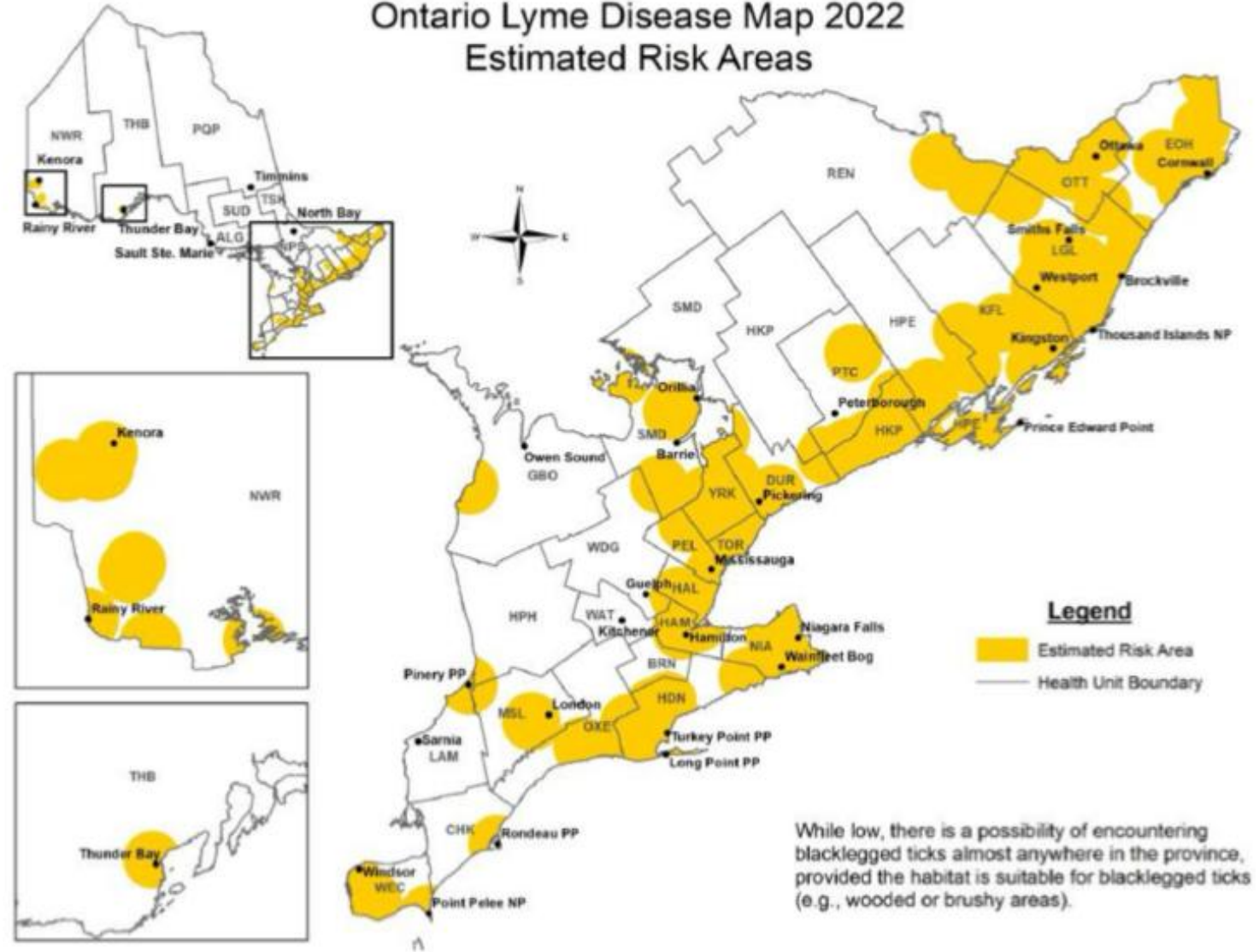


Blacklegged Ticks in Ontario

Ontario Lyme Disease Map 2016
Estimated Risk Areas



Ontario Lyme Disease Map 2022
Estimated Risk Areas



While low, there is a possibility of encountering blacklegged ticks almost anywhere in the province, provided the habitat is suitable for blacklegged ticks (e.g., wooded or brushy areas).

Lyme Disease Prevalence

~476,000 new cases each year in the **USA** (US CDC, 2021)

https://wwwnc.cdc.gov/eid/article/27/2/20-2731_article ; <https://www.hopkinslymetracker.org/>

Canada

There were **11,051 cases** of reported cases of Lyme disease from 2017-2021 (a 5 year period), almost double the number of cases from the previous 9 years (6,029)*.

True number of cases are likely 14x greater (Ogden et al 2024**)

* <https://www.Canada.ca/en/public-health/services/diseases/lyme-disease/health-professionals-lyme-disease.html>

** Environmental Health Perspectives 2024 Feb 13;132(2):027005



Adult female black-legged tick at various stages of feeding (from Government of Canada website)

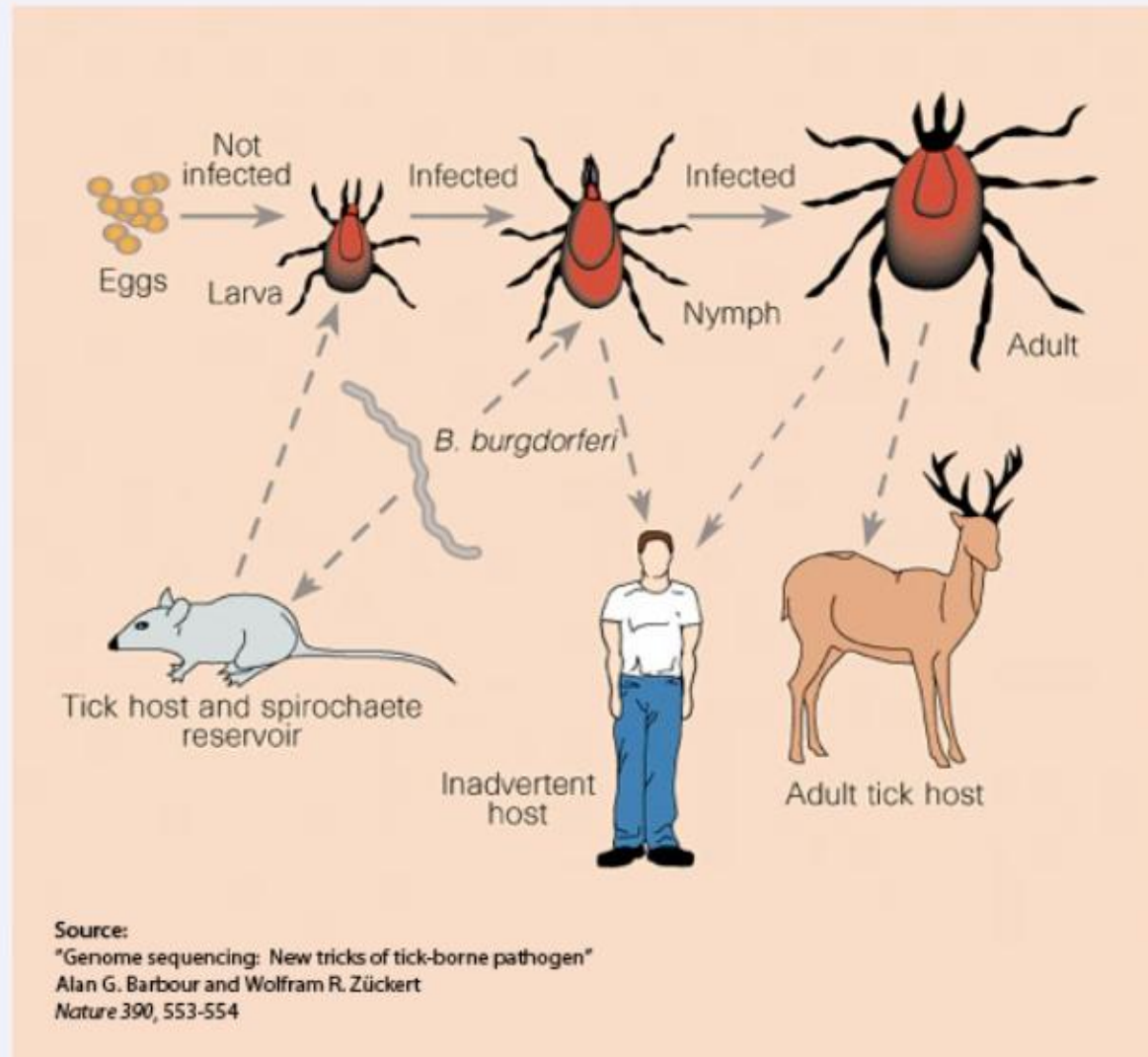


Illustration 2: How Lyme Spreads

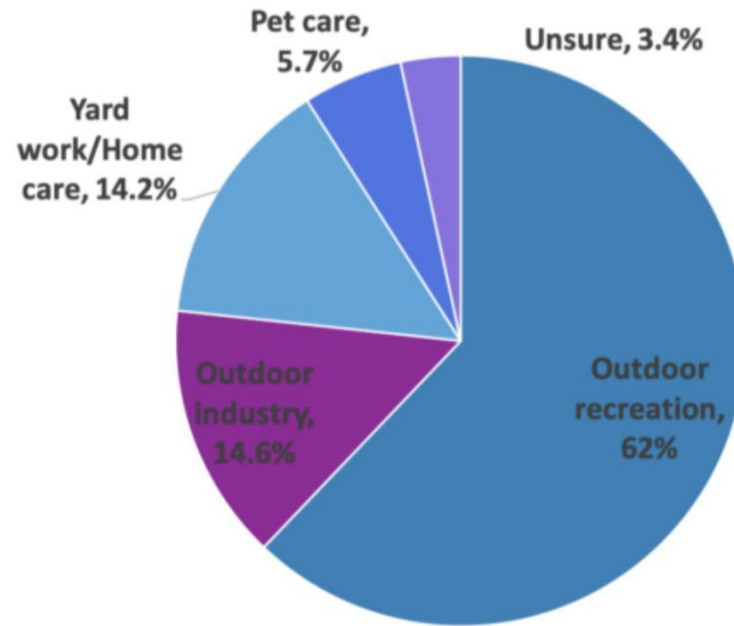
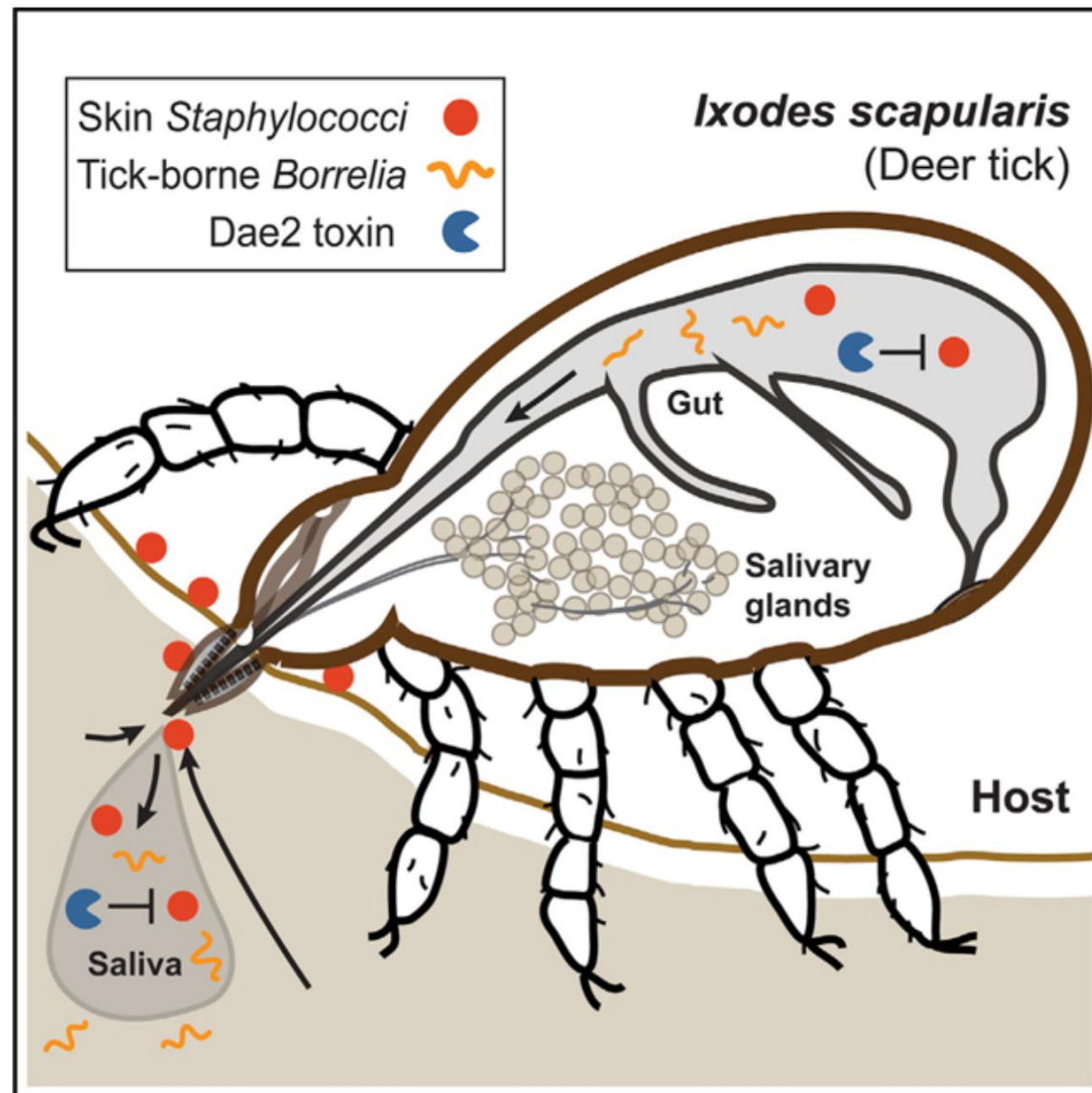


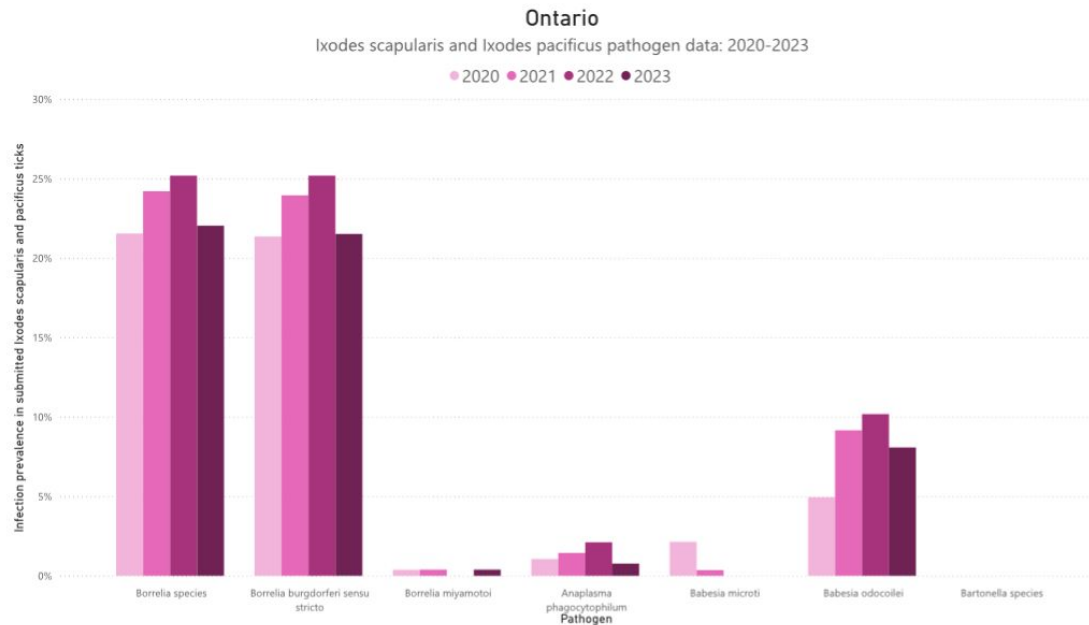
Figure 3 - Distribution of ticks (any species) submitted to Geneticks by the activity an individual reported to have been participating in when they encountered the tick.

<https://www.geneticks.ca>



Hayes et al; Cell. 2020 Dec 10; 183(6);1562-1571.e12

What pathogens have been found in blacklegged ticks submitted from within Ontario from 2020-2023?



Courtesy of Geneticks.
www.Geneticks.ca

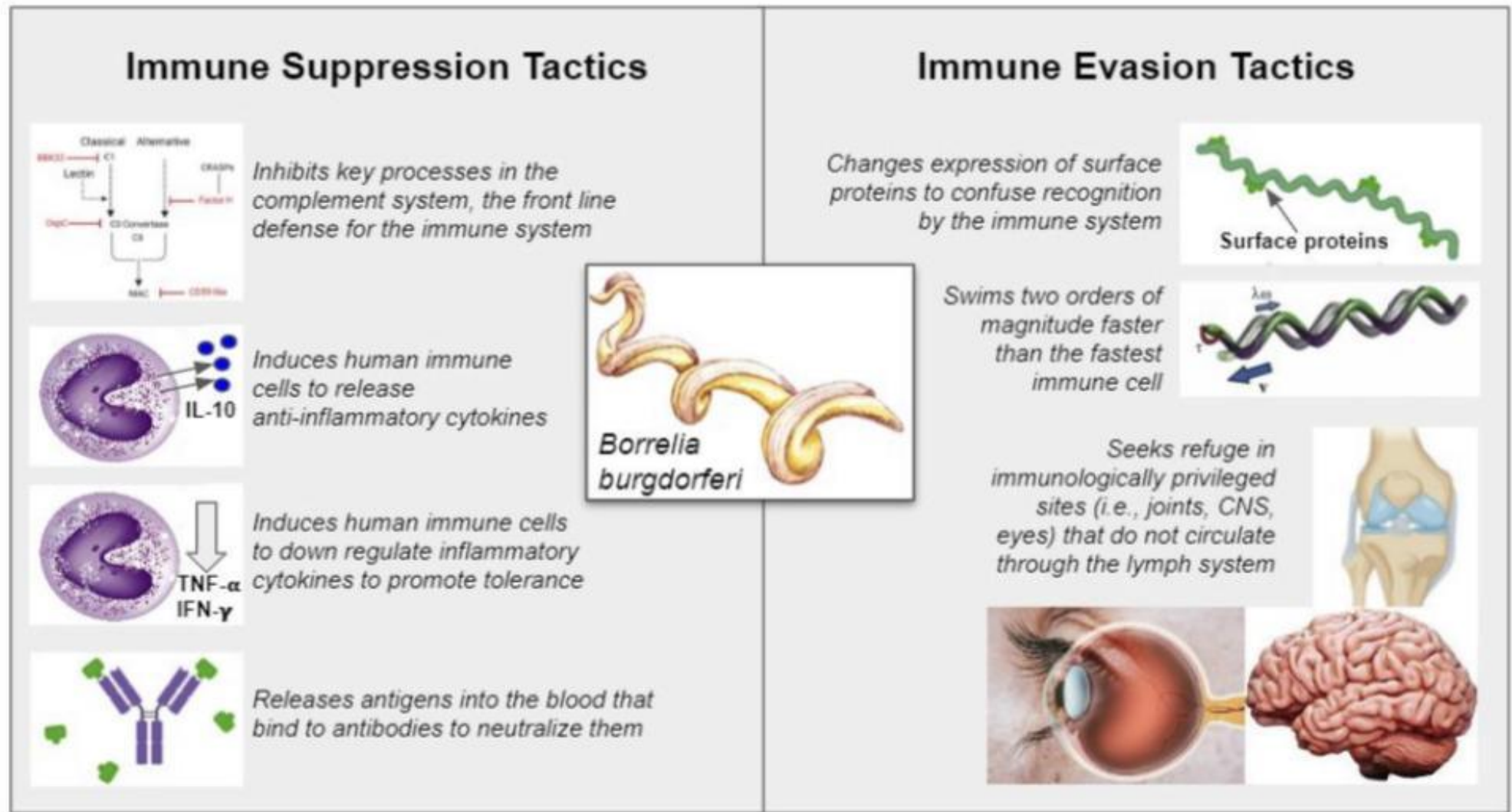
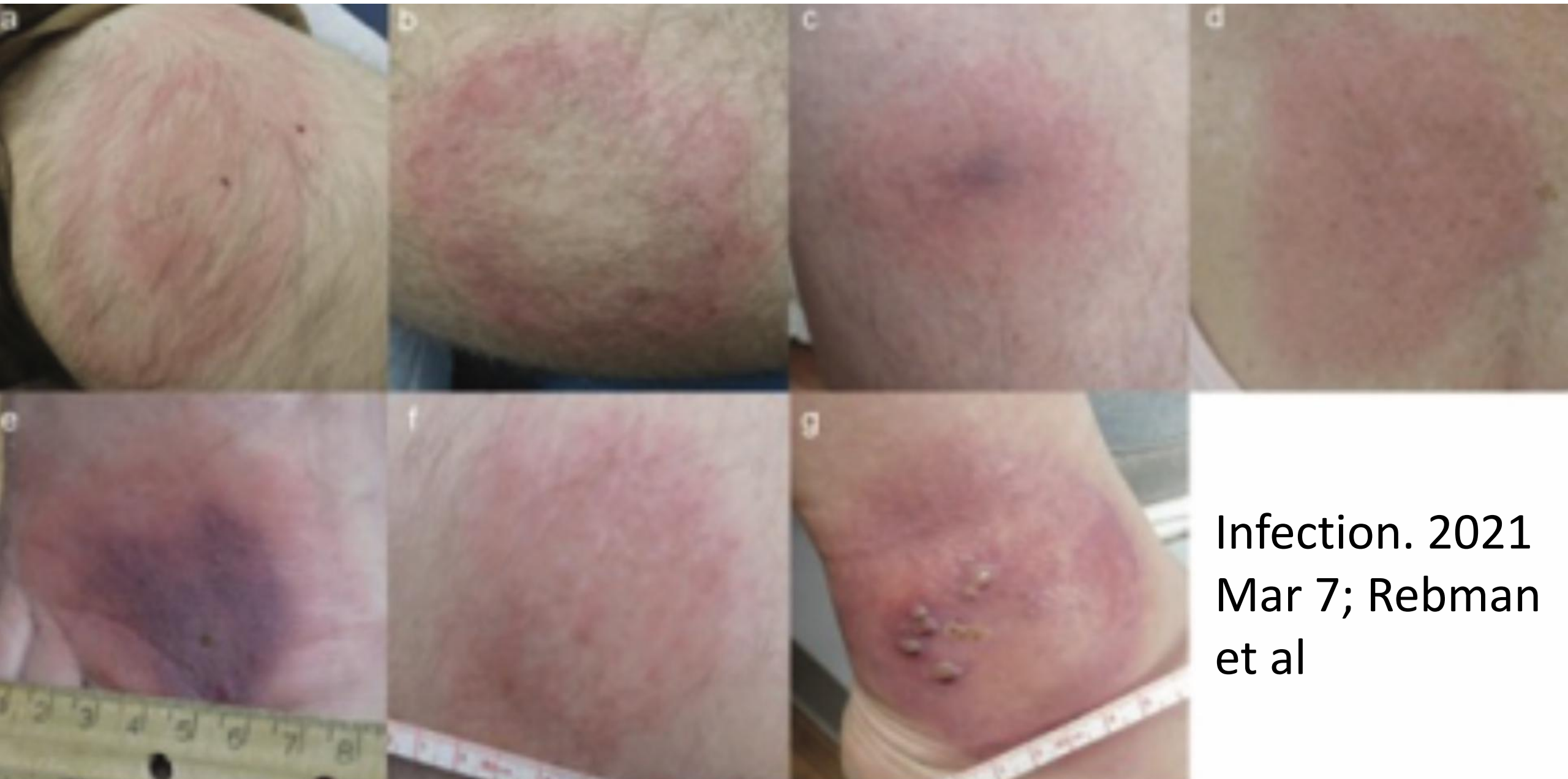


FIGURE 9: A summary of *Borrelia*'s immune suppression and evasion tactics. The organism has an array of techniques to avoid detection and destruction by the immune system. Source: Created with information from Embers et al., 2004, Bamm et al., 2019, and Malawista and de Boisfleury Chevance, 2008.

Early Lyme

- Flu-like symptoms
- Rash
- Headaches
- Enlarged lymph nodes
- Asymptomatic
- Many don't recall a tick bite





Infection. 2021
Mar 7; Rebman
et al

Early Disseminated Lyme

- Joint pain
- Muscle pain
- Fatigue
- Rash
- Bell's palsy
- Encephalitis
- Lyme carditis

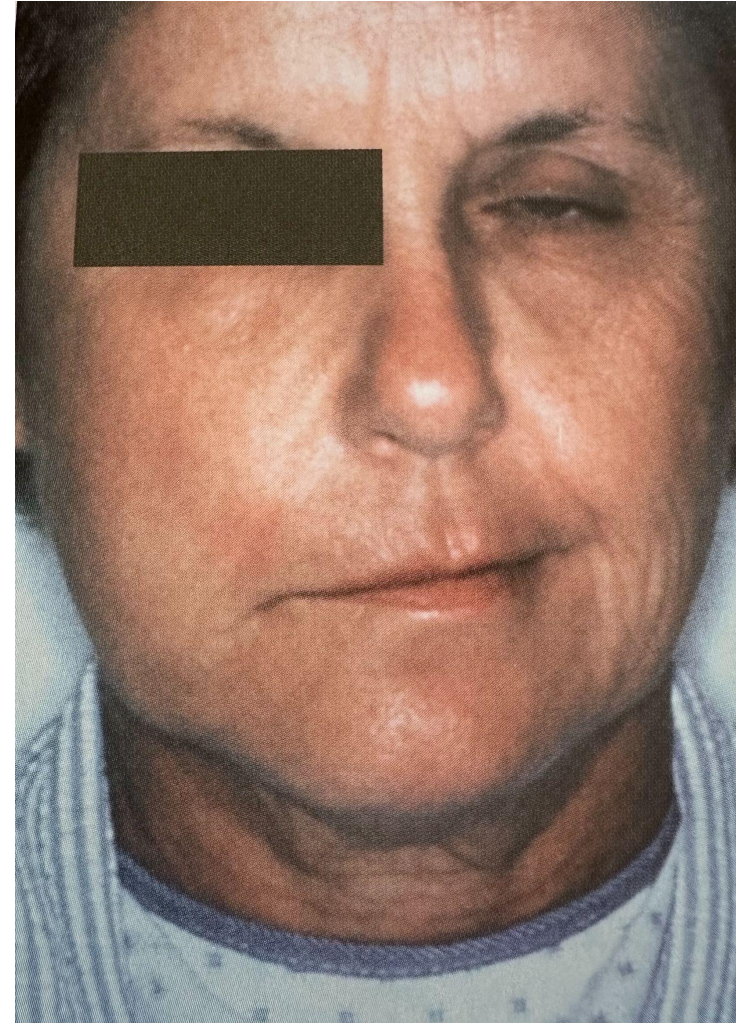
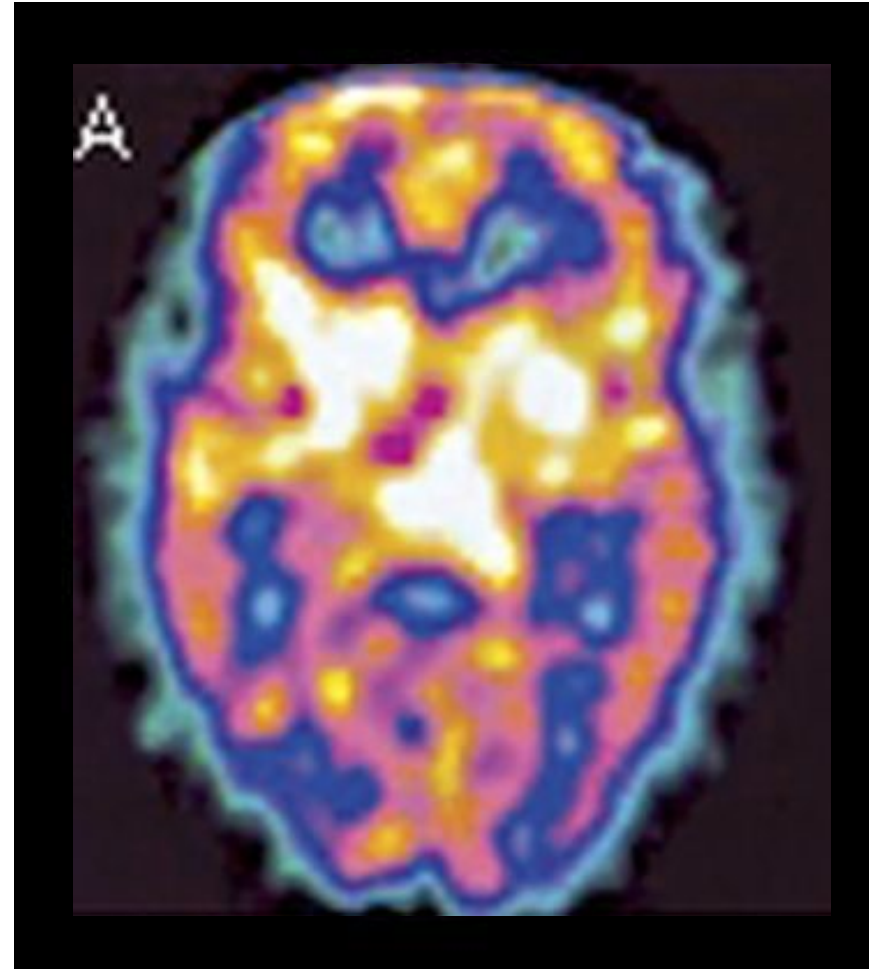


Photo taken from Shelley Ball's book, Lyme disease, ticks and you: a guide to navigating tick bites, Lyme disease and other tick-borne infections

Late Disseminated Lyme

- Joint pain or swelling
- Fatigue
- Brain fog
- Depression
- Meningitis
- “The Great Mimic”:
 - Dementia
 - MS
 - ALS



Donta ST, Noto RB, Vento JA. 2012. SPECT Brain Imaging in Chronic Lyme Disease. *Clinical Nuclear Medicine*. 37(9):e219–e222. doi:<https://doi.org/10.1097/rlu.0b013e318262ad9b>.

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

Brian A. Fallon, M.D., M.P.H., Trine Madsen, Ph.D., Annette Erlangsen, Ph.D., Michael E. Benros, M.D., Ph.D.

Objective: 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.

Methods: 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.

Results: 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.

Conclusions: 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.

Am J Psychiatry 2021; 178:921–931; doi: 10.1176/appi.ajp.2021.20091347

A Nationwide Study on the Link between Lyme Disease and Mental Health (Denmark 1994 - 2016)

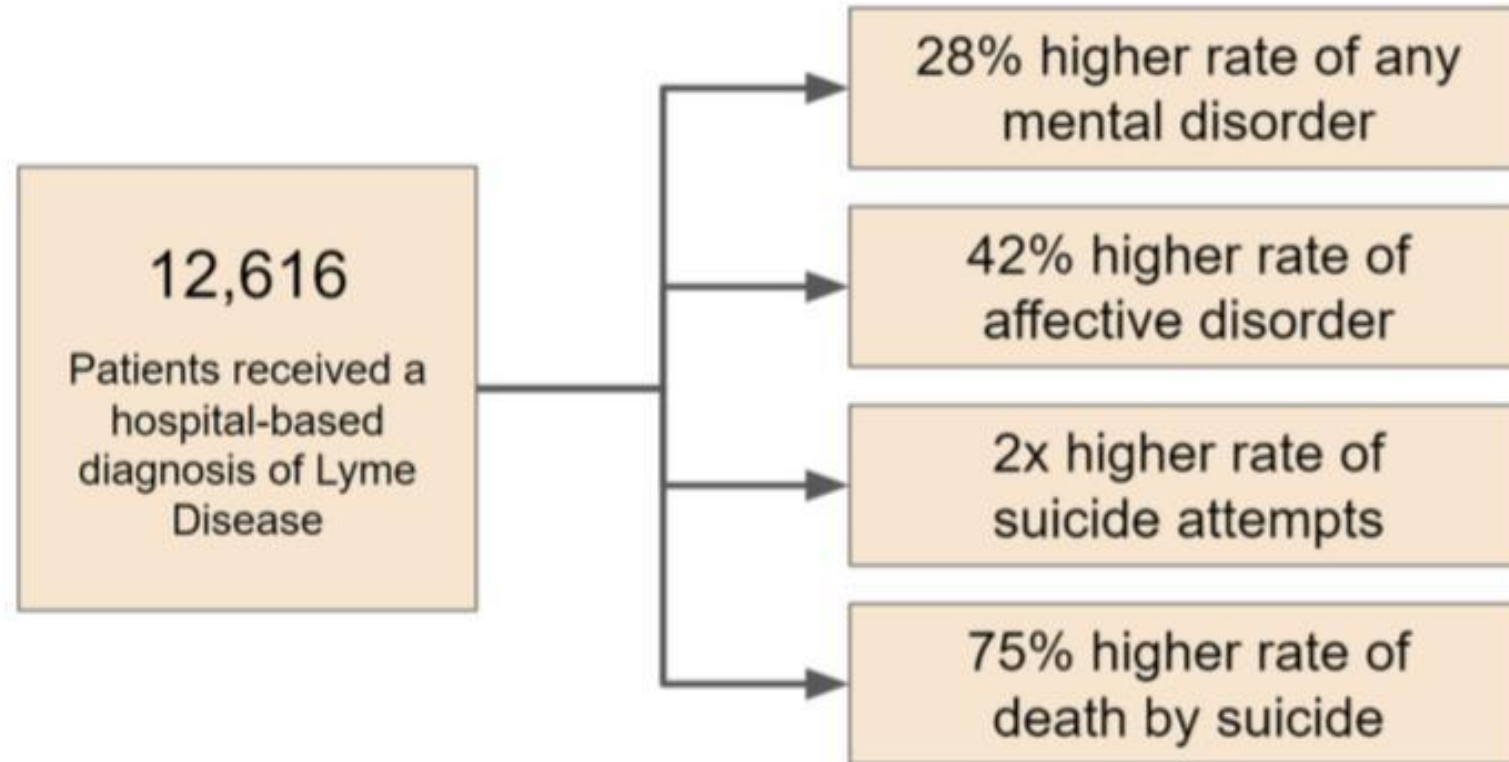


FIGURE 13: Summary of a nationwide study of people living in Denmark from 1994-2016 investigating the link between Lyme disease and mental health. Results demonstrate a higher incidence of subsequent psychiatric disorders in patients with a hospital-based diagnosis of Lyme disease. Source: Generated from Fallon et al. 2021.



Neuropsychiatric Lyme Disease and Mental Health Issues

- Mechanisms by which *B. burgdorferi* may cause neuropsychiatric symptoms are explored
- Neuropsychiatric manifestations may be the first presentation of chronic Lyme disease
- Lack of recognition of these manifestations by clinicians including psychiatrists
- Lack of recognition by clinicians of the existence of chronic Lyme resulting in gaslighting of the patient
- The stigma associated with mental illness
- Suicide is the commonest cause of death

3rd Report

Supported by the U.S. Department of Health and Human Services • Office of the Assistant Secretary for Health

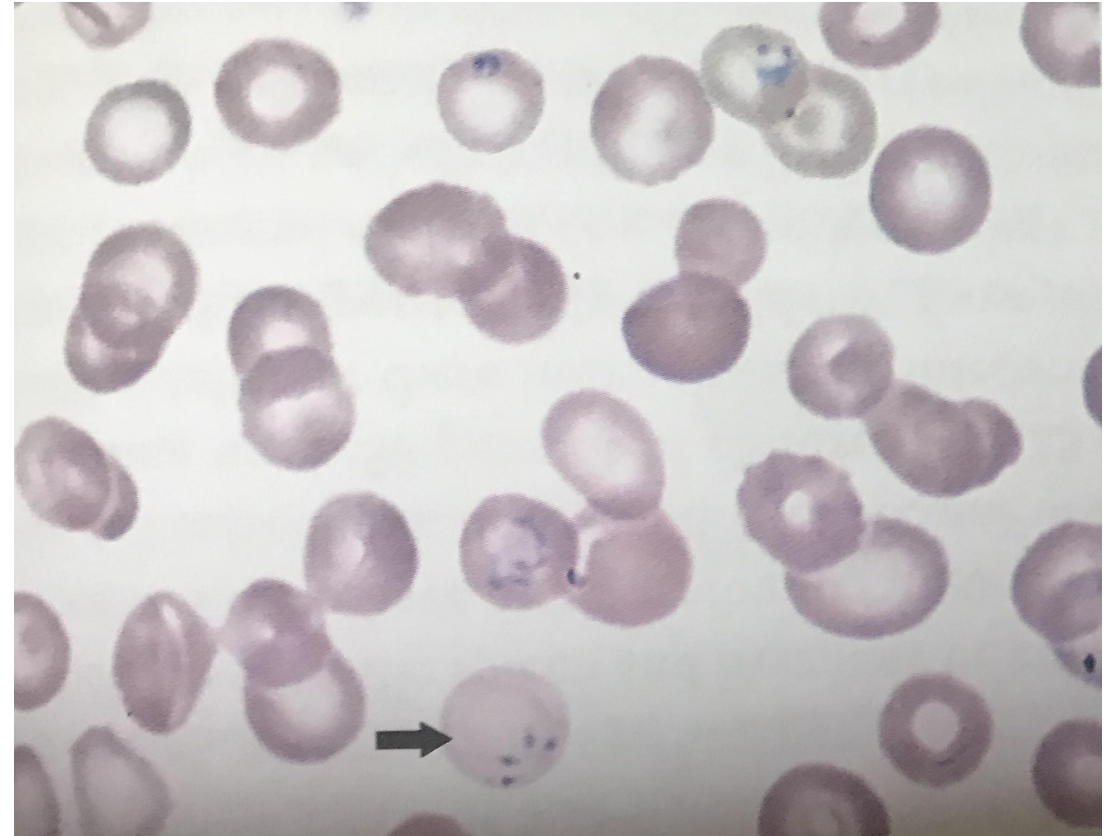
Tick-Borne Disease
Working Group
2022 Report to Congress



Information and opinions in this report do not necessarily reflect the opinions of each member of the Working Group, the U.S. Department of Health and Human Services, or any other component of the federal government.

Other Tick Borne Diseases - Babesiosis

- In some areas of the US Babesiosis is as common as Lyme disease
- Transmitted by black legged ticks
- Commonly a co-infection with Lyme
- Sx include drenching night sweats, flushing, cough, air hunger, fatigue, sensitivity to light and sound



Bartonellosis

- Bacteria *Bartonella henselae* – Cat Scratch disease
- Can be transmitted by fleas, animal bites and scratches, needle sticks and has been found in ticks
- A frequent co-infection with Lyme
- Can cause chronic intravascular infection lasting months to years with headache, neuropsychiatric manifestations, fatigue and insomnia, burning sensation soles of feet

Bartonellosis



Bartonella Rash courtesy LDA and Martin Fried, MD, Jersey Shore University Medical Center

Pathology of Lyme

Where are the pathologist researchers?

Alan B. MacDonald; Journal of Clinical and Medical Issues; Jan 10, 2022: Brain Herniation Death in pediatric lyme borreliosis followed by kidney organ donation

- Case report of a child who died at 19 months after a 12 month history of Lyme disease
- Cardiac arrest followed by brain swelling and tonsillar herniation
- H&E sections did not show significant inflammation



Figure 1: The patient's brown skin color renders the exact outermost borders of the flat erythematous ring to be indistinct but the "central clearing" and inner border zone of erythema in the EM lesion is distinct.

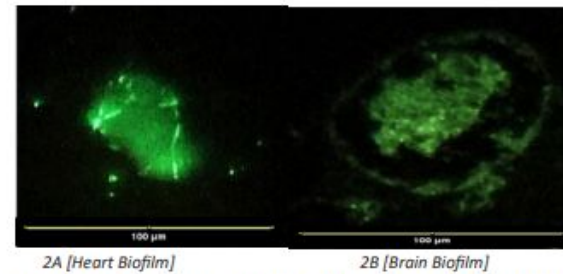


Figure 2: Biofilm community borrelia burgdorferi in specialized colony type morphology showed discrete bright signal fluorescent spirochetes surrounded by a veil like lower signal intensity fluorescent gel-like extracellular matrix. FISH method with DNA probe for Flagellin B gene of borrelia burgdorferi. (BBO 0147) Probe Sequence: (nucleotide) TGG GAG TTT CTG GTA AGA TTAA; --- fluorescein isethionate label 5' position.

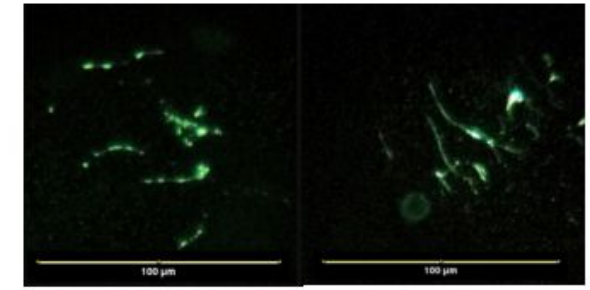
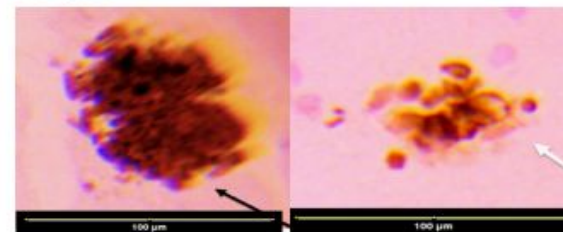


Figure 4: Singleton (planktonic form) borrelia spirochetes were observed in FISH studies as multiple separate borrelia burgdorferi microbes in a single microscopic field of view. FISH method with borrelia burgdorferi DNA probe for gene BBO 0147 -Flagellin B. (Probe Sequence: (nucleotide) TGG GAG TTT CTG GTA AGA TTAA; --- fluorescein isethionate label 5' position).

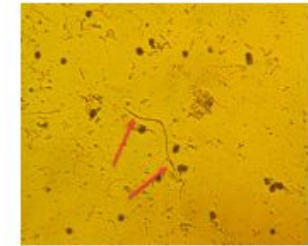


Figure 5: Warthin Starry Stain of Autopsy Brain: Red arrow points to an elongated borrelia burgdorferi spirochete. Abundant Round body spirochetal forms (Black color) are present.

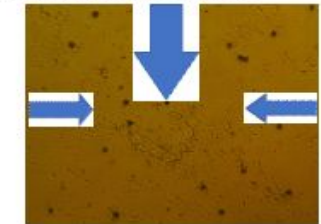
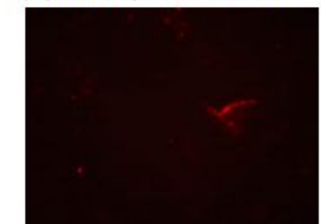


Figure 6: Warthin Starry stain of Autopsy Brain: Blue color arrows designate a grouping of borrelia burgdorferi spirochetes in brain tissue. Round body spirochetal forms (black color).

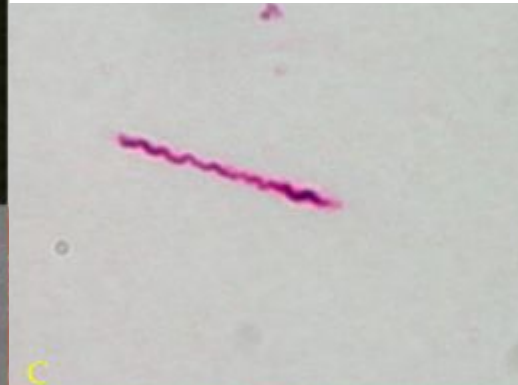


Article

Persistent Borrelia Infection in Patients with Ongoing Symptoms of Lyme Disease

Marianne J. Middelveen ¹, Eva Sapi ² , Jennie Burke ³, Katherine R. Filush ², Agustin Franco ⁴,
Melissa C. Fesler ⁵ and Raphael B. Stricker ^{5,*} 

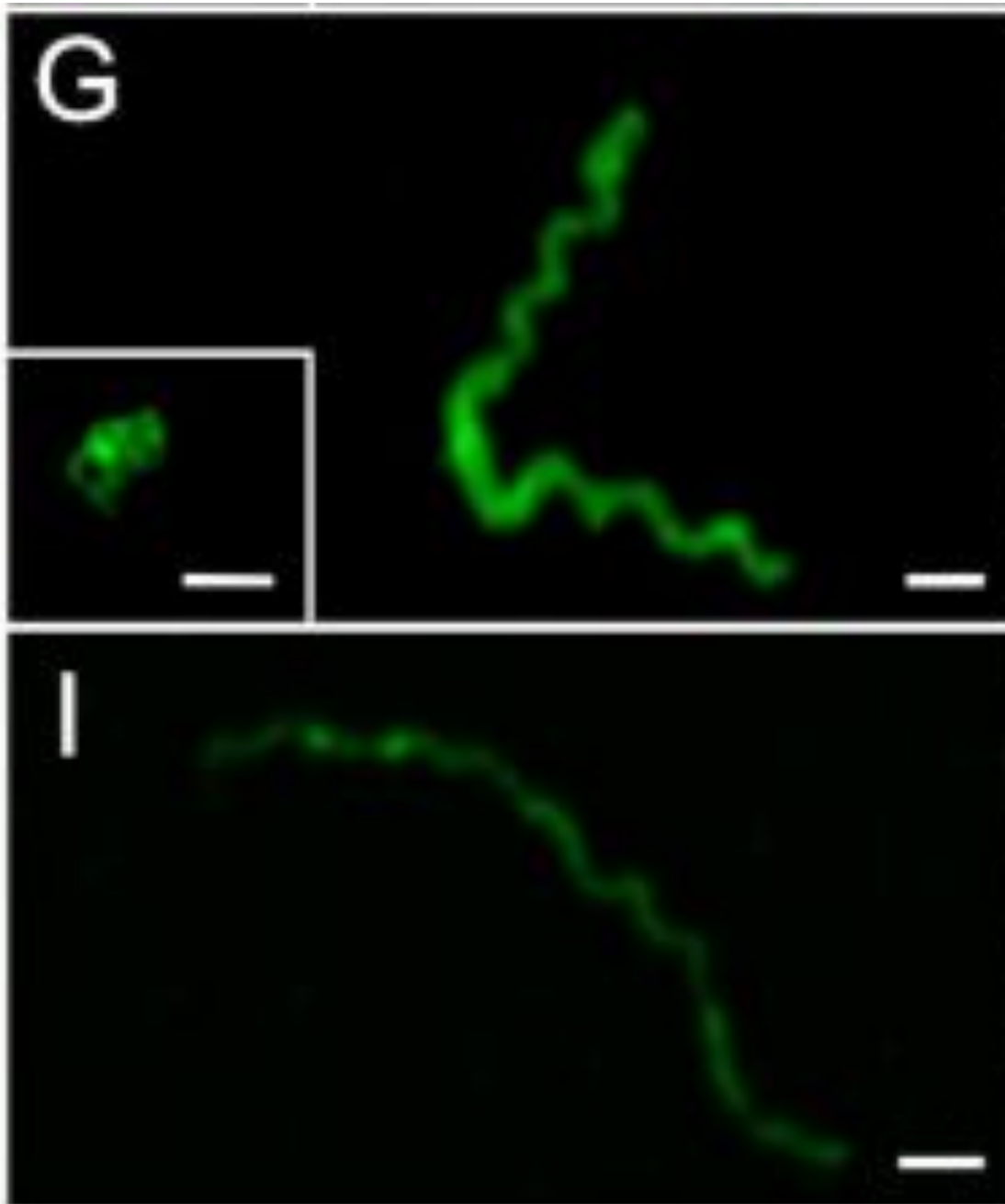
Darkfield with spirochete
and round form



Immunostain

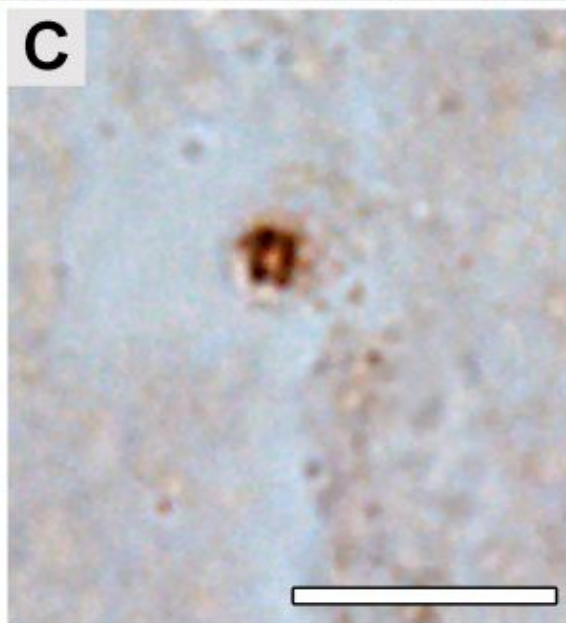
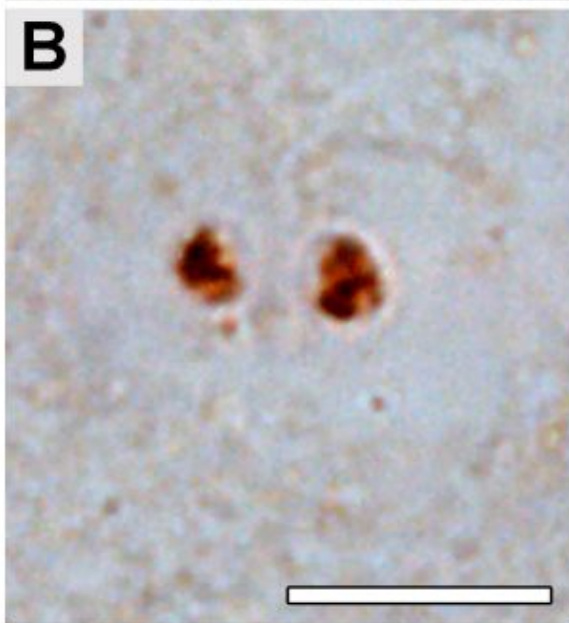
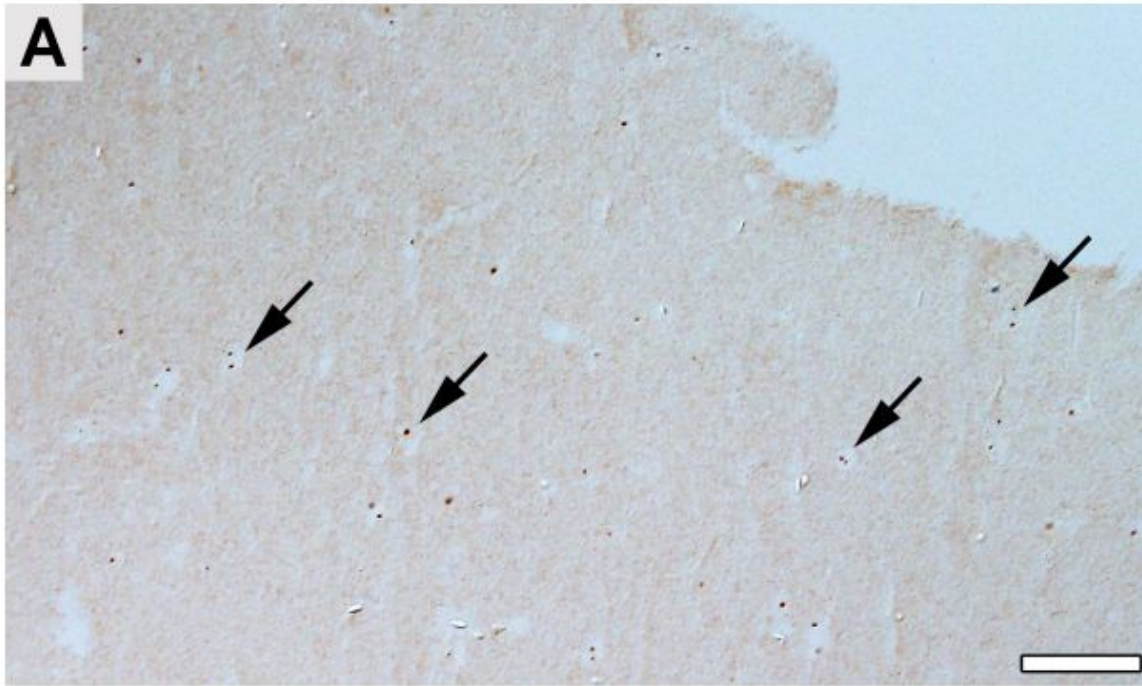
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International Journal of Molecular
Sciences 2023, 24, 16906
Golovchenko et al
Concurrent Infection of the Human
Brain with Multiple *Borrelia* Species

- Autopsy study on a young man who died by suicide
- Infection by *B. burgdorferi* and *B. garinii* confirmed by PCR, IHC



Golovchenko 2023 (continued)

Immunohistochemistry of occipital lobe; anti-*B. burgdorferi* polyclonal antibody

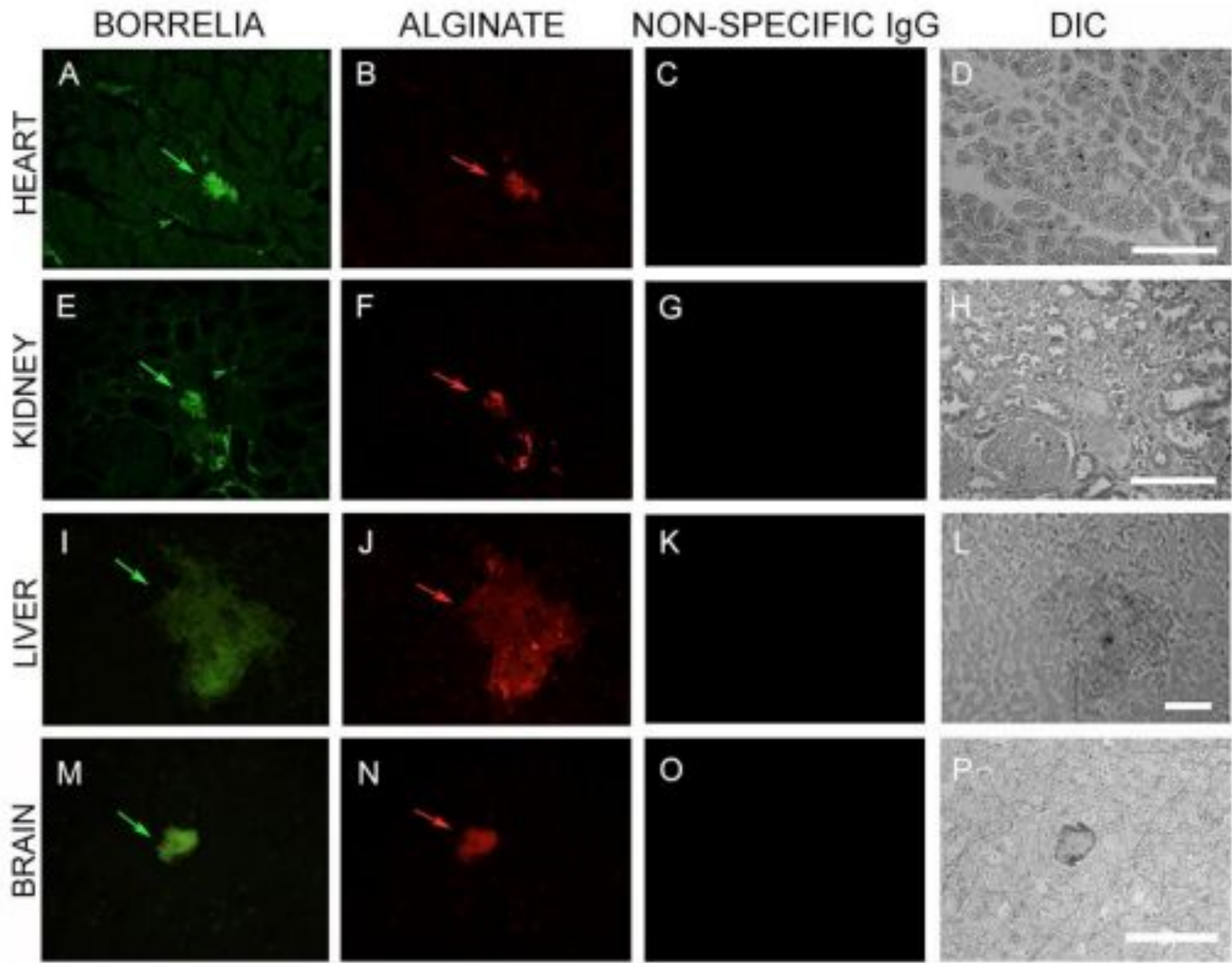
Lower bars 10 microns

Article

The Long-Term Persistence of *Borrelia burgdorferi* Antigens and DNA in the Tissues of a Patient with Lyme Disease

Eva Sapi ^{1,*}, Rumanah S. Kasliwala ¹, Hebo Ismail ¹, Jason P. Torres ¹, Michael Oldakowski ¹, Sarah Markland ¹, Gauri Gaur ¹, Anthony Melillo ¹, Klaus Eisendle ², Kenneth B. Liegner ^{3,4,5}, Jenny Libien ⁶ and James E. Goldman ⁷

- 2019 case study
- 53 year old woman with 16 year history of Lyme and extensive antibiotic Rx
- Antibiotic treatment was eventually denied by her insurer and she deteriorated, developed seizures and died
- Extensive chronic inflammation in brain, meninges, cranial nerves, kidney and liver
- Extensive interstitial fibrosis in heart



Scale bar
200 microns



Contents lists available at [ScienceDirect](#)

Heliyon

journal homepage: www.cell.com/heliyon

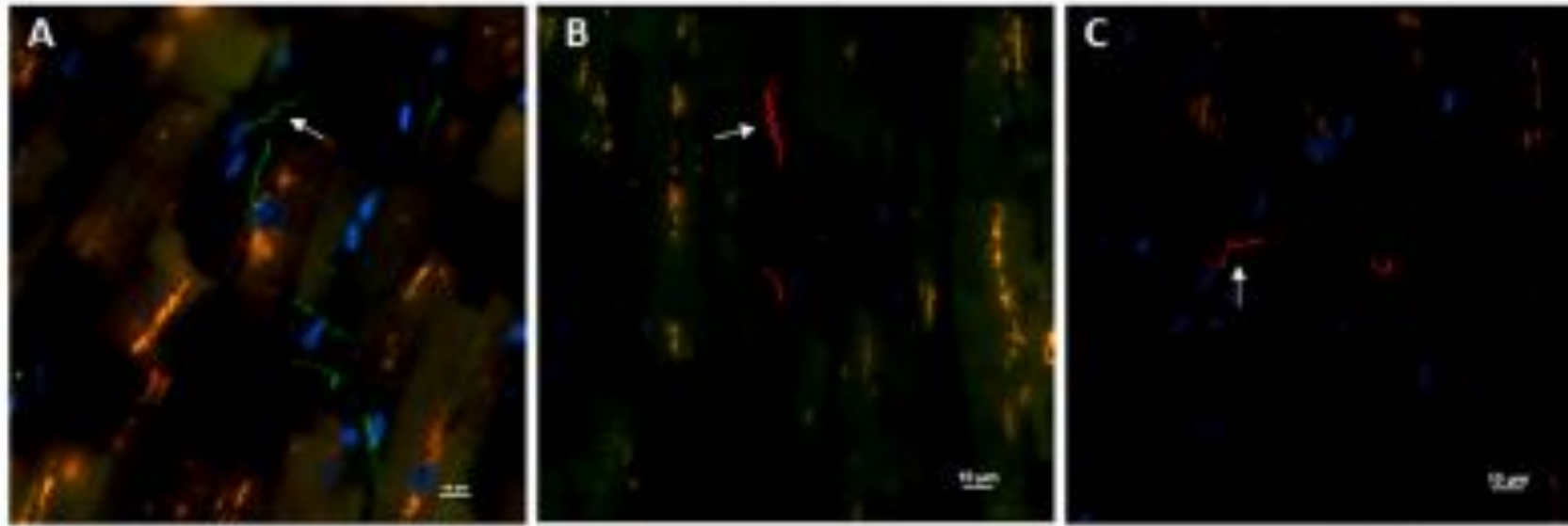


Case report

Late-stage borreliosis and substance abuse

Robert C. Bransfield^a, Shiva Kumar Goud Gadila^b, Laura J. Kursawe^c, Andrew J. Dwork^{d,e,f,g}, Gorazd Rosoklija^{e,g}, Elizabeth J. Horn^h, Michael J. Cookⁱ, Monica E. Embers^{b,*}

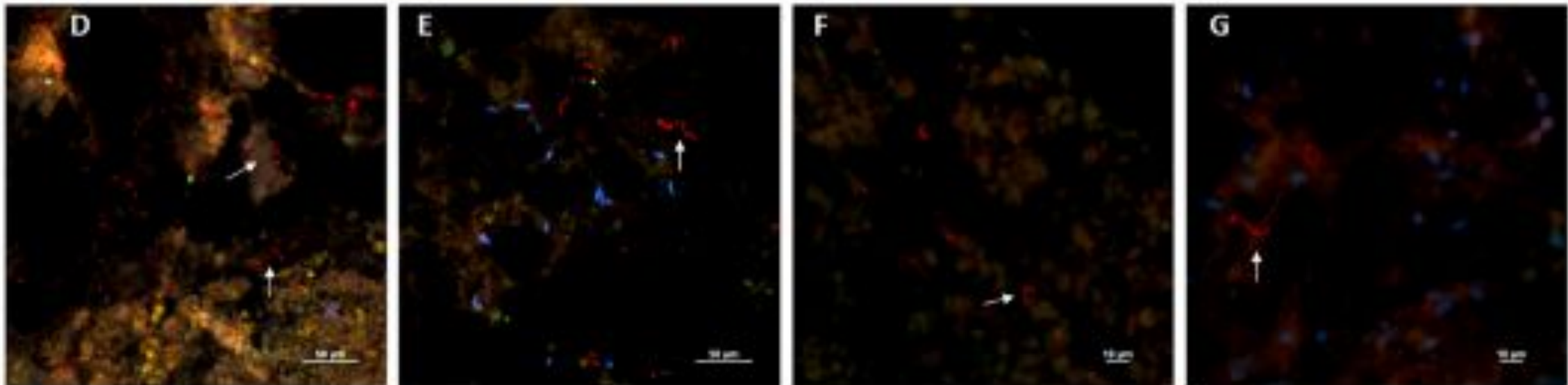
- Young male with a history of tick bites, Lyme sx and delayed treatment
- Experimented with drugs including phencyclidine (PCP)
- During PCP withdrawal he committed a homicide and suicide
- Autopsy tissue was submitted to the Lyme Disease Biobank in Portland Oregon



Heart



Pancreas



Immunofluorescent staining with monoclonal antibodies; B. Burgdorferi was not detected in the brain; Scale bar 50 microns

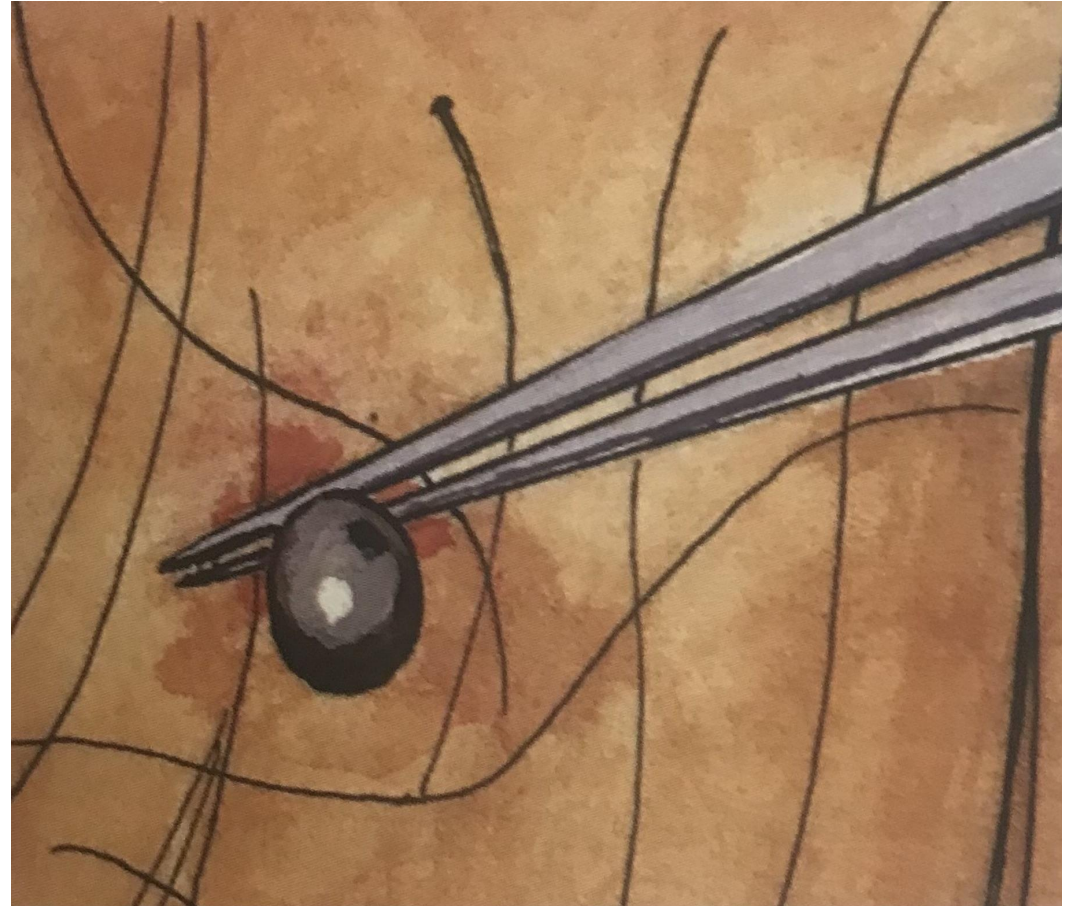
Prevention

- Deet
- Icaridin/Picaridin
- Permethrin treated clothing
- Natural sprays such as Atlantick
- Tick checks



WHAT TO DO WITH AN EMBEDDED TICK

- Remove with fine-tipped tweezers
- Save the tick in the freezer
- Blood tests are not effective initially
- Watch for signs and symptoms e.g. erythema migrans rash or “summer flu”
- Tick can be sent to Geneticks.ca to look for borrelia and other pathogens
- Early treatment with antibiotics can prevent chronic lyme but there is no evidence that single dose doxycycline is effective



Diagnosis of Lyme Disease

- Current testing is flawed
- Standard testing relies on detecting antibody response to *Borrelia* and has low specificity, particularly in the early stage of Lyme when prompt treatment could prevent chronicity
- For optimal testing chronic Lyme patients often turn to private labs outside of Canada (Armin Labs in Germany, IGeneX in US)
- Lyme is a clinical diagnosis based on symptoms
- For effective treatment it is necessary to find a Lyme literate practitioner

HMQ: Horowitz/MSIDS Questionnaire

This is a questionnaire to determine the probability of your having Lyme disease and other tick borne disorders.

Think about how you have been feeling over the previous month and how often you

have been bothered by the following:

Frequency

	Never	Sometimes	Most of the time	All of the time	Not Applicable
Unexplained fevers, sweats, chills, or flushing	0	1	2	3	X
Unexplained weight change.....Loss or Gain	0	1	2	3	X
Fatigue, tiredness	0	1	2	3	X
Unexplained hair loss	0	1	2	3	X
Swollen glands	0	1	2	3	X
Sore throat	0	1	2	3	X
Testicular pain / Pelvic Pain	0	1	2	3	X
Unexplained menstrual irregularity	0	1	2	3	X

0-24	Tick-Borne Illness is Not Likely	
25-44	Tick-Borne Illness is Possible	
45-62	Tick-Borne Illness is Probable	
63 and above	Tick-Borne Illness is Highly Probable	

Citera, Freeman and Horowitz: Empirical Validation of Horowitz Multiple Systemic Infectious Disease Syndrome Questionnaire for Suspected Lyme Disease; International Journal of General Medicine 2017:10 249-273

Treatment

- Must be individualized and effectiveness monitored
- Mainstay is antibiotics
- Herbal remedies can help especially when antibiotics aren't tolerated
- Low dose naltrexone can help dampen the immune response
- The treating physician must be Lyme literate – education is available

Barriers to Treatment

- Lack of research
- Lack of physician education
- Flawed and outdated infectious disease guidelines which are followed by most physicians
- Patients must educate themselves and advocate for themselves

Do Tick Borne Diseases Contribute to Suicide in Ontario?

- Tick borne disease research is badly needed to address this and many other aspects of these diseases
- Small venture grants are available from the Canadian Lyme Disease Foundation
- Canadian Lyme Disease Biobank at Mount Allison University

Resources

Contact me: sarah@canlyme.com

For Research Opportunities:

- Canadian Lyme Disease Foundation (CanLyme) www.canlyme.com
- Canadian Lyme Disease Biobank www.Lloydticklab.ca

To Learn more about diagnosis and treatment:

- International Lyme and Associated Diseases Society (ILADS)
<https://www.ilads.org>
- Invisible International www.invisible.international