TICKS AND TICK-BORNE DISEASES IN NEBRASKA

NEBRASKA DEPARTMENT OF HEALTH AND HUMAN SERVICES

VECTOR-BORNE DISEASE PROGRAM

TUESDAY, MARCH 21, 2023

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DEPT. OF HEALTH AND HUMAN SERVICES

DIVISION OF PUBLIC HEALTH

Credit: J. Hamik, NDHHS

LEARNING OBJECTIVES

- Identifying the primary life stages of a tick and how this relates to the transmission of tick-borne disease in Nebraska
- Discuss the primary goals of the Nebraska Tick Surveillance Program including the public health importance in controlling and preventing ticks and tick-borne diseases based on evidence-based research
- Describe best practices in preventing tick bites to reduce the risk of acquiring a tick-borne disease including potential signs and symptoms

NDHHS Vector-Borne Disease Program

Credit: CDC, NCEZID-DVBD

WHO WE ARE

Credit: NDVA Central Office

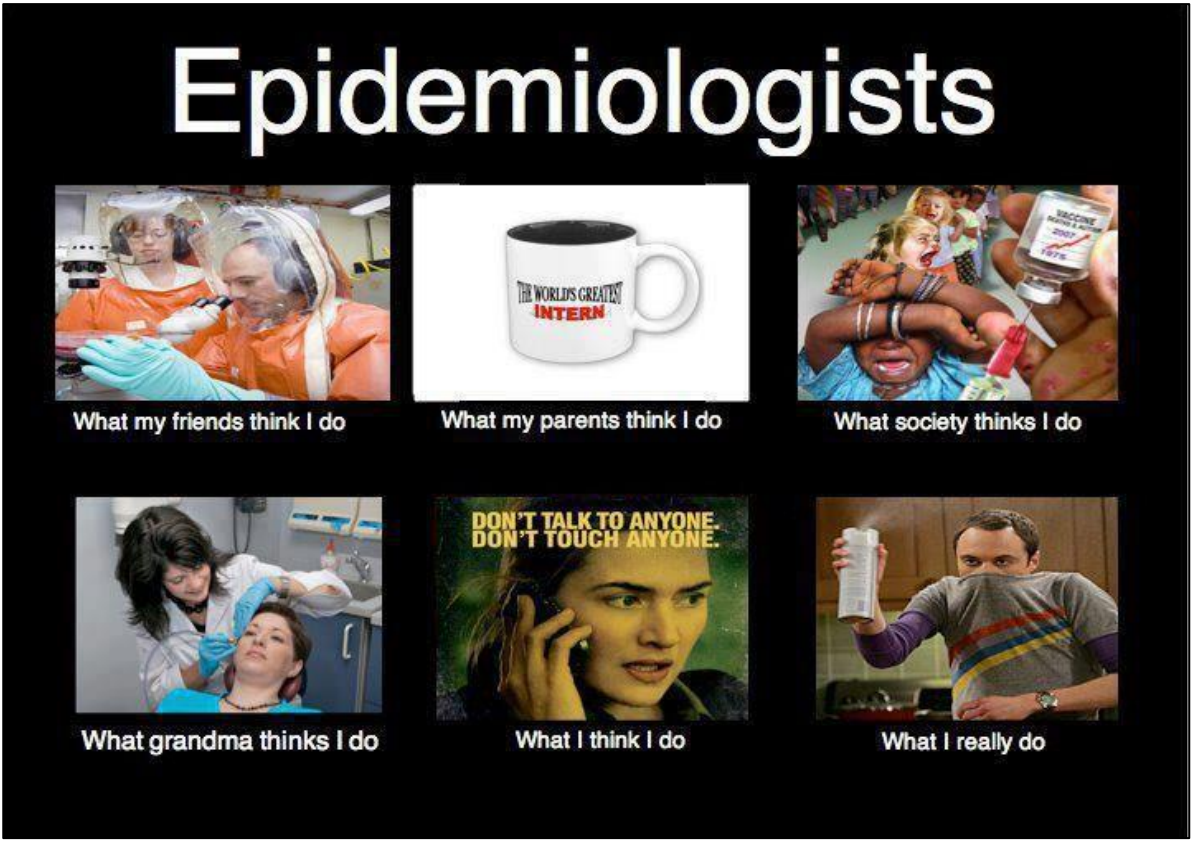
Credit: NDHHS

- Who We Are:
  - Nebraska Dept of Health and Human Services
  - Division of Public Health
  - Epidemiology Unit
  - Vector-Borne Disease Program

WHO WE ARE

L. Lynch-O'Brien, UNL

- Vector-Borne Program:
  - Epidemiologist/Public Health Entomologist- Jeff Hamik
  - Vector-Borne Disease Investigator- Halie Smith
  - Vector-Borne Disease Community Health Educator- Tammy Dawdy
  - Vector-Borne Surveillance Techs- Fellows/University Students/Interns

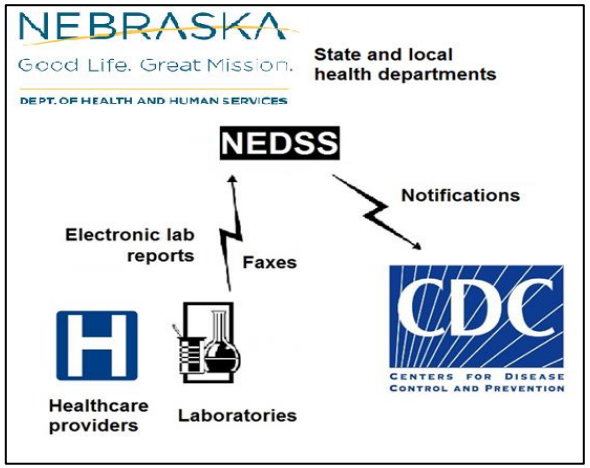


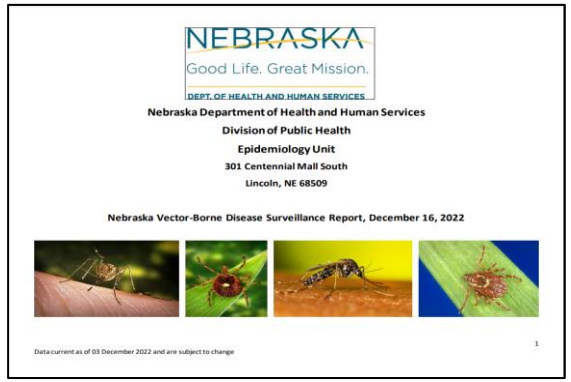
Credit: Lisa Hesse, https://www.pinterest.com/pin/165718461258716966/

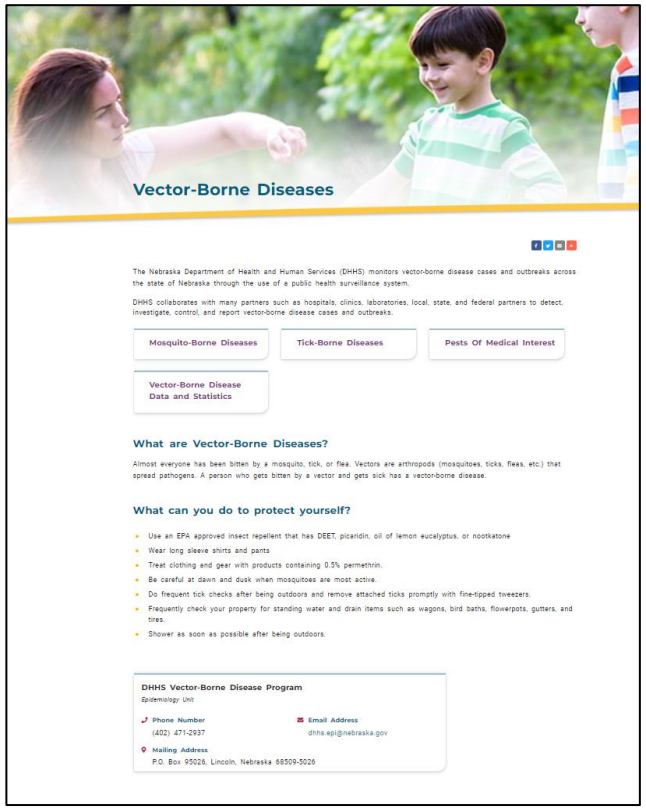
WHAT WE DO

- Vector-Borne Program:
  - Two primary areas of focus
    - Human disease surveillance
    - Ecological/Environmental surveillance (e.g. mosquito and tick surveillance)
  - Coordinate surveillance activities with local health departments
  - Train local health departments
  - Provide subject matter expertise
  - Provide funding to local health departments
  - Assist local health departments with conducting disease investigations
  - Conduct ecological/environmental surveillance
  - Create data-driven reports
  - Create and distribute educational/outreach materials

WHAT WE DO







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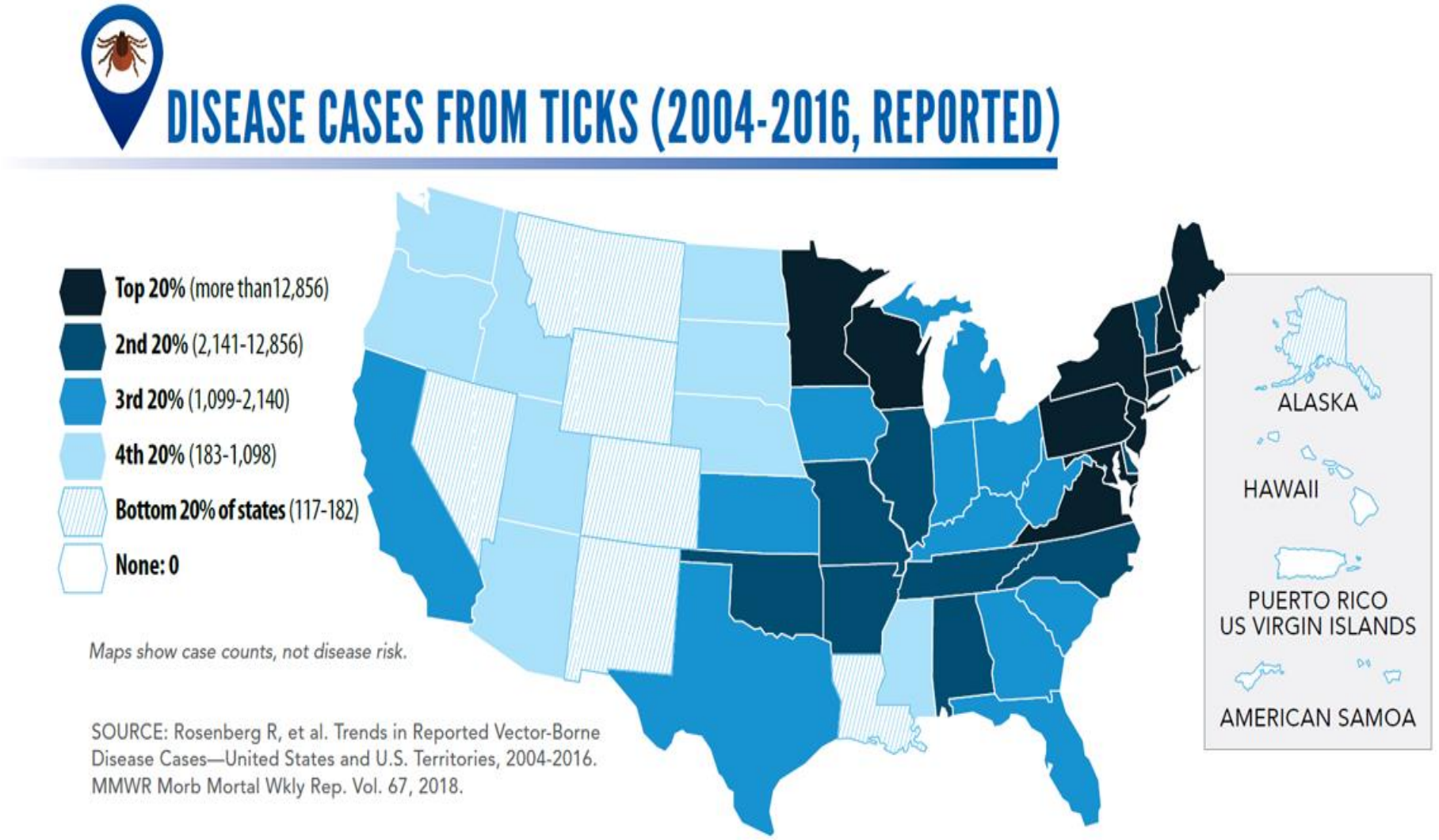
Credit: CDC, NCEZID-DVBD

Tick Life Stages/Biology

INCREASING & EMERGING TICK-BORNE DISEASES



Credit: CDC, NCEZID-DVBD

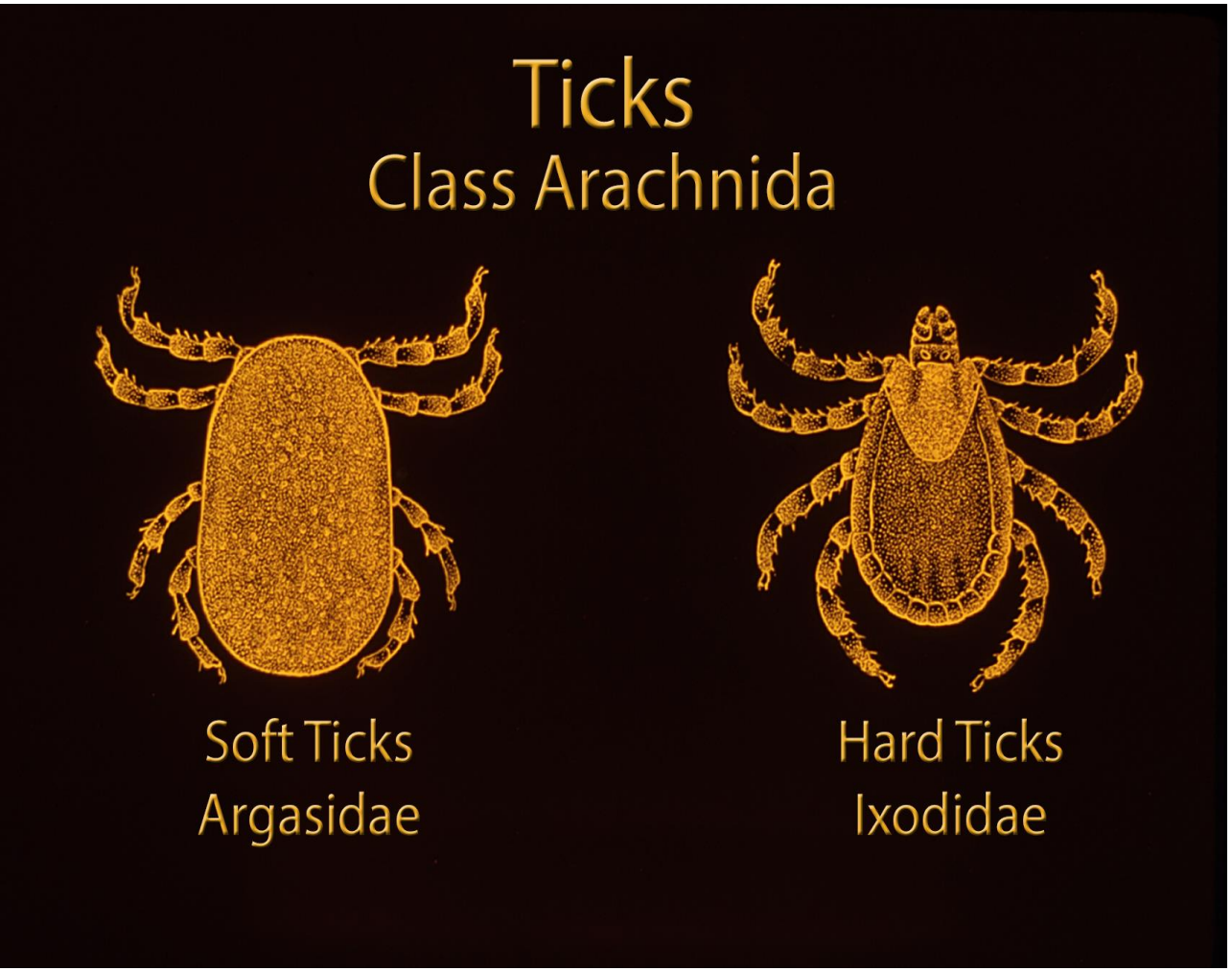
- From 2004 – 2016 cases of tick-borne disease doubled in the U.S.[1]

COMPARISON OF TICK-BORNE DISEASE CASES IN NEBRASKA

	Ehrlichiosis	Lyme Disease	SFGR (Includes RMSF)*	Tularemia	Total TBD
2002 - 2011					
Avg. Number of Cases Per Year (Median)	1.1 (1.0)	6.6 (6.5)	11.6 (11.0)	5.4 (5.0)	25.4 (22.5)
Min. Number of Cases	0	2	4	1	11
Max. Number of Cases	3	12	25	10	46
2012 - 2021					
Avg. Number of Cases Per Year (Median)	5.2 (7.0)	10.6 (10.0)	19.8 (16.5)	10.7 (8.5)	47.4 (48.5)
Min. Number of Cases	0	5	5	5	31
Max. Number of Cases	8	17	49	24	73
% Change in Avg. Number of Cases Compared to 2002 -2011	372.7	60.6	70.7	98.1	86.6

*** = Spotted Fever Group Rickettsioses including Rocky Mountain Spotted Fever**

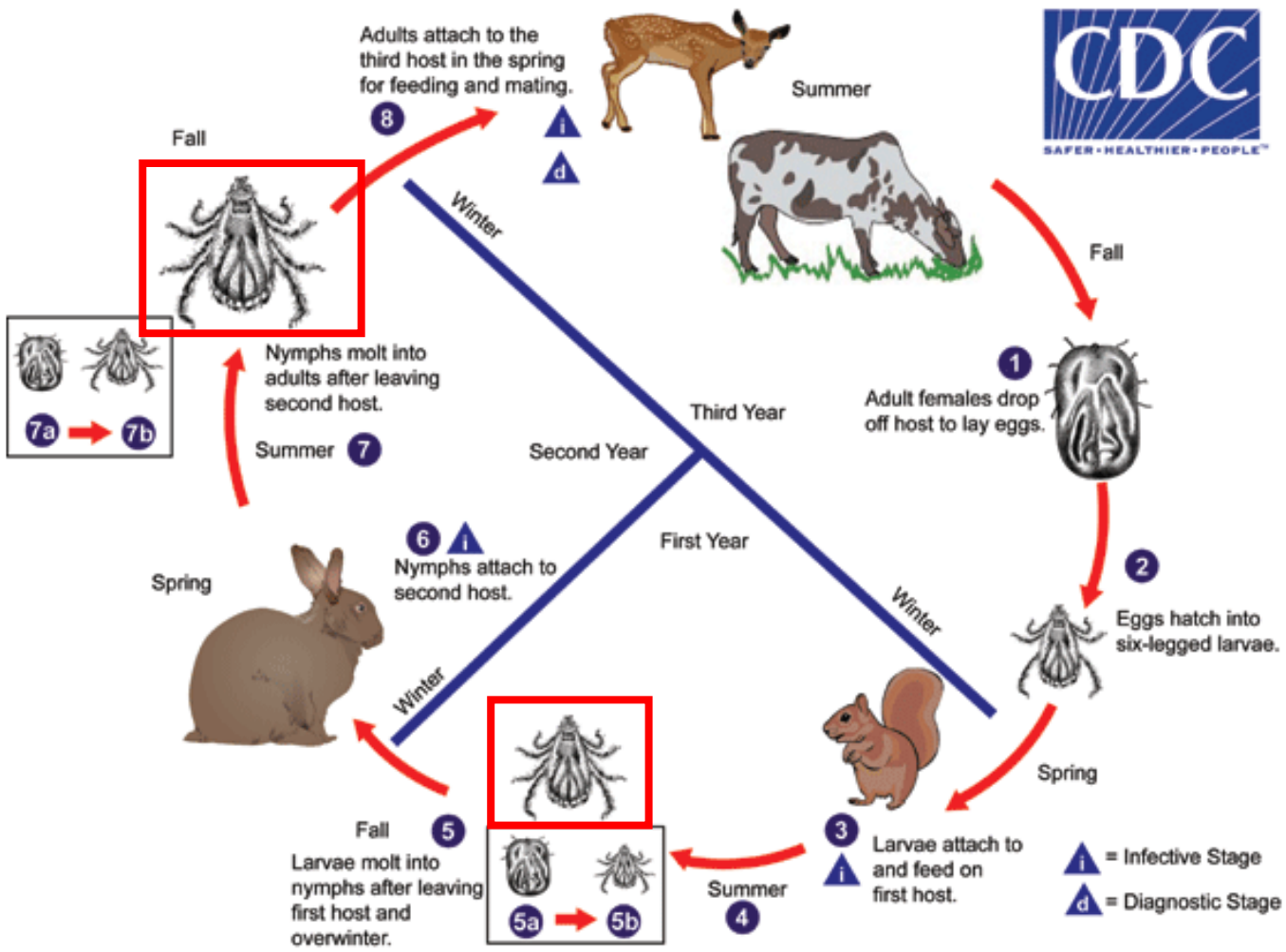
TYPES OF TICKS



- Two main types of ticks
  - Soft ticks – Argasidae
  - Hard ticks – Ixodidae
- Hard ticks are responsible for most of the transmission of tick-borne pathogen and disease
  - 1-host hard ticks
  - 2-host hard ticks
  - 3-host hard ticks
    - Most medically significant group

Credit: CDC, Public Health Image Library

THREE-HOST HARD TICK



Credit: CDC, NCEZID-DVBD

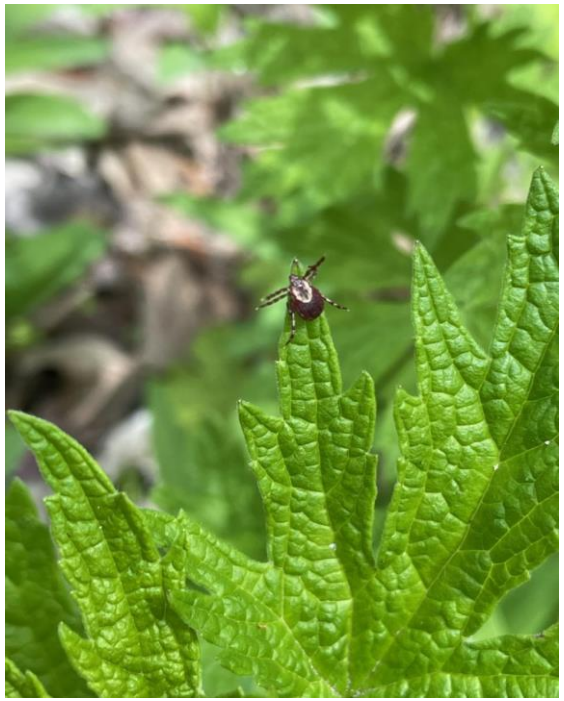
- 4 life stages: egg, larvae, nymph, adult
- Bloodmeal from a <u>new host:</u>
  - Before each mobile life stage goes to the next life stage
  - Before laying eggs
- Eggs hatch into larvae – Blood feed
- Larvae molt to nymphs – Blood feed
- Nymphs to adults – Blood feed
- Adults mate and females lay eggs
- Each bloodmeal that is obtained by the tick is an opportunity to acquire or transmit a pathogen

WHERE ARE THE TICKS AT?

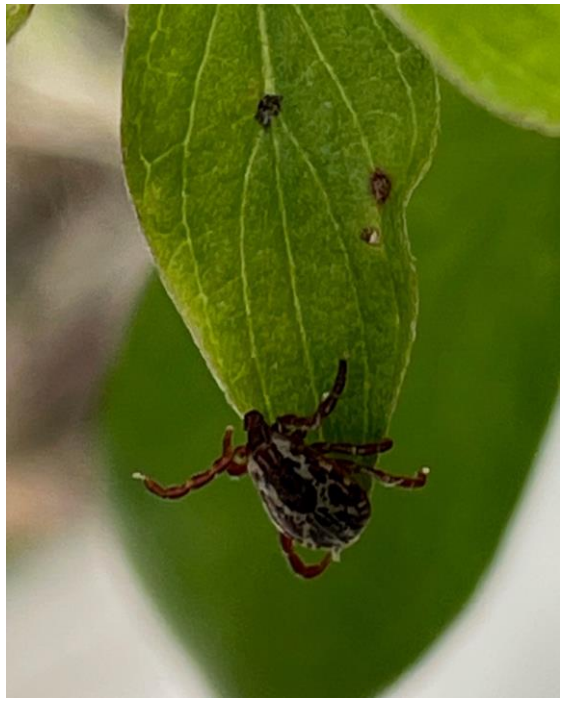
- Prevent drying out and find hosts
- Microclimates with elevated humidity
- Quest on vegetation or in the leaf litter
- Understory of a wooded area
- Sides of trails or walkways
- Grassy areas
- Transition zones between two habitats

Credit: H. Smith, NDHHS

WHERE ARE THE TICKS AT?



Credit: T. Dawdy, NDHHS



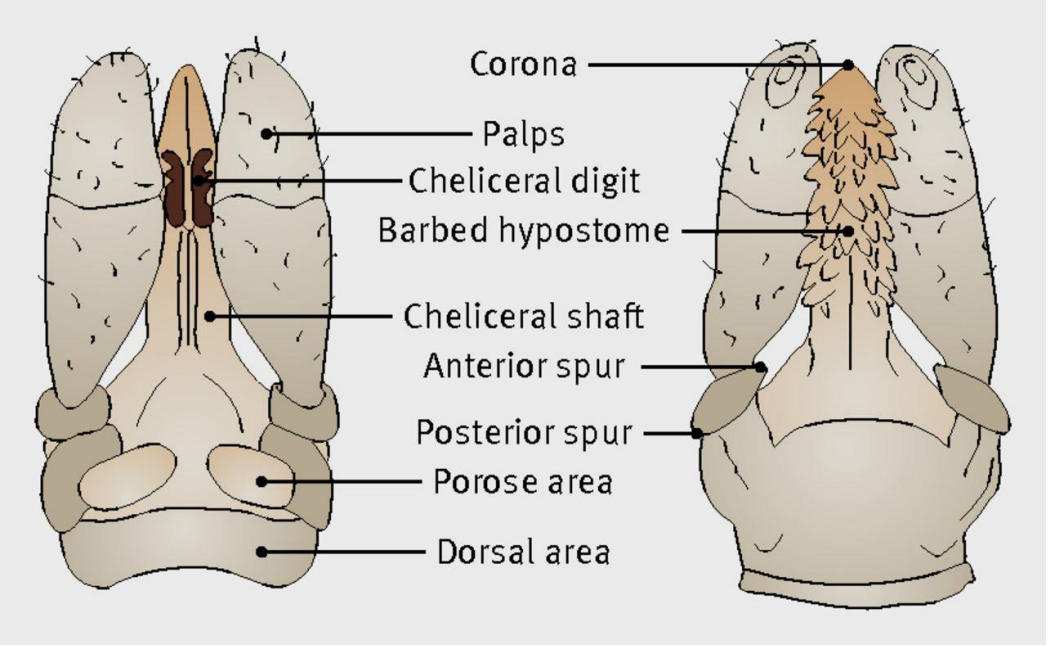
Credit: T. Dawdy, NDHHS

Credit: T. Dawdy, NDHHS

HOW DO TICKS FIND A HOST?

- Questing
  - Hold out front legs while on vegetation waiting for a host to pass by and grab on to them
  - DO NOT fall from trees
  - 2 primary modes
    - Sit and wait (ambush)
      - American dog tick
      - Blacklegged tick
      - Lone star tick
    - Active (pursue or hunt)
      - Lone star tick
  - Some tick species will do both
    - Lone star tick
  - Sense CO2 and vibrations

Credit: CDC, NCEZID-DVBD



Credit: Due et al. 2013[2]

HOW DO TICKS FEED?

- Contact the host
- Cut skin with chelicera
- Insert hypostome
- Produce cement
  - Saliva
  - Feed
- Detach
- Drop

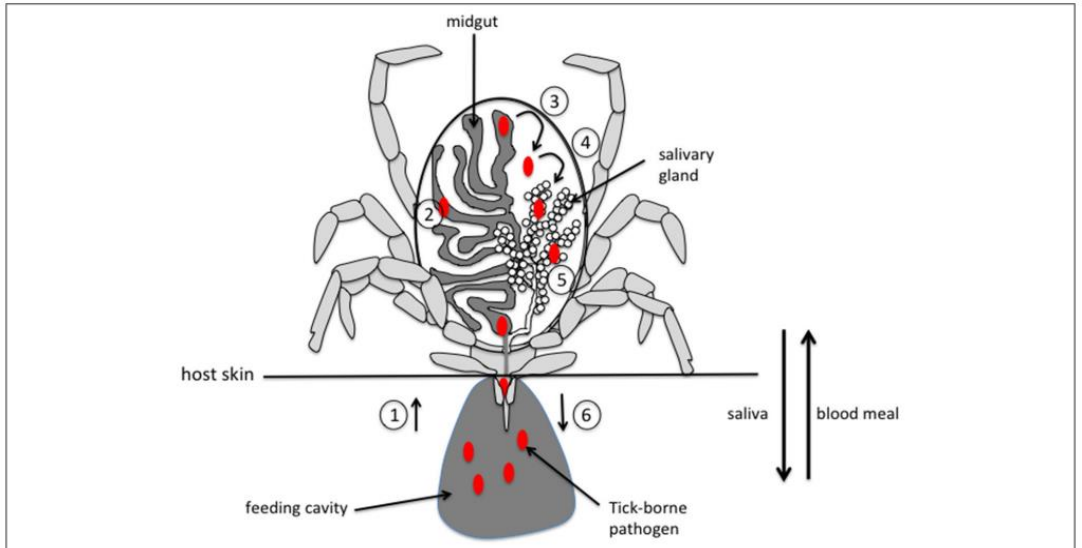


FIGURE 1 | Schematic representation of pathogen acquisition, development and transmission by a tick. (1) pathogens are ingested by the tick along with the blood meal during the bite. (2) Pathogens invade the midgut and, depending on the species, stay in the midgut until the next feeding or immediately cross the epithelium of the digestive tract (3) to invade the tick body. (4) Pathogens move into the salivary glands by crossing the epithelium and invade the acini (5). (6) Pathogens are injected into a new host during feeding, along with saliva that counteracts host hemostasis, inflammation and immune responses, thus facilitating pathogen infection of host. Please note that, for clarity, only half of the digestive tract and a single salivary gland are represented.

Credit: Simo et al. 2017[3]

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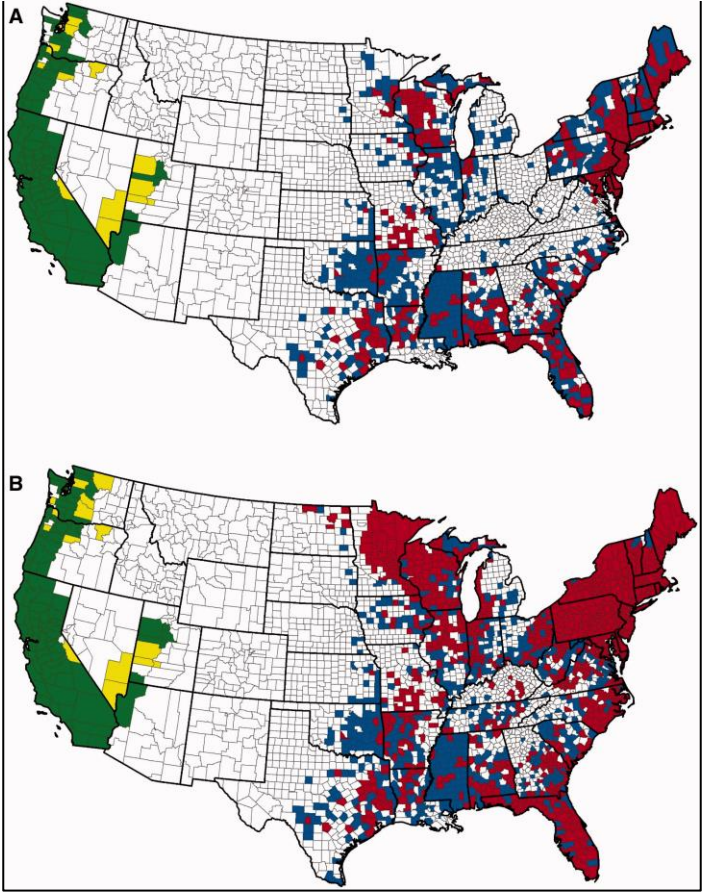
Nebraska Tick Surveillance Program

Credit: H. Smith, NDHHS

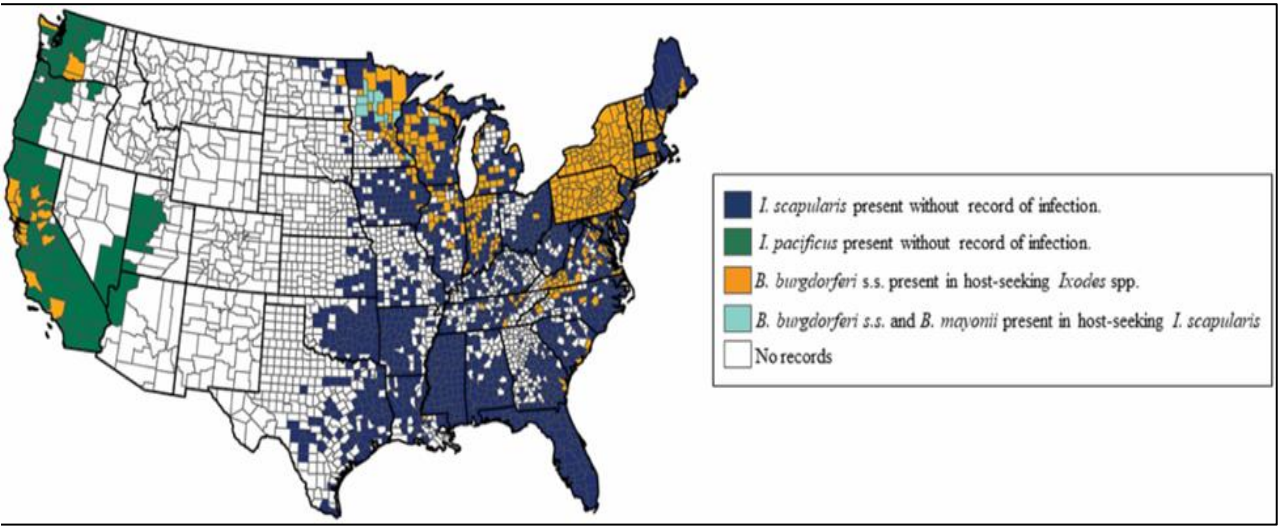
TICK SURVEILLANCE AS A PUBLIC HEALTH TOOL

Credit: J. Hamik, NDHHS

- Why not just use human tick-borne disease data?
  - While human disease data is important it can be inaccurate
  - Reporting practices between states may vary (e.g. not all conditions are reportable in each state)
- Tick surveillance helps to compliment human surveillance[3]
  - Provide actionable, evidence-based information to clinicians, the public, and policy makers on where and when people are at risk for exposure to ticks and tickborne pathogens
    - Used to target diagnosis/treatment, prevention, and control strategies
- Help explain epidemiological trends[3]
  - Expanding range and incidence of disease
  - Risk exposure to tickborne pathogens that are not reportable
  - Predict future expansion of tickborne disease
    - e.g. Lyme disease in Nebraska[4]
- Identify the presence and distribution of newly discovered tick-borne pathogens[2]



Credit: Eisen et al. 2016[5]



Credit: Fleshman et al. 2021[6]

GOALS OF THE PROGRAM

- 4 primary goals
  - Classify county status
    - Established tick vector populations
      - ≥6 specimens of a single life stage in a 12-month period
      - >1 life stage in a 12-month period (e.g. nymph and adult)
    - Reported tick vector populations
      - <6 specimens of a single life stage in a 12-month period
    - No records
  - Presence and prevalence of tickborne pathogens at the county level
  - Estimate the density of infected host-seeking tick vectors at the county level
  - Document host-seeking phenology

TICK SURVEILLANCE

Credit: L. Lynch-O'Brien, UNL

Credit: R. Birn, NDHHS

- We use the tick flagging technique
- 3 m x 3 m piece of fabric (e.g. cotton canvas)
- Fabric is mounted to a wooden dowel
- Fabric is moved horizontally across and over the vegetation or leaf litter

TICK SURVEILLANCE

Credit: T. Dawdy, NDHHS

Credit: H. Smith, NDHHS

TICK SURVEILLANCE

Credit: T. Dawdy, NDHHS

TICK SURVEILLANCE

- After ticks are collected, they are put into vials containing 95% ethanol
- Ticks are then identified back at the lab
- Portion of the collected ticks are tested for pathogens
  - Blacklegged ticks are tested at CDC
  - All other ticks are tested at the University of Nebraska – Kearney
- Test results reported back to NDHHS and shared with stakeholders

Credit: T. Dawdy, NDHHS

Credit: CDC, NCEZID-DVBD

Preventing Tick Bites and Reducing Risk of Acquiring a Tick-Borne Disease

TICK BITE PREVENTION

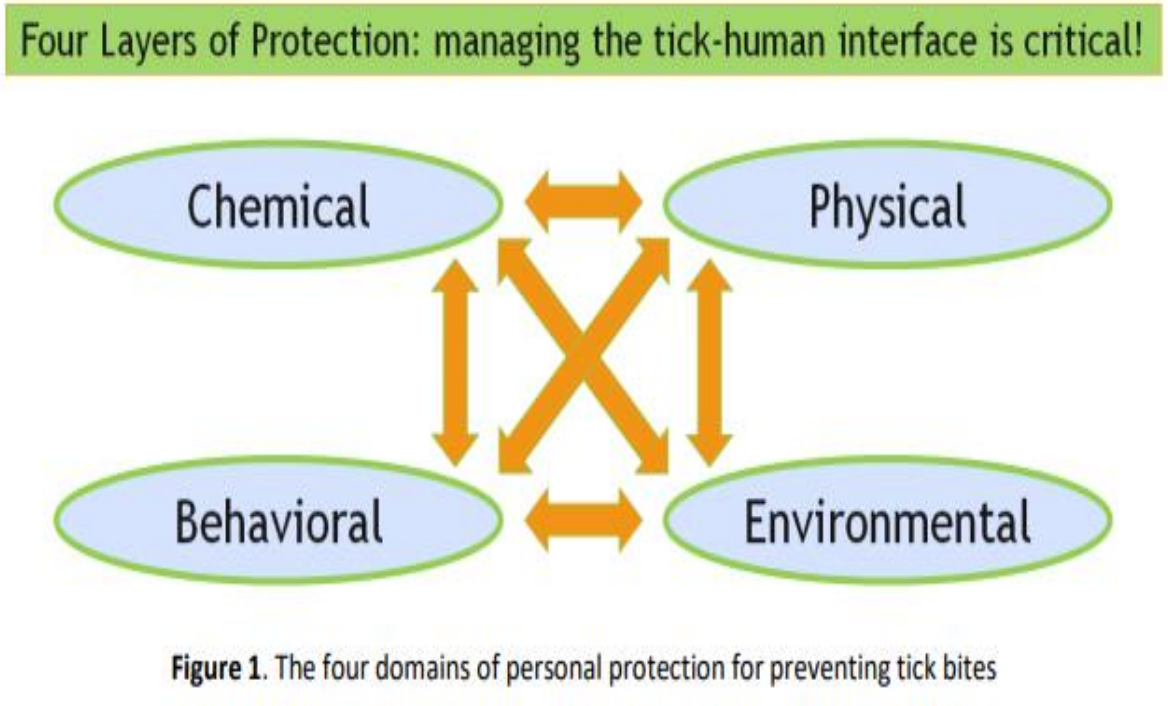


Figure 1. The four domains of personal protection for preventing tick bites

Credit: Holly Tuten, INHS Medical Entomology Lab - Illinois Statewide Tick Surveillance Program[9]

- Why not just spray for ticks like we do for mosquitoes?
  - At present, studies have not shown reductions in human-tick encounters or number of tick-borne diseases at the individual household or neighborhood level after the application of pesticides[7,8]
- What can you do to prevent tick bites and reduce your risk of acquiring a tick-borne disease?
  - 4 strategies
    - Chemical
    - Physical
    - Behavioral
    - Environmental

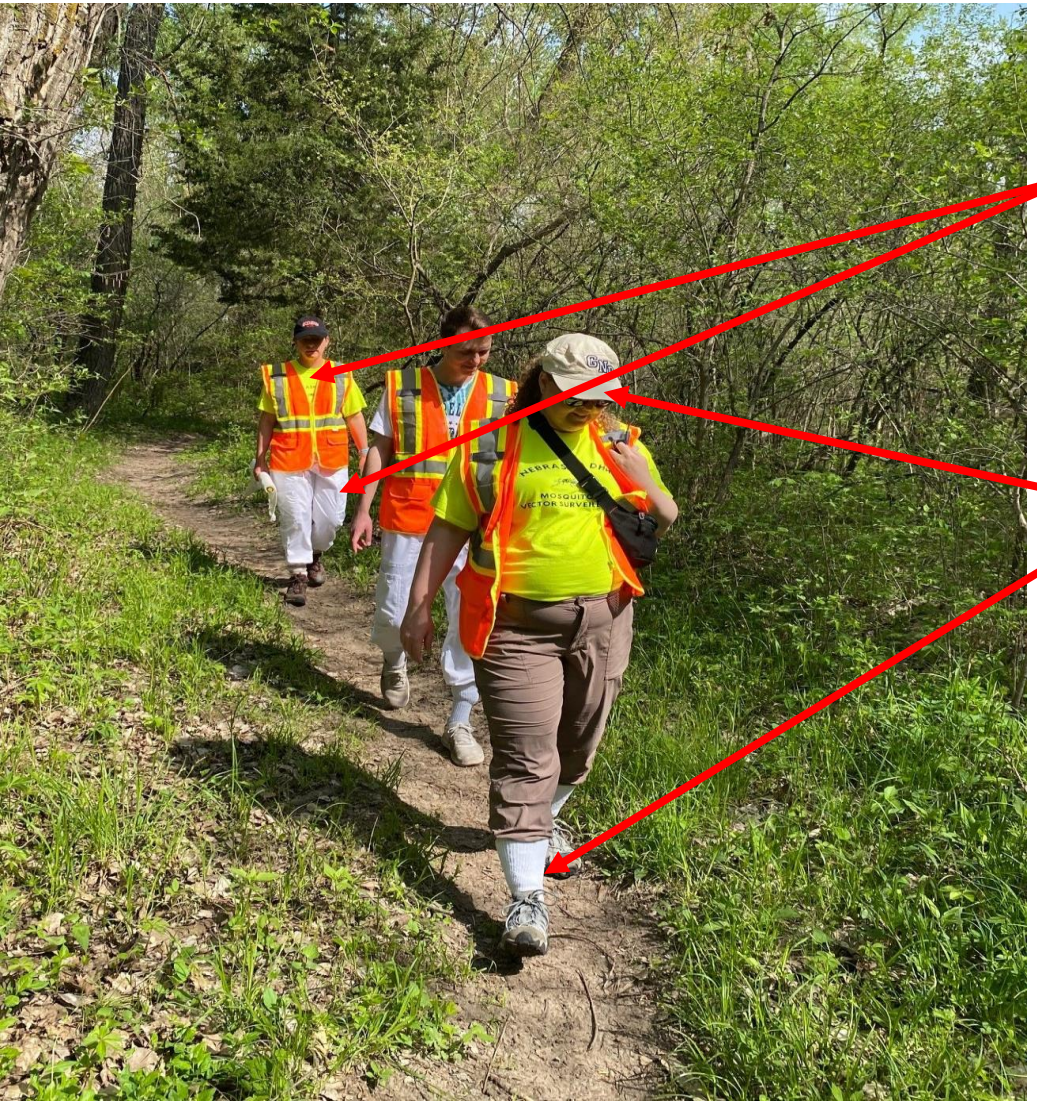
CHEMICAL PROTECTION

- The base of tick bite prevention
- Use EPA-registered repellents – tested and approved for safety and efficacy
  - DEET
  - Picaridin
  - IR3535
  - Oil of lemon eucalyptus
  - Para-menthane-diol
  - https://www.epa.gov/insect-repellents/find-repellent-right-you
- Read the label thoroughly with every new bottle
- Follow the manufacturer's directions on the label!
  - Most toxicity events due to misuse[10]
  - Small percentage of people may have allergies to some of the products – talk with your healthcare provider if you have known allergies or questions before using

CHEMICAL PROTECTION

- Permethrin
  - Insect repellent/pesticide
  - Can only be used on clothing, shoes, and gear
- Some repellents, such as DEET can be used along with permethrin
  - Some can also be used on children, some cannot- read the label and check here:
    - https://www.epa.gov/insect-repellents/using-insect-repellents-safely-and-effectively

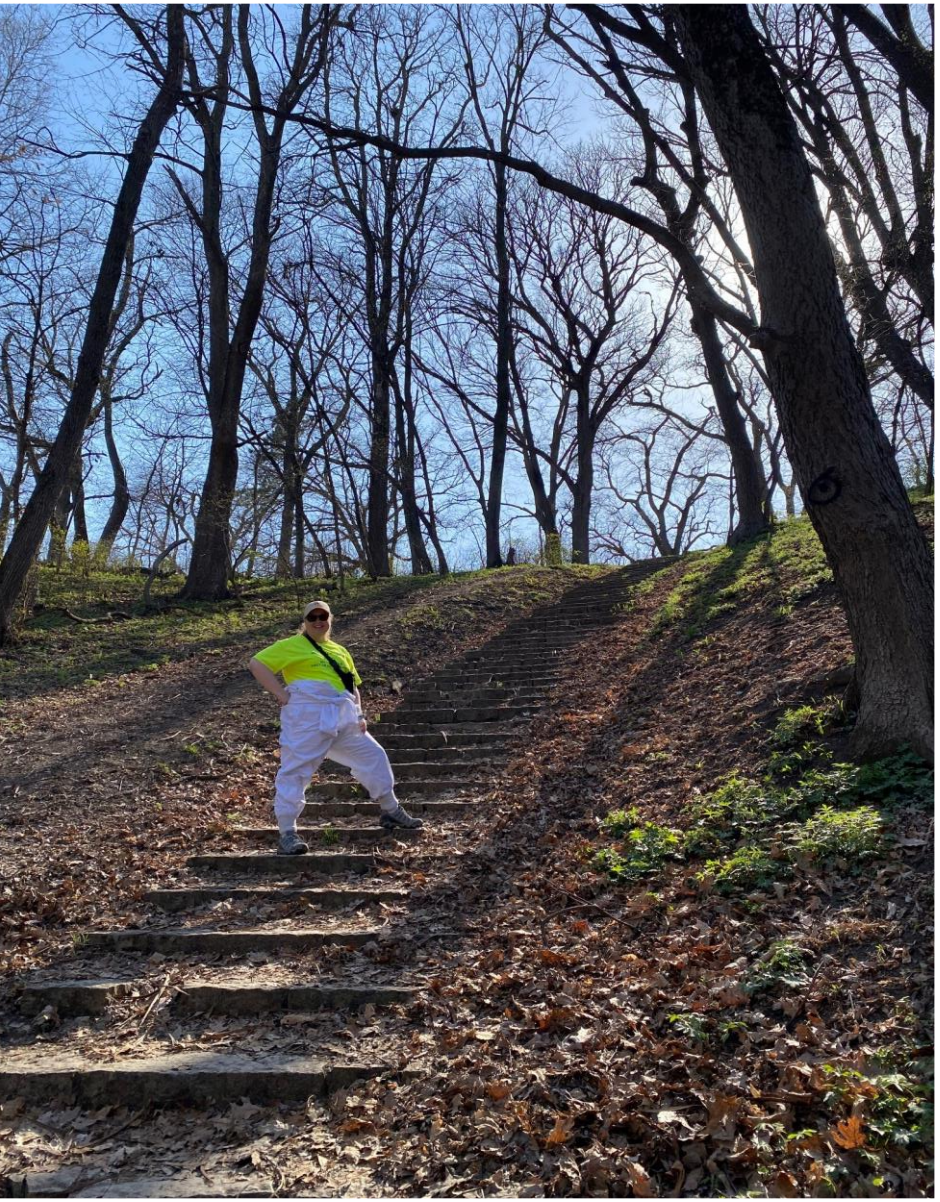
PHYSICAL PROTECTION



- Use light-colored and solid-colored clothes when you will be out in tick habitat
  - This makes it easier to spot ticks that get on you and you can remove them quickly
- Tucks pants into socks – Tuck shirt into pants – Tuck hair up if you have longer hair
  - Use socks that have a tight weave pattern
    - Larval ticks of some species may be able to wiggle through large weave patterns in socks
- Makes an ascending barrier
  - Forces ticks to crawl up where they can be seen and removed from your clothing
- Carry a trusty lint roller with you or in your vehicle
  - Works great to pick up smaller tick life stages (e.g. nymphs or larvae)

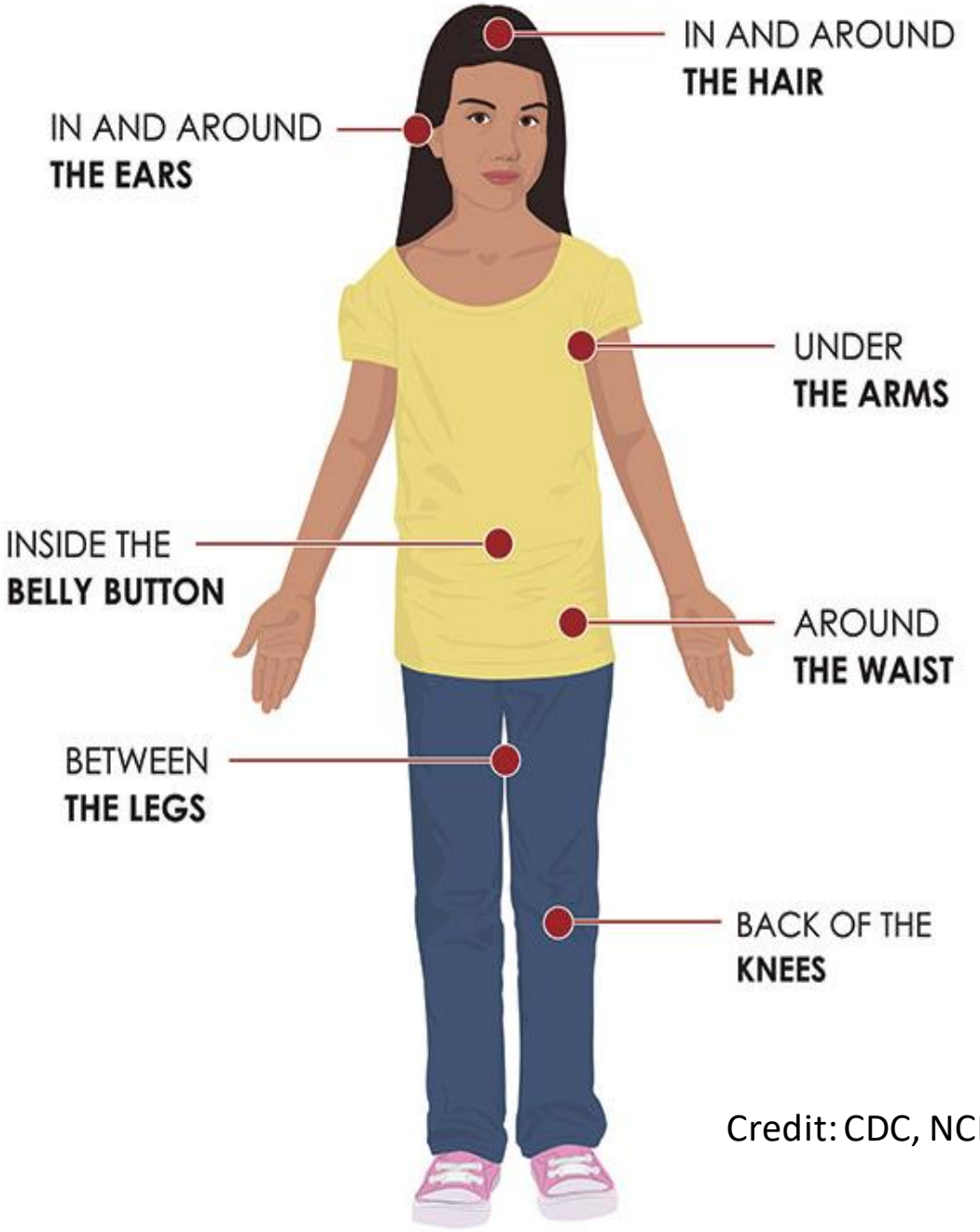
Credit: H. Smith, NDHHS

BEHAVIORAL PROTECTION



Credit: H. Smith, NDHHS

- Before going outdoors, get prepared
  - If using permethrin apply it to gear ahead of time using manufacturer's recommendation
  - Dress appropriately (e.g. light colored clothes)
  - Bring along a pair of fine-tipped tweezers for tick removal
- Once you arrive to your outdoor destination and explore
  - Apply your insect repellent
  - Scan yourself for ticks while outdoors
    - Start on one side of your body and work your way down, then move back up and scan on the other side of your body
  - Stay on trails and walk in the middle of them
    - Highest concentration of ticks will be near the trail edge in the taller grass

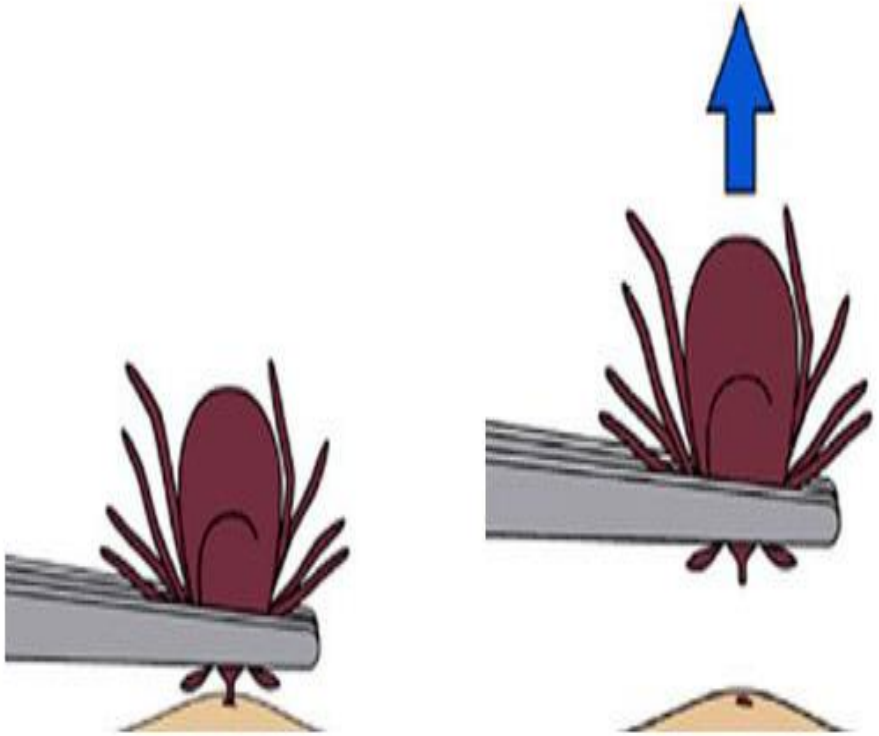


Credit: CDC, NCEZID-DVBD

BEHAVORIAL PROTECTION

- After you return from the outdoors
  - Put clothes in the dryer on high heat for at least 10 minutes to kill any ticks
  - If you can, dry clothes first, then wash
  - Check any gear for ticks
  - Check pets for any ticks if they came along
  - If possible shower within 2 hours after returning
  - Conduct a thorough tick check by sight and feel
    - Check before you shower
    - Check after you shower
    - Be sure to check between toes as well

BEHAVORIAL PROTECTION



Credit: CDC, NCEZID-DVBD

- Properly remove any embedded ticks you find on yourself
  - Avoid folklore remedies like "painting" the tick with clear nail polish or petroleum jelly
  - Do not use heat (e.g. match) to make a tick detach from the skin
  - Can cause the tick to regurgitate its gut contents including any potential pathogens
  - Testing of ticks is not currently recommended
    - If tick tests positive, it does not mean you were infected – takes ticks a long time to transmit pathogens
    - If tick tests negative, it does not mean you may not have been bitten by another tick unknowingly that was infected – gives a false sense of assurance
- If you develop a rash or fever within several weeks of removing a tick or being in tick habitat, see your healthcare provider

ENVIRONMENTAL PROTECTION

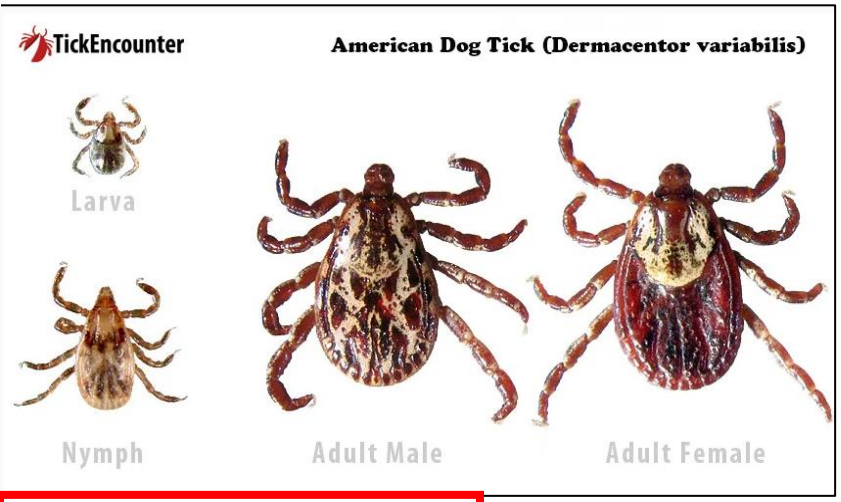
Credit: K. Stafford III, CAES[11]

1	**Tick zone**	Avoid areas with forest and brush where deer, rodents, and ticks are common.
2	**Wood chip barrier**	Use a 3 ft. barrier of wood chips or rock to separate the "tick zone" and rock walls from the lawn.
3	**Wood pile**	Keep wood piles on the wood chip barrier, away from the home.
4	**Tick migration zone**	Maintain a 9 ft. barrier of lawn between the wood chips and areas such as patios, gardens, and play sets.
5	**Tick safe zone**	Enjoy daily living activities such as gardening and outdoor play inside this perimeter.
6	**Gardens**	Plant deer resistant crops. If desired, an 8-ft. fence can keep deer out of the yard.
7	**Play sets**	Keep play sets in the "tick safe zone" in sunny areas where ticks have difficulty surviving.

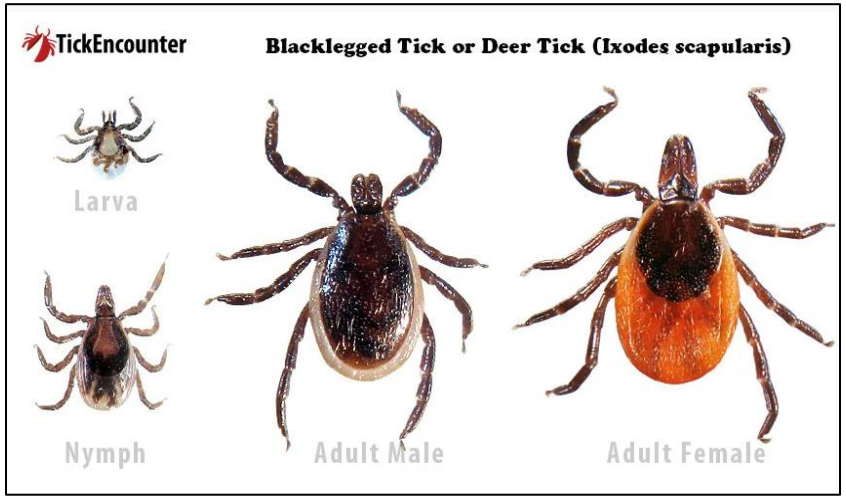
Based on a diagram by K. Stafford, Connecticut Agricultural Experiment Station

Credit: CDC, NCEZID-DVBD

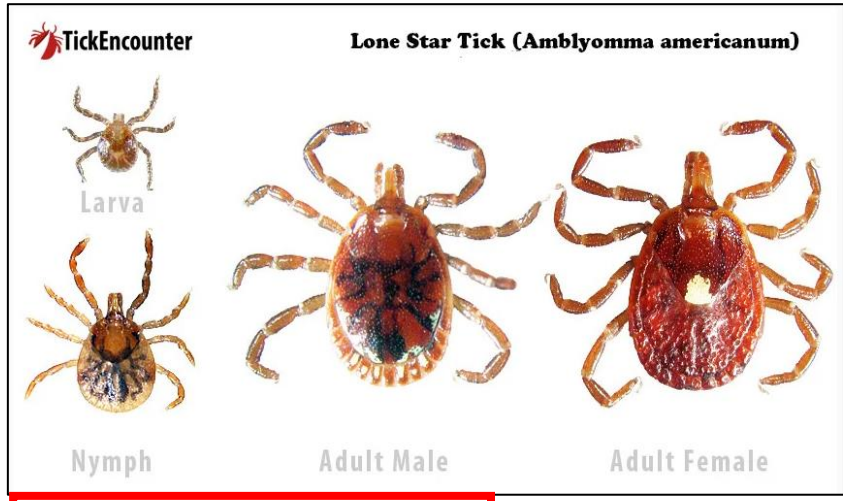
TICK-BORNE DISEASE OF NEBRASKA



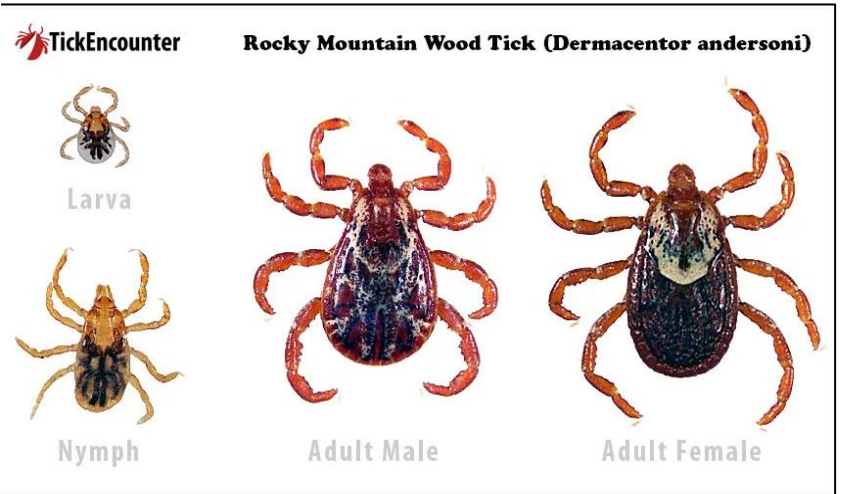
- Rocky Mtn Spotted Fever
- Tularemia



- Anaplasmosis
- Babesiosis
- Lyme disease
- Tick-borne relapsing fever
- Powassan virus

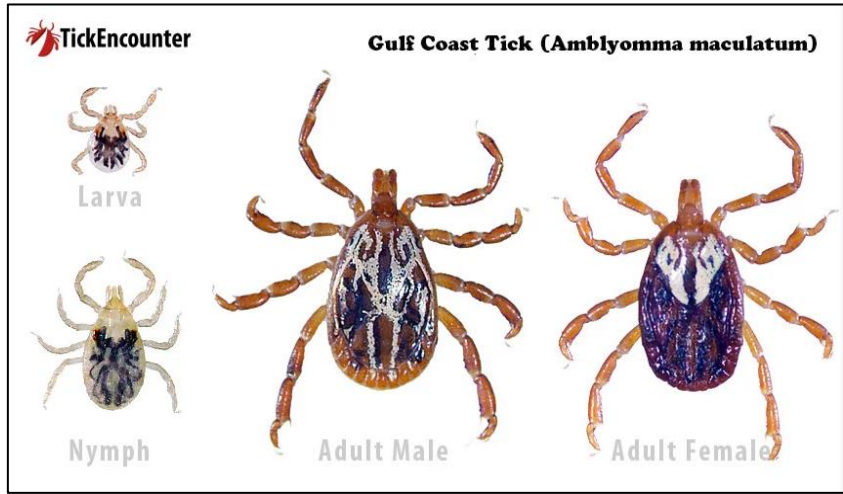


- Ehrlichiosis
- Tularemia
- Spotted Fever Group Rickettsioses?
- Heartland virus
- Alpha-gal Syndrome*



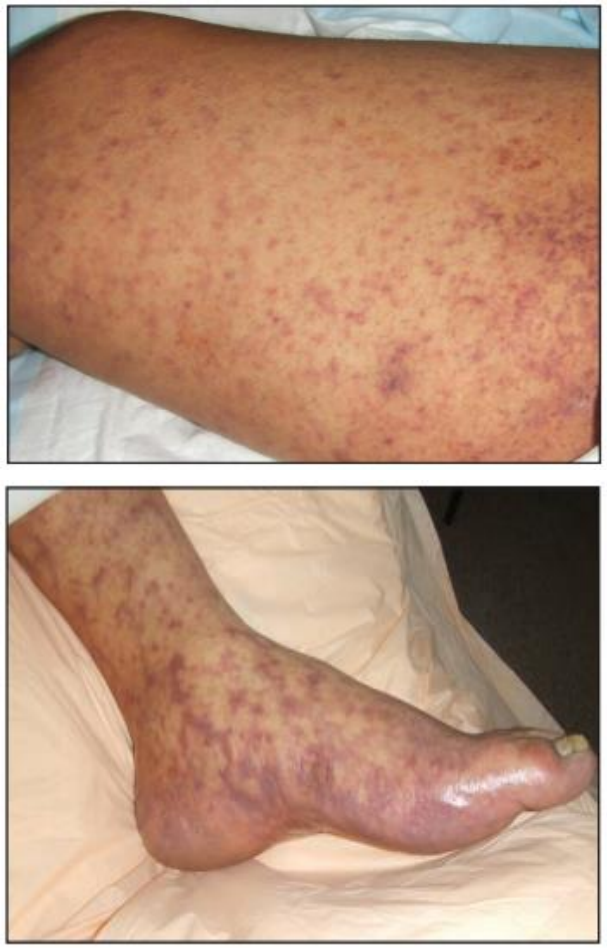
- Rocky Mtn Spotted Fever
- Tularemia
- Colorado Tick Fever Virus

- Tidewater Spotted Fever



Credit: TickEncounter, University of Rhode Island

SPOTTED FEVER GROUP RICKETTSIOSES, INCLUDING RMSF



Credit: Biggs et al. 2016[12]

- Disease caused by a group of closely related bacteria
  - Most famous of these is Rocky Mountain Spotted Fever (RMSF) caused by *Rickettsia rickettsii*
  - Signs/Symptoms[12]
    - Fever
    - Headache
    - Muscle aches
    - Nausea/vomiting
    - Low platelet count (thrombocytopenia)
    - Elevated liver enzymes
    - Rash- appears in 90% of RMSF patients
      - Appears 2 – 4 days after initial symptoms
      - Small, flat, pink, macules on the wrist or forearms, and ankles and spreads to the trunk and sometimes the palms and soles of the feet
  - Treatment[11]
    - Antibiotics- doxycycline
    - All ages including children <8 years of age[13]
    - Initiate treatment right away if suspected spotted fever

TULAREMIA

An ulcer caused by *Francisella tularensis*.

Credit: CDC, NCEZID

- Also known as rabbit fever
- Caused by bacteria *Francisella tularensis* – category A bioterrorism agent
- Many routes of transmission (e.g. water, dust, rabbit/rodent carcasses, ticks)
  - Primarily tick-borne in Nebraska
- Signs/Symptoms
  - Varies depending on how the bacteria entered the body – almost all have a fever
    - Range from mild to life-threatening
  - Ulceroglandular- most common usually occurs following tick or deer fly bite
    - Skin ulcer or sore at site of the bite
    - Swelling of regional lymph glands, usually in the armpit, groin, or neck
  - Other forms- glandular, oculoglandular, oropharyngeal, pneumonic, and typhoidal
- Treatment
  - Antibiotics- e.g. streptomycin, gentamicin, doxycycline, and ciprofloxacin

LYME DISEASE

Credit: CDC, NCEZID

- Caused by bacteria *Borrelia burgdorferi* and *Borrelia mayonii*
- First definitive evidence of local Lyme disease transmission in Nebraska in 2021[4]
- Signs/Symptoms
  - Early stage symptoms
    - Fever/chills
    - Headache
    - Muscle/join aches
    - Swollen lymph nodes
    - Erythema migrans rash- 70 – 80% of cases have rash
      - "Bulls-eye" rash
      - Not always "bulls-eye" in shape
  - Late stage symptoms
    - Facial palsy
    - Arthritis
    - Heart palpitations/Irregular heartbeat
    - Inflammation of brain or spinal cord
    - Nerve pain

LYME DISEASE

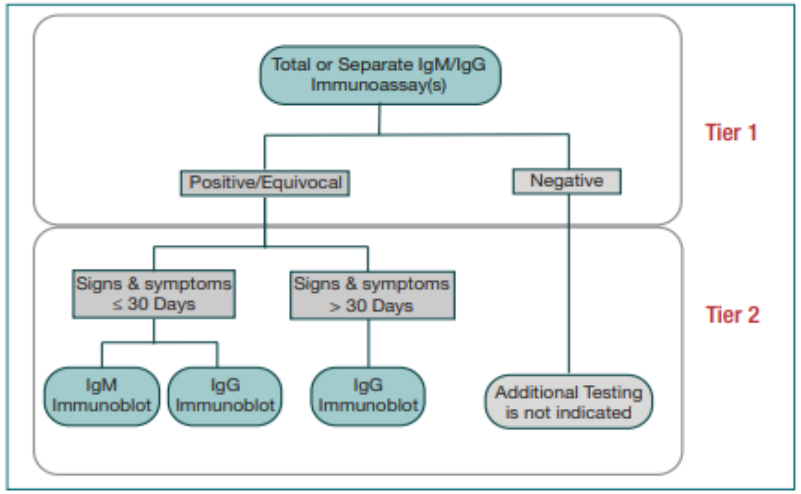
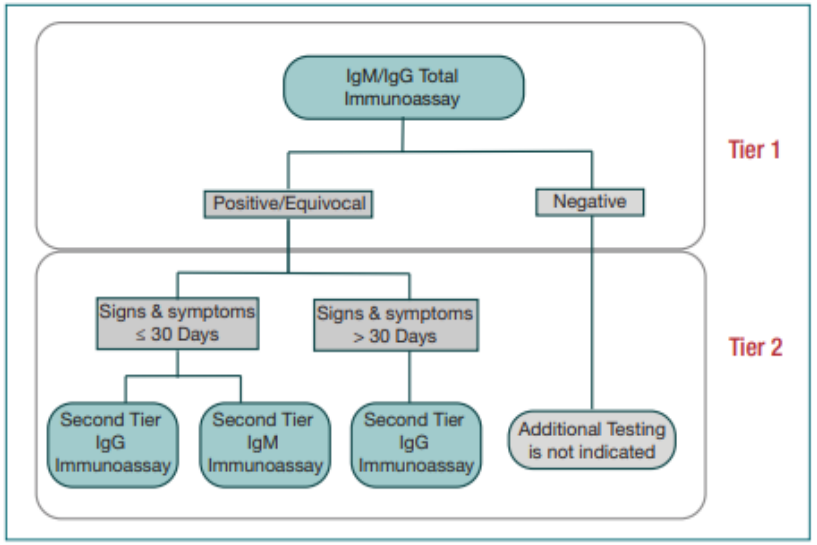


Figure 1: Standard Two-Tiered Testing (STTT)

Credit: APHL[14]

Figure 3: Modified Two-Tiered Testing Algorithm (MTTT) 2 – Separate IgM and IgG Second Tier immunoassays



Credit: APHL[14]

- Testing for Lyme disease
  - Can be complicated
  - Two primary test types used
    - Detection of antibodies (serological tests)
    - Standard two-tiered testing (STTT)[14]
    - Modified two-tiered testing (MTTT)[14]
- Treatment
  - Early and proper antibiotic treatment
  - Treatment on four primary manifestations[15]
    - Erythema migrans rash
    - Neurological Lyme disease
    - Lyme carditis
    - Lyme arthritis
  - Post treatment Lyme disease syndrome (PTLDS)
    - Small percentage of patients report pain, difficulty thinking, and fatigue after treatment
    - Unknown cause
      - Auto-immune response, persistent infection, other causes?

EHRLICHIOSIS

- Caused by bacteria *Ehrlichia chaffeensis* and *Ehrlichia ewingii*
  - Related to the spotted fever group rickettsioses
- In 2022 = 19 cases reported (most all-time)
  - Most reported tick-borne disease of the year
- Signs/Symptoms[12]
  - Fever, chills
  - Severe headache, muscle aches
  - Nausea/vomiting, diarrhea
  - Rash (more common in children)
  - Low platelet count (thrombocytopenia)
  - Elevated liver enzymes
  - Organ failure, respiratory failure
  - Death
- Treatment[12]
  - Antibiotics- doxycycline
  - All ages including children <8 years of age[13]
  - Initiate treatment right away if suspected

THANK YOU

DIVISION OF PUBLIC HEALTH

NEBRASKA
Good Life. Great Mission.
DEPT. OF HEALTH AND HUMAN SERVICES

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Additional Resources

RESOURCES

1. CDC Tick-Borne Diseases of the United States
2. CDC Ticks
3. Nebraska DHHS Vector-Borne Diseases
4. University of Nebraska Tick-Tag-Go
5. University of Rhode Island TickEncounter