Epidemiology and Prevention of Tick-Borne Diseases in California

Information for Physicians and Other Health-Care and Public Health Professionals
Objectives of this Presentation

• Familiarize health-care providers with California ticks and the diseases they carry
• Describe the epidemiology of selected tick-borne diseases in California
• Describe tick exposure risk in California, including pertinent ecology
• Provide tick-bite prevention and tick removal information
• Provide information on educational resources available at the California Department of Public Health

Note: Photos, tables, and diagrams originate with the California Department of Public Health or are publically available clipart except where otherwise indicated.
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• Tick species and biology in California
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Most tick-borne diseases are reportable
(California Code of Regulations, Title 17)

Click here to see list of reportable conditions:

http://www.cdph.ca.gov/healthinfo/Pages/ReportableDiseases.aspx
### Number of Human Tick-borne Disease Cases* Reported in CA, 2004-2013

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<th>Disease</th>
<th>Number of Reported Confirmed Cases</th>
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<td>Lyme disease</td>
<td>765</td>
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<td>61</td>
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<td>6</td>
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<tr>
<td>Babesiosis</td>
<td>2</td>
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</tbody>
</table>

* Number reflects only those cases that fit the surveillance criteria for a confirmed case
** Number reflects only cases for which tick-bite likely exposure
California Tick Species

There are 47 species of ticks in California
  • Only 8 species bite humans

“Hard” (Ixodid) ticks
  • Western blacklegged tick (*Ixodes pacificus*)
  • American dog tick (*Dermacentor variabilis*)
  • Pacific Coast tick (*Dermacentor occidentalis*)
  • Wood tick (*Dermacentor andersoni*)
  • Brown dog tick (*Rhipicephalus sanguineus*)

“Soft” (Argasid) ticks
  • *Ornithodoros hermsi*
  • *Ornithodoros parkeri*
  • *Ornithodoros coriaceus*
Tick Life Stages

• **Hard ticks**
  - Hard ticks have a hard outer covering
  - Hard ticks have three life stages (larva, nymph, and adult) and feed once per life stage, for days at a time
  - Larvae rarely bite humans

• **Soft ticks**
  - Soft ticks have a soft outer covering
  - Soft ticks have multiple life stages, each life stage may feed several times, for only minutes at a time
  - Most patients rarely see or know they have been bitten by a soft tick

Source: Unknown
Common Human-Biting Hard Ticks in California

Western blacklegged tick
*Ixodes pacificus*
Vector for Lyme disease and anaplasmosis

Pacific Coast tick
*Dermacentor occidentalis*
Vector for Rocky Mountain spotted fever, spotted fever group, tularemia

American dog tick
*Dermacentor variabilis*
Vector for Rocky Mountain spotted fever, tularemia

Brown dog tick
*Rhipicephalus sanguineus*
Vector for Rocky Mountain spotted fever
Most species of hard ticks are found on wild grasses and low plants. Ticks do not fall from trees, jump or fly.

Adult ticks quest by waiting at the ends of grass or other foliage for a host to brush by so they may attach.

From top to bottom: Pacific Coast tick male, Pacific Coast tick female, western blacklegged tick male. Two female western blacklegged ticks questing.
The brown dog tick occurs in urban environments, often associated with pets.

Ticks feed on dog, drop off in environment to molt to next life stage, then attach again to dog to feed.

Source: https://www.studyblue.com/notes/note/n/ticks/deck/7965547
Common Human-Biting Soft Ticks in California

- Soft ticks are difficult to detect
  - Patients rarely see them
- Soft ticks are the vector for tick-borne relapsing fever
Soft Tick Habitat
(Ornithodoros hermsi)

Rodent nests in the wild

Rustic dwellings
Lyme Disease

Western black legged tick (*Ixodes pacificus*)
**Borrelia burgdorferi**

- Spirochete
  - Host-associated helical bacteria
  - First identified in 1982 by W. Burgdorfer as spirochete*

- *Borrelia burgdorferi* is etiologic agent of Lyme disease in U.S.**

- Lyme disease is the most common vector-borne disease in the U.S.

- In California, *Ixodes pacificus* is the only tick that transmits Lyme disease***

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***Lane et al. 2004 J. Med Entomol. (41): 239-248
Symptoms of Lyme Disease

Early Symptoms
• Non-specific “flu-like” symptoms
  – Headache
  – Myalgia
  – Fever
  – Malaise
• Erythema migrans (EM) rash

Later symptoms
• Facial palsy (Bell’s palsy)
• Arthritis in one or more joints
• Rare cardiac involvement
Tick Bites and Lyme Disease

• Erythema migrans (EM) rash
  – EM rash is slowly expanding and sometimes has central clearing
  – Rash typically develops 7-10 days following tick bite (range 1-30 days)
  – Rash is rarely pruritic
    • (Wormser, N Engl J Med 2006;354:2794-801)
  – Reported in ~60% of CA cases

• Rash should not be confused with tick-bite lesions (or allergic response)
  – Occurs within 1-24 hrs and does not spread

Source: Lake County HD
Diagnosis

• Symptoms
  – EM rash, facial palsy

• Exposure potential
  – History of tick-bite or being in tick-infested area

• Serologic test: two-test approach
  – ELISA, IFA, or C6
  – If test positive, follow with confirmatory western blot

Source: CDC
Treatment

• Early disease
  – Oral doxycycline
  – Oral amoxicillin
    • For children and pregnant women

• Late and/or neurologic disease
  – Intravenous ceftriaxone

• Slow recovery (i.e. weeks to months) can occur
History of Lyme Disease in California

• First human case identified in 1978 in a hiker from Sonoma County

• Lyme disease became a reportable condition in 1989
  – In 2005, it became laboratory reportable
  – Since 1989, > 2,500 cases of Lyme disease reported through passive surveillance to the California Department of Public Health

• Western blacklegged tick is the only tick that transmits Lyme disease to humans in California
Reported Cases of Lyme Disease -- United States, 2012

1 dot placed randomly within county of residence for each confirmed case

Reported Cases of Lyme Disease by Year, United States, 1995-2013

*National Surveillance case definition revised in 2008 to include probable cases; details at [http://www.cdc.gov/lyme/stats/chartstables/casesbyyear.html](http://www.cdc.gov/lyme/stats/chartstables/casesbyyear.html)
Reported Cases of Lyme Disease per Year in California
Reported cases per 100,000 person-years

- Trinity 5.9
- Humboldt 4.3
- Mendocino 4.0
- Sierra 3.1
- Nevada 2.4
- Mono 2.0
- Santa Cruz 1.7
- Mariposa 1.7
- Amador 1.6
- Sonoma 1.4
- Marin 1.0
- Others 0.1 – 0.9
- No cases reported

- Although Lyme disease cases have been reported in nearly every county, cases are reported based on the county of residence, not necessarily the county of infection.
- The incidence of Lyme disease has remained consistent over the last 20 years.
- Northwestern coastal counties are areas of highest risk.
Confirmed Lyme Disease Cases by Age and Gender 2002-2011
Borrelia burgdorferi has been found in western blacklegged ticks in 42 California counties*

Physicians should be aware that people can be exposed to Lyme disease-carrying ticks in many regions of California

* VBDS surveillance data
Transmission of *Borrelia burgdorferi* to Humans in California

*Ixodes pacificus*

Life cycle

- Larva
- Nymph
- Adult female
- Female lays eggs

Larvae or nymphal ticks acquire the bacteria by feeding on infected mammal hosts.

People are accidentally infected through the bite of an infected nymph or adult female western blacklegged tick.
Western Blacklegged Tick Infection Prevalence with *Borrelia burgdorferi*

- **Adult** western blacklegged tick: typically 1-5% infected
- **Nymphal** western blacklegged tick: typically 0-15% infected
  - In northern CA where studied (Mendocino, Placer, Yolo counties), prevalence is often higher in nymphal than adult ticks*
- **Larval** western blacklegged tick: 0%
  - Larvae rarely bite people

The greatest number of acute cases of Lyme disease acquired in California (as evidenced by EM rash) occurs in June, one month after the peak nymphal tick season.
Nymphal Tick Exposure Risk by Habitat

- Grassland (very low)
- Chaparral (low)
- Woodland-grass (low)
- Dense woodland (≥moderate)

Slide courtesy R. S. Lane
California: Lizards and Lyme Disease

- Nymphal western blacklegged ticks feed on lizards
- A borreliacidal protein in lizard blood kills *Borrelia burgdorferi* spirochetes in the gut of infected nymphal ticks*
- As a result, in some areas in California, the proportion of infected adult western blacklegged ticks is lower than in the nymphal western blacklegged ticks

-The blood meal from the lizard “cleaned” the tick

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*Lane and Quistad 1997. J. Parasitol. 84: 29-34*
To find out more about Lyme disease in California, visit the CDPH website at:

http://www.cdph.ca.gov/healthinfo/discond/Pages/LymeDisease.aspx
Spotted Fever Group
*Rickettsia*
including: Rocky Mountain spotted fever
( *Rickettsia rickettsii*)

American dog tick (*Dermacentor variabilis*)

Source: CDC
Spotted Fever Group Rickettsia: *Rickettsia rickettsii* and *Rickettsia 364D*

- Genus *Rickettsia* is in bacterial tribe *Rickettsiieae*, family *Rickettsiaceae*, and order *Rickettsiales*
- Related to *Ehrlichia* and *Anaplasma*
- All intracellular pathogens
- Called “spotted fever group” due to the rashes typically seen with these infections

Dumler and Walker, 2001; Lancet Infectious Diseases; April 21-28
Rocky Mountain Spotted Fever

Source: CDC
Rocky Mountain Spotted Fever (RMSF)

- Most severe tick-borne illness in the United States
  - 3-5% case fatality if treated
  - 20% case fatality if untreated*
  - Recent studies suggest case fatality has decreased to as low as 0.5%
    - Higher risk of fatality in children 5-9 years**
    - Most cases occur during summer months

- Primary California tick vectors
  - American dog tick (*Dermacentor variabilis*)
  - Wood tick (*Dermacentor andersoni*)

- Family Rickettsiaceae
  - *Rickettsia rickettsii*
  - Small, intracellular bacteria

* Chapman et al., MMWR Recomm Rep 55: 1 – 27
Clinical Features of RMSF

• Sudden fever, myalgia, nausea, headache
  – 2 to 14 days after tick bite

• Rash (81%-91% of patients*)
  – Usually 3 to 5 days after tick bite
  – Starts as blanching macular rash
    • Eventually become papular**
  – Often on palms and soles (36-82% cases)*
  – Often spreads to entire body
  – The later the rash appears, the higher the mortality*

• Thrombocytopenia
  – Leads to severe complications
    • Acute respiratory distress syndrome (ARDS), abdominal pain, neurologic or bleeding disorders, loss of circulation (gangrene)

* Mandell et al, Principals and Practices of Infectious Diseases, 2005 pp 2288-2293
**CDC Rocky Mountain Spotted Fever: http://www.cdc.gov/ncidod/dvrd/rmsf/Signs.htm
Diagnosis and Treatment

• **Diagnosis**
  – **Serology**
    • Rising antibody titers (four-fold change in acute and convalescent samples)
    • IFA or ELISA tests
  – **PCR, immunohistochemical staining of tissue (difficult to obtain), culture**

• **Treatment**
  – **Doxycycline**
    • Adults and children (not pregnant women)*

*Do not wait for diagnosis – must treat on suspicion!*

* Mandell et al, Principals and Practices of Infectious Diseases, 2005 pp 2288-2293
Annual Reported Incidence for Rocky Spotted Mountain Fever in the United States, 2000-2007

Reported Incidence and Case Fatality of Rocky Mountain Spotted Fever in the United States, 1920-2008

http://www.cdc.gov/rmsf/stats/index.html
Since 2002 there have been 13 confirmed cases of RMSF reported in California

- Travel history out of county
- Fatality

County of residence of confirmed RMSF human cases
• Ticks acquire infection by feeding on infected mammal (such as chipmunk, squirrel, dog)
• Ticks maintain and pass on infection between life stages (transstadial) and through eggs to larvae (transovarial)
• Ticks function as both reservoir and vector
• Ticks require 6-20 hours of feeding to transmit Rickettsiae
  • Shorter transmission time than for other tick-borne diseases

Tick-Pathogen Cycle

Source: Unknown
Ticks Associated with RMSF Transmission and Distribution in California

Wood tick
*Dermacentor andersoni*

Pacific Coast tick
*Dermacentor occidentalis*

American dog tick
*Dermacentor variabilis*

Brown dog tick
*Rhipicephalus sanguineus*

Red circles generalize tick species distribution

*The Ticks of California, by D. Furman and E. Loomis, 1984*
American Dog Tick
*dDermacentor variabilis*

- Primary vector of RMSF in southeastern states
- Common tick in California
- Adult tick preferred host
  - large and medium-sized mammals including domestic dog
  - Often bites humans
- Immature stages preferred host
  - small rodents

Source: CDC

Range of *D. variabilis* in the US

Source: CDC
Rocky Mountain Wood Tick
(Dermacentor andersoni)

- Vector for RMSF in Rocky Mountain region
- Adult tick feeds on large domestic and wild mammals and also bites humans
- Immature stages feed on rodents

Source: CDC

Range of D. andersoni in the US
Brown Dog Tick  
* (Rhipicephalus sanguineus)  

- Historical and known vector in South America  
- Recently implicated in the U.S. as primary vector in two recent RMSF outbreaks  
  - Eastern Arizona 2003 - current  
  - Mexicali outbreak 2008 - current  
- *R. sanguineus* appears to be predominant vector of RMSF in the southwest U.S.  
- Continued environmental and dog-targeted tick control necessary to prevent continued transmission  

**Range of *R. sanguineus* in the U.S.**

Source: CDC
Other Spotted Fever Rickettsiae
Tick-Borne Spotted Fever Rickettsiae in the United States

- In addition to *Rickettsia rickettsii* (RMSF), several other tick-borne species of Rickettsiae, “spotted fever group *Rickettsia*" have been shown to cause human infections
- Spotted fever group *Rickettsia* are transmitted to humans by the bite of an infected tick
  - May cause similar signs and symptoms to those observed for RMSF
- Pathogens in the U.S. include several species of *Rickettsia*
  - *Rickettsia parkeri*
    - Transmitted by *Amblyomma maculatum* (Gulf Coast tick)
    - Eastern and southern U.S., particularly along the coast
  - *Rickettsia* species 364D (*Rickettsia philipii*)
    - Transmitted by *Dermacentor occidentalis* (Pacific Coast tick)
**Rickettsia philipii**

- Originally described as “*Rickettsia 364D*”
- First detected in ticks in 1966 in California
- To date, detected in Pacific Coast ticks (*Dermacentor occidentalis*) ticks only
- First human case from Lake County, California July 2008
- Common sign includes a local cutaneous eschar (dark crusted ulcer)
- Treated with doxycycline

![Eschar on forearm](image1.png)

![Eschar on arm](image2.png)
Rickettsia philipii
Clinical Case Summary 2008 - 2013 (n=12)

• Proposed clinical name: Pacific Coast Tick Fever
• Clinical
  – Fever 92%
  – Headache 90%
  – Lymphadenopathy 46%
  – Eschar 100%
    • some multiple, at least one with petechial rash
  – Only 3 with recalled tick bite
• Lab
  – Often low white blood cell count
  – Thrombocytopenia
  – Liver function transaminases (LFTs) sometimes mild abnormal
Challenges for Diagnosing

– Many “look-alikes”

**Tick-bite reaction**
Source: Mariposa Environmental Health

**Cutaneous anthrax**
Source: CDC.gov

**Parapox virus**
Source: Colorado State University Extension
Distribution of *Rickettsia philipii* Cases and Infected Ticks in California

Human case

Human case and positive ticks

Positive ticks (adult Pacific Coast ticks: 2.6% N. California; 6% S. California)

Reported Human Cases in California
2013: 3 cases
2012: 4 cases
2011: 5 cases
2008: 1 case
If You Identify A Suspect *Dermacentor* Tick-Bite Associated Eschar:

- Submit whole blood sample for Spotted Fever Group *Rickettsia* testing to CDPH, Viral and Rickettsial Disease Laboratory (VRDL; add details/contact) at time of identification and convalescent sample 3-4 weeks later
- Collect two samples from wound under eschar with dry cotton swabs, store in vials, send to VRDL for PCR

[Lab Testing for Spotted Fever Rickettsiosis](http://www.cdph.ca.gov/programs/vrdl/Pages/WhatsNew.aspx)
To find out more about spotted fever group Rickettsiae in California, visit the CDPH website at:

http://www.cdph.ca.gov/HealthInfo/discond/Pages/TickBorneDiseases.aspx
Tick-borne Relapsing Fever (TBRF)

Agent
- *Borrelia hermsii*, *B. parkeri*, *B. turicatae*
- Visible on stained red blood smear

Vector
- In U.S., *O. hermsi*, *O. parkeri*, *O. turicata*
- Transmitted from infected female tick to her progeny (transovarial transmission) and from one life stage to next (transtadial transmission)

Reservoir
- Peridomestic rodents
  - Chipmunks, squirrels, rats, mice
- Infected animals carry the organism in their blood
- A soft tick acquires infection when they take a blood meal from an infected animal
Tick-borne Relapsing Fever

• TBRF is a serious disease
  – However, if treated the case fatality rate is less than 5%
  – If acquired during pregnancy, TBRF poses a high risk of fetal loss (up to 50%)

• Symptoms
  – Incubation period: 1 to 14 days
  – Fever, headache, chills, myalgia
  – Febrile episodes 1 to 7 days separated by afebrile periods of 1 to 5 (up to 20) days
  – Up to 10 relapses

http://www.cdc.gov/relapsing-fever/clinicians/
Reported Cases of Tick-borne Relapsing Fever, United States

Cases of Tick-borne Relapsing Fever - United States, 1990 - 2011

Each dot, placed randomly within the county of exposure (where known), represents one case.

Each dot, placed randomly within the county of residence, represents one case.

http://www.cdc.gov/relapsing-fever/resources/CasesTBRF.pdf
Tick-borne relapsing fever in California
10 year summary: 2005-2014

• 53 cases over last 10 years
• Median of 5 cases each year (range = 1 - 11)
• Case age range from 1 to 79 years
  – Median 36 years
  – Males more than females (30 to 23)
• Most cases contracted in summer months
  – June to September
• Most frequent counties of exposure (all in the Sierra mountain range)
  – Mono > El Dorado > Nevada > Inyo > Fresno
The majority of TBRF cases in California are acquired in mountainous regions

* CDPH surveillance data
Tick-borne Relapsing Fever Exposure

- High risk sites:
  - Rodent-infested cabins 3000 - 9000 feet elevation
  - Coniferous forest

- Soft ticks live in rodent nests in building
  - Seek out blood meal when rodents vacate nest
  - Humans vulnerable when sleeping on floor or in beds in contact with walls
Tick-borne Relapsing Fever Exposure

Cabins in northern California where TBRF cases were exposed

In the United States, TBRF exposure most often occurs in a rustic cabin where rodents have made their nests
Preventing Tick-borne Relapsing Fever

- Prevent rodent infestations of dwellings
- Discourage feeding of chipmunks and squirrels
- Store firewood away from dwelling
Preventing Tick-borne Relapsing Fever

• Keep beds away from walls

• Removal of rodents from structure without ectoparasite control may increase disease potential
  – chemicals may not penetrate cracks in walls
  – attempt to identify and remove rodent nests
To find out more about tick-borne relapsing fever in California, visit the CDPH website at:

http://www.cdph.ca.gov/HealthInfo/discond/Pages/TickBorneRelapsingFever.aspx
Anaplasmosis

Western blacklegged tick (*Ixodes pacificus*)

Source: CDC
Anaplasmosis

- Small gram negative bacteria
  - Invade and replicate inside granulocytes (neutrophils)
  - Colonies inside granulocytes are called morula
  - Organism called *Anaplasma phagocytophilum*
- Disease: Human granulocytic anaplasmosis (HGA)

![Image of morula within a granulocyte](image-url)
Anaplasmosis

• Clinical
  – Fever, headache, malaise, myalgia common
  – Respiratory and/or GI symptoms (cough/dyspnea, nausea, diarrhea, vomiting) in some
  – Leukopenia and thrombocytopenia common
  – Rash rarely observed with anaplasmosis
  – Incubation period typically 1 week
  – Fatal outcomes rare, often associated with immune-compromised conditions

Annual Incidence of Anaplasmosis in the United States

- First recognized as a disease of humans in the U.S. in the mid-1990’s
  - Become reportable in 1999
- The number of anaplasmosis cases reported has increased steadily
  - 348 cases in 2000, to 1,761 cases in 2010
- The incidence of anaplasmosis has also increased
  - 1.4 cases/million persons in 2000 to 6.1 cases/million persons 2010
- The case fatality rate has remained low (less than 1%)

*NN= Not Notifiable

http://www.cdc.gov/anaplasmosis/stats/
Incidence by Age Group for Anaplasmosis and Ehrlichiosis in the United States 2000-2010

- The frequency of reported cases of anaplasmosis is highest among males and people over 50 years of age
  - A compromised immune system may increase the risk of severe outcome
- Individuals who reside near or spend time in known tick habitats may be at increased risk for infection

http://www.cdc.gov/anaplasmosis/stats/
California Human Cases of Anaplasmosis 1994-2012*

- HGA (16 cases)

- Case associated with travel through endemic area

* CDPH surveillance data, county of residence

*A. phagocytophilum* detected in adult *I. pacificus* ticks in 10 of 18 counties surveyed (0.3 - 9.9%)

- Fritz et al, J Vector Ecol. 2005; 30:4-10
- Lane et al, Vector Borne Zoo Dis. 2001;197-210
- Lane et al, J Med Entomol. 2004;41:239-48
- Barlough et al, J. Clin Micro. 35: 2018-2021
- VBDS-CDPH data
Reported Anaplasmosis cases, California, 2004-2013

N=16
Mean age= 50 years
9 (56%) male
Mammalian Reservoir Anaplasma phagocytophilum

• Nicholson et al. 1999
  – Rodent study in Sonoma, Placer, Santa Cruz counties
  – Dusky-footed woodrats (Neotoma fuscipes)
    • 34% seroreactive
    • Anaplasma DNA detected in 31% of seroreactive woodrats
To learn more about anaplasmosis in California, visit the CDPH website at:

http://www.cdph.ca.gov/healthinfo/discond/Pages/Anaplasmosis.aspx
Babesiosis

- Intraerythrocytic protozoan (piroplasm)
  - *Babesia divergens* (primarily Europe)
  - *Babesia microti* (Northeastern and North Central U.S.)
  - *Babesia duncani* (Western U.S.)

- *B. duncani* (WA-1 type *Babesia*)
  - Most recently characterized human *Babesia* sp.*

Common morphology of small *Babesia*. Left to right: ring form, amoeboid, “Maltese-cross” or dividing form. Giemsa-stained blood smear of *B. duncani.*

Clinical Human Babesiosis

Signs and symptoms
- Infections can be asymptomatic
- Gradual onset of high fever, chills, fatigue, malaise, and anorexia
- Less frequent: arthralgia, myalgia, nausea and vomiting, abdominal pain
- Leukopenia, thrombocytopenia are common
- *B. duncanii* infection may cause pulmonary congestion
- Severe hemolytic anemia reported
- Rash is rare

Predisposing factors for acute clinical disease
- Older age -- majority of cases >50 years old
- Immunosuppression / splenectomy

Diagnosis of Babesiosis

• Clinical symptoms
• Parasites on Geimsa-stained thin blood smears
• Serology: Immunoflorescent antibody test (IFAT) available now in commercial laboratories; immunoblot
• Hamster inoculation (CDC, research)
• PCR (CDC, research)
Blood Smear Evaluation: Babesia

*Babesia:* Ring form may be confused with Plasmodium but dividing tetrads typical of *Babesia* spp.
Treatment of Babesiosis

- Azithromycin and Atovaquone
- Quinine and Clindamycin
- Blood transfusion
11 cases of babesiosis caused by *Babesia duncani* or closely related species have been documented in California, 1966 - present.

*Blood donor and recipient
Babesiosis Ecology in California

Animal reservoirs and tick vectors are unknown

Genetically identical *Babesia* to California human *Babesia* spp. have been recovered from bighorn sheep and deer in California, some in areas where human cases have been exposed. Tick vector is unknown.

Kjemtrup et al, Parasitology 2000: 487-493
Transfusion transmitted babesiosis (mostly *Babesia microti*) is the leading infectious cause of mortality (38%) in transfusion recipients as reported to the Food and Drug Administration. Infected donors have been identified year around; infected recipients have been identified in non-endemic states.

**Prevention:**
- Prescreen on donation questionnaire
- Monitor recipient for febrile illness post transfusion, particularly in endemic areas
- Blood bank screening
  - Test for *B. microti* under development
- Documented infection results in permanent deferral

To learn more about babesiosis in California, visit the CDPH website at:

http://www.cdph.ca.gov/healthinfo/discond/Pages/Babesiosis.aspx
Tularemia

American dog tick (*Dermacentor variabilis*)

Source: CDC
Tularemia

• Caused by *Francisella tularensis*
  – Gram negative bacteria

• First described from ground squirrels in Tulare Co., CA in 1912*

• Two primary biovars (type A and B)
  – **Type A** associated with arthropod vectors (biting flies, ticks) and mammalian hosts (rabbits, rodents, hares, ground squirrels)
    • Tends to cause more virulent infections
  – **Type B** associated with water
    • Tends to cause less virulent infections**

• Considered a Category A bioterrorism agent

*McCoy and Chapin. 1912 J. Infect Dis; 10:61-72
**Farlow et al., 2001. J. Clin Micro: 3186-3192

Source: CDC
Symptoms of Tularemia

Incubation 1-21 days

Case fatality proportion: 0-14% (higher for type A in eastern US)

Six classic forms:

1. Ulceroglandular: Ulcers on the skin or mouth, swollen and painful lymph glands, swollen and painful eyes, and a sore throat
   - Most common
   - Tick or fly bites and animal contact usual exposure

2. Glandular: regional lymphadenopathy but no cutaneous lesions

3. Oculoglandular: photophobia, tearing, conjunctivitis, small yellow conjunctival ulcers or papules
   - Associated with exposure to contaminated fingers, splashes and aerosols
Symptoms of Tularemia

Six classic forms (continued)*:

4. **Pharyngeal**: fever, sore throat, exudative pharyngitis
   – Associated with contaminated food or water

5. **Typhoidal**: febrile illness, no lymphadenopathy
   – No direct exposure association—exposure to potential tick bites, outdoor exposure, should be sought

6. **Pneumonic**: fever, chills, cough, pneumonia
   – Often associated with occupational exposure e.g. sheep shearers, farmers, landscapers, lab workers

* Mandell et al, Principals and Practices of Infectious Diseases, 2005 pp 2674-2685
Reported Cases of Tularemia, United States 2001 - 2010

http://www.cdc.gov/tularemia/statistics/map.html
Reported Tularemia Cases by Year, United States, 1950 - 2010

Transmission

- Biting arthropod (such as tick, deerfly)
- Exposure can also occur through contact with an infected carcass
- Eating / drinking contaminated animals or infected water sources
- Inhalation of bacteria
- NOT spread person-to-person
To find out more about tularemia in California, visit the CDPH website at:

http://www.cdph.ca.gov/healthinfo/discond/Pages/Tularemia.aspx
Colorado Tick Fever

Wood tick (*Dermacentor andersoni*)

Source: Wisconsin Department of Public Health
Colorado Tick Fever (CTF)

- Double-stranded RNA virus
- Family: *Reoviridiae*; Genus: *Coltivirus*
- Transmitted primarily by *Dermacentor andersoni*
  – Secondary vector *Dermacentor occidentalis*
- Small rodents are primary reservoirs

Source: CDC
CTF Clinical Features

- Incubation period 2-3 days (range 1-14 days)
- Nonspecific febrile illness
- Fever is often biphasic
- Rarely presents as encephalitis
- ~15% of cases hospitalized
- Illness duration 7-10 days
  - Malaise can persist for weeks

CTF Diagnosis

- Testing available at CDC and some state health departments
- Viremia can persist for weeks due to CTF virus infecting red blood cells
- Culture and RT-PCR performed during first two weeks of illness
- IgM and IgG antibodies slow to develop
- Convalescent samples are key to serologic diagnosis
  - If sample is obtained within first two weeks of illness onset, lack of IgM does not rule out the diagnosis

*Staples, J. Erin. Tick-borne Viral Diseases: Colorado Tick Fever, Powassan. Division of Vector-borne Infectious Disease, CDC*
CTF Treatment and Outcome

- No specific treatment
- Majority of cases with self-limited illness
- Complications and fatalities are rare
  - Rare neurologic illness; encephalitis and meningitis more common in children*

CTF Epidemiology

• Endemic to mountainous regions (4,000-10,000 feet) of western U.S. and southwestern Canada
• CTF is currently reportable in only 5 states*
  – AZ, NM, OR, UT, WY
• 90% of CTF cases usually recall tick bite
• Other modes of transmission
  – Blood-borne
  – Laboratory transmission

*Staples, J. Erin. Tick-borne Viral Diseases: Colorado Tick Fever, Powassan. Division of Vector-borne Infectious Disease, CDC
Distribution of Human CTF Cases in the United States 1987 - 2008

*CTF is currently notifiable only in the following states: AZ, CA, NM, OR, UT, and WY.

Staples, J. Erin. Tick-borne Viral Diseases: Colorado Tick Fever, Powassan. Division of Vector-borne Infectious Disease, CDC
CTF Cases by Year in the United States 1988 - 2007

Median 65 cases/year
Median 10 cases/year

Number of cases

*Staples, J. Erin. Tick-borne Viral Diseases: Colorado Tick Fever, Powassan. Division of Vector-borne Infectious Disease, CDC*
Month of Illness Onset for CTF Cases
MT, UT, and WY, 1995 - 2003

Historic Detection
CTF in California
1959
(Murray-Barnes, Bureau Vector Control Report)
2010 CTF Tick Surveillance
VBDS/CDC: # Ticks Tested

- **D. occidentalis**
  - 8/55 (14.5%)
- **D. andersoni**
  - 2/31 (6.4%)

Source: CDC

Positive
Negative

Dermacentor occidentalis

Dermacentor andersoni

Click to go table of contents
Tick Paralysis
Tick Paralysis

• Tick paralysis is a loss of muscle function that results from a neurotoxin transmitted by a biting tick
  – Often associated with *Dermacentor* spp., but other tick species can transmit a neurotoxin
  – More commonly found in children

• Symptoms
  – Unsteady gait, followed several days later by weakness in lower legs
  – Ascending paralysis
  – May cause difficulty breathing and flu-like symptoms

• Treatment
  – Removal of the tick removes the source of the neurotoxin
  – Recovery is rapid once tick is removed
  – Full recovery is expected

Prevention of Tick-Borne Diseases

Don't Let the Ticks Bite!
Tick Repellents

- Treat clothing with permethrin to kill ticks (do not apply to skin)
  - Properly treated clothes can be washed multiple times without retreatment

- Apply DEET repellent (>20%) to skin that is not covered by clothing to repel ticks (can be used on clothing too)

www.tickencounter.org

Deetonline.org
Personal Protection: Avoid Areas Where Ticks are Found

Adult ticks

– Commonly found on grasses and bushes on uphill side of trails
– Stay on trails!

Source: California Department of Public Health
Personal Protective Measures:
Avoid Areas Where Ticks are Found

- Nymphal ticks are found in leaf litter and on trees and logs in hardwood forests
- Avoid contact with logs, tree trunks, and fallen branches in forests

Picture source: Dr. Robert Lane, UC Berkeley
Personal Protective Measures

Check clothes while in tick habitat. Full body check at home up to three days after being in areas where ticks are found: hair line, armpit, back of knees, groin

Parents should inspect children

Check pets: use effective tick repellents on them

Tick attached at the hairline of a child’s head.
Source: used with permission Annie Smith
Patient recommendations:
- Promptly remove tick
- Cleanse the area with soap and water
- If you develop any symptoms 1-30 days after bite, consult your physician
- Let your physician know that you were bitten by a tick

Physician recommendations:
- Prophylactic administration of 200mg doxycycline shown to be useful in highly endemic areas of eastern U.S.; not studied in CA and prevalence does not reach “highly endemic”*
- Testing the tick for medical decision making not recommended by CDPH [http://www.cdph.ca.gov/HealthInfo/discond/Documents/TickTestQandA.pdf](http://www.cdph.ca.gov/HealthInfo/discond/Documents/TickTestQandA.pdf)

To prevent disease transmission, remove ticks as soon as they are detected!
Tick Removal Technique

• Place the tip of fine tweezers around the tick mouthpart
• Pull the tick firmly away from the skin (do not jerk, crush, squeeze, or puncture the tick)
• Do not use insecticides, lighted matches, gasoline, petroleum jelly, or liquid soaps to remove ticks as these techniques may cause injury and are ineffective

Source: Rick Baier, MD, Yosemite Pathology

Barbs on tick mouth parts can make ticks difficult to remove
Should an attached tick be tested for *Borrelia*?

**NOT** for individual clinical management

- Results not always timely for medical decision making
- Positive result does not mean patient will contract *Borrelia*
  - False positive
  - Tick not attached or not attached long enough to transmit
- Negative result does not guarantee free of exposure to *Borrelia*
  - False negative
  - Could have been bitten by another infected tick that was not detected

http://www.cdph.ca.gov/HealthInfo/discond/Documents/TickTestQandA.pdf
Tick Testing and Identification

- Submit ticks for identification to local health department, vector control district, or CDPH
  - Ticks can be alive, dead, or preserved in alcohol or formalin
- If tick testing still desired, dead or live western blacklegged ticks can be tested for *Borrelia* by IFA at some commercial laboratories and some local health departments
  - Ticks must be kept moist in small container
Resources Available from CDPH
Tick Identification

The Vector-Borne Disease Section regularly identifies ticks submitted by public and health care providers.

Call (916) 552-9730 for more information.
www.cdph.ca.gov

Type “tick” in search box
Find Out Where Infected Ticks and Human Cases Occur:

Interactive Lyme Disease and Western Blacklegged Tick Map
Thank you for your attention. A short quiz follows.
Quiz

1. When considering a diagnosis of tick-borne disease, an important question(s) to include during a patient interview is...(circle all that apply)

   a) Recent history of crawling or attached tick on person
   b) Recent history of crawling or attached tick on pet
   c) Recent history of outdoor activity (e.g., camping, hiking, dog walking, wood gathering)
   d) Recent foreign or domestic travel to a tick-borne disease endemic region
   e) All of the above
Quiz

2. Which of the following are considered appropriate for tick removal? (circle all that apply)
   a) Fingernail polish
   b) Lit matches
   c) Fine-tipped forceps
   d) Petroleum jelly
   e) All of the above
Quiz

3. Treatment of Rocky Mountain spotted fever using a tetracycline should be initiated only after laboratory confirmation of infection is obtained.

a) True

(b) False
4. In California, the following tick(s) transmits *Borrelia burgdorferi*, the agent of Lyme disease (circle all that apply):

a) Pacific Coast tick (*Dermacentor occidentalis*)
b) Deer tick or blacklegged tick (*Ixodes scapularis*)
c) Western blacklegged tick (*Ixodes pacificus*)
d) Brown dog tick (*Rhipicephalus sanguineus*)
5. What activity would put a patient at risk for tick-borne relapsing fever (circle all that apply)?

a) Hiking through vegetation
b) Sleeping in rustic mountain cabin
c) Petting dogs
d) Eating / drinking contaminated food or water
6. Which of the following agents is not transmitted by ticks in California?

a) *Francisella tularensis*

b) *West Nile virus*

c) *Babesia duncani*

d) *Borrelia burgdorferi*

e) *Anaplasma phagocytophilum*
Quiz

7. Personal protective measures against tick-borne disease include (circle all that apply):
   a) Apply DEET to skin not covered by clothing
   b) When in tick habitat, check yourself for ticks frequently
   c) Shower when returning from tick-habitat
   d) Conduct full body check for ticks for 3 days after being in areas ticks are found
   e) All of the above
Quiz Key

• Question 1,   E  All of the above
• Question 2,   C  Fine-tipped forceps
• Question 3,   B  False
• Question 4,   C  *Ixodes pacificus* (Western blacklegged tick)
• Question 5,   B  Sleeping in rustic mountain cabin
• Question 6,   B  West Nile virus
• Question 7,   E  all of the above
THE END

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