TICKBORNE DISEASES

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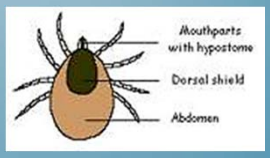
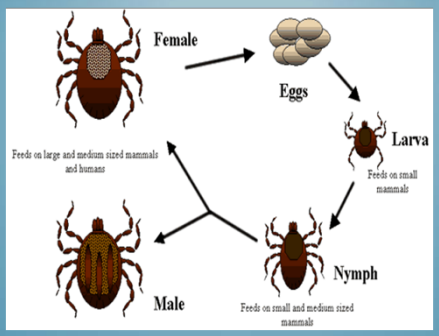
OBJECTIVES

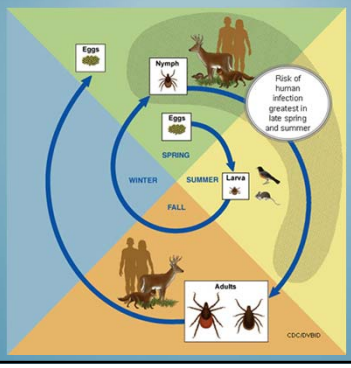
- Describe the epidemiology, origin, treatment, and prevention of tick borne diseases.
- Solve case studies.



TICK LIFE CYCLE



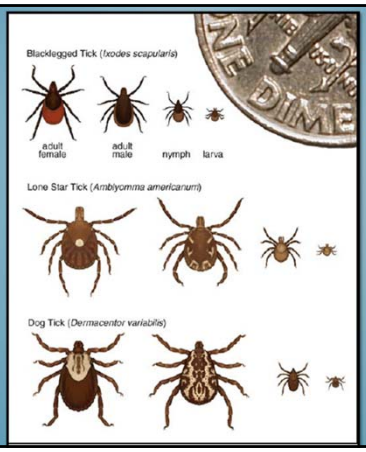
BLACKLEGGED TICKS



HOW TICKS SPREAD DISEASE

- Preparing to feed 10 min to 2 hrs
- Cuts skin surface & inserts feeding tube
- Secrete saliva to modulate host defenses
  - Pain and itch
  - Hemostatis
  - Inflammation and wound healing
- Transmits pathogen while feeding for days
- Drops off to complete next life stage

MOUTH PARTS



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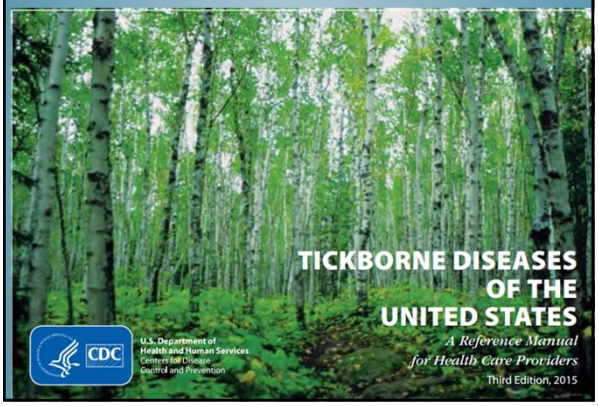
TickNET—A Collaborative Public Health Approach to Tickborne Disease Surveillance and Research

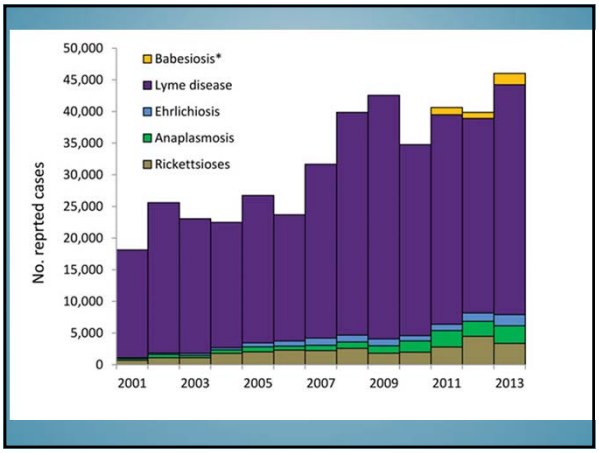
Paul Mead, Alison Hinckley, Sarah Hook, C. Ben Beard

- Emerging Infections Program
- CDC in 2007
- Coordinate surveillance
  - Public health impact
  - Cost
  - Tick density and acaridice treatment
  - Trap rodents and treat with fipronil
  - Identify novel pathogens molecularly

RESEARCHER DRAGS FOR TICKS

WWW.CDC.GOV/PUBS



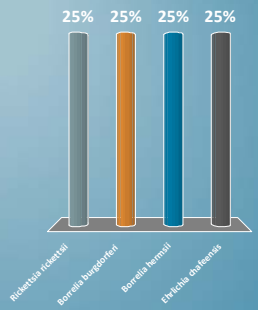


CASE 1

- 12 y. o. from Santa Cruz, CA
- Swollen painful right knee and hip
- Recurrent knee swelling & pain lasting several days every 4-5 months
- Treated with herbs instead of antimicrobials
- WBC = 7000, HCT 33%, ESR 73mm/h
- Knee aspirate: 59,000 WBCs and protein of 5 g/dL
- No growth on bacterial cultures but positive by PCR

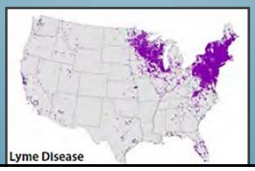
WHAT DO YOU SUSPECT IS THE PATHOGEN?

A. Rickettsia rickettsii
B. Borrelia burgdorferi
C. Borrelia hermsii
D. Ehrlichia chafeensis



LYME DISEASE

- **Most common tick-borne disease in North America**
- **Caused by *Borrelia burgdorferi***
- >21,000 cases reported during 2014
- 5th among all nationally notifiable conditions
- **90% cases occur in 12 states**
- **Tick vectors: *Ixodes scapularis***
  I. pacificus



I. SCAPULARIS I. PACIFICUS

Top 7 Notifiable Diseases United States, 2009

Rank	Disease	U.S.
1	Chlamydia	1,244,180
2	Gonorrhea	301,174
3	Salmonellosis	49,192
4	Syphillis	44,828
5	Novel influenza A	43,696
6	Lyme disease	38,468
7	AIDS	36,870

Rank	Disease	New England
1	Chlamydia	39,246
2	Lyme disease	9,205
3	Gonorrhea	5,470
4	Salmonellosis	2,244
5	Varicella	1,729
6	Giardiasis	1,660

STAGE 1: LOCALIZED INFECTION

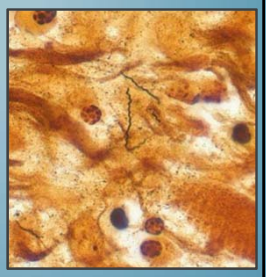
- **Erythema migrans**
- **Occurs in ~90%**
- **Begins 7-10 days after tick bite**
- **Expands over days to weeks**
- **Central clearing occurs in minority**
- **Constitutional: flu-like and lymphadenopathy**

LYME DISEASE

- **Seasonal (April-September)**
- **Low risk of disease if tick attached <36 hrs**
- **Signs/symptoms begin 7-10 days after bite (range 3-30 days)**
- **May be asymptomatic**
- **Rarely fatal**

DISSEMINATED STAGE

- **Multiple skin lesions**
- **Generalized lymphadenopathy**
- **Malaise, fatigue,**
- **5% develop cardiac involvement**
  - **Conductional abnormalities—atrio-ventricular node block**
  - **Myocarditis**
  - **Pericarditis**



DISSEMINATED: RHEUMATOLOGIC MANIFESTATIONS

- **60% untreated 20 yrs ago developed joint swelling –10%**
  - **Synovial fluid 24,000 WBC with granulocytes**
- Migratory transient intermittent arthritis and effusions
- Pain in muscles, bones, tendons, bursa
- Baker's cyst

DISSEMINATED EARLY NEUROLOGIC MANIFESTATIONS

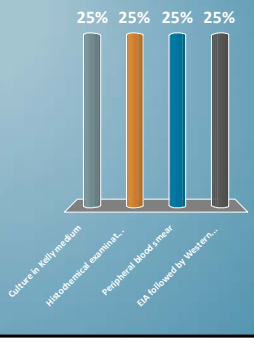
- Cranial neuropathy
  - Bell's palsy
- Meningitis-lymphocytic
- Cognitive difficulties
- Memory, mood,
- Sleep disturbances

LATE NEUROLOGICAL LYME DISEASE--RARE

- Encephalomyelitis
  - Parenchymal inflammation of brain and/or spinal cord
  - CSF= lymphocytic, mod ↑ protein, normal glucose
- Peripheral neuropathy
  - Intermittent ↓ vibratory sensation of legs and feet
- Encephalopathy
  - Memory and cognitive impairment
  - CSF normal

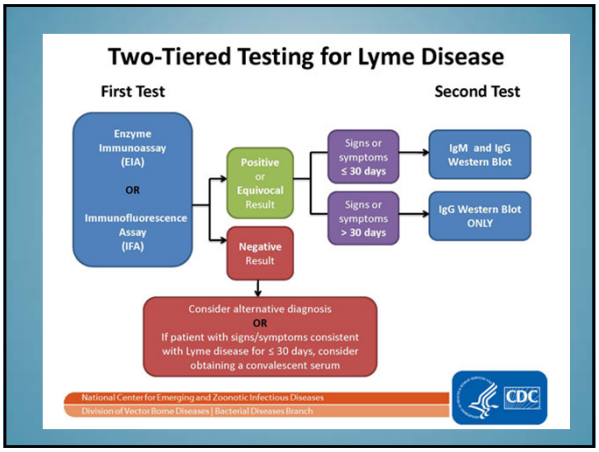
HOW IS LYME DISEASE BEST DIAGNOSED?

A. Culture in Kelly medium
B. Histochemical examination of tissue
C. Peripheral blood smear
D. EIA followed by Western blot



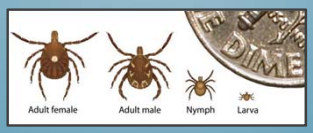
DIAGNOSIS

- **Characteristic clinical picture**
- **Serology: 2-step**
  - **1) Polyvalent ELISA: 60-70% positive by wk 4**
  - **if equivocal or +**
  - **2) Western blot (IgG and separate IgM): requires 5 of 10 bands**
- **PCR**
- **Culture: low yield (27%)**



SOUTHERN TICK-ASSOCIATED RASH ILLNESS

- Seronegative Lyme Disease
- Southern Lyme Disease
- "One of the more obtuse diseases. . ."



SOUTHERN TICK-ASSOCIATED RASH ILLNESS

- Red, expanding-3"
- 7 days of bite
- Long star tick
- Geography
- Cause unknown

AMBLYOMMA AMERICANUM

LONE STAR TICK

- Range and abundance ↑over past 20-30 years
- Large numbers in Maine and as far west as central Texas and Oklahoma
- All life stages will feed on humans—aggressive
- Feed readily on dogs and cats
- Saliva can be irritating; redness and discomfort at a bite site does not necessarily indicate an infection

CLINICAL MANIFESTATIONS

- Early Lyme Disease
  - Fatigue, headache, fever, and muscle pains
- No arthritis, neurological disease or chronic symptoms

DIAGNOSIS

- Clinically: symptoms, geographical location and tick bite
- No blood tests because don't know etiological agent

DIFFERENCE WITH LYME DISEASE

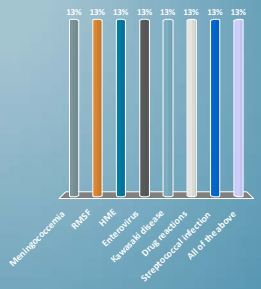
- STARI patients recall tick bite
- Time from bite to symptoms shorter
- Patients with rash less likely to have symptoms
- Smaller and fewer lesions
- More likely to have central clearing

CASE #2

- In June, 5 y.o. female
- Taken to an ED in Missouri
- 3-day history of intermittent fever, headache, mild nausea, and a sore throat
- Fever of 105˚F (40.6˚C)
- Maculopapular rash on her legs, including the soles of her feet.

WHAT SHOULD BE INCLUDED IN THE DIFFERENTIAL DIAGNOSIS?

A. Meningococcemia
B. RMSF
C. HME
D. Enterovirus
E. Kawasaki disease
F. Drug reactions
G. Streptococcal infection
H. All of the above



FURTHER INFO NEEDED

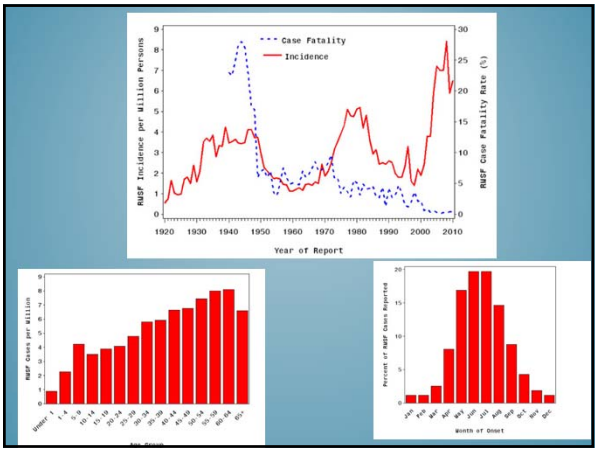
- How long has rash been there?
- Where it appeared before onset of fever?
- Medications?
- Immunocompromising conditions?
- Recent activities?
- Ill contacts?
- Travel?
- Tick exposures?

CASE CONTINUED

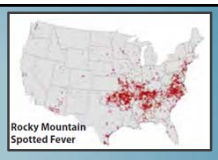
- Rash began on the arms and legs same day
- Did not own a dog
- No history of recent travel out of the local area
- No history of a tick bite but ticks in the area around their house
- 8.8 x 10^9 WBC with 5% bands, 70% neutrophils
- 50 x 10^9 platelets

ROCKY MOUNTAIN SPOTTED FEVER

- **Etiologic agent: *Rickettsia rickettsii***
- **Vectors:**
  - ***Dermacentor variabilis* (dog tick)**
  - ***D. andersoni* (wood tick)**
  - ***Amblyomma americanum* (lone star tick)**

RMSF



- 91 cases in 2014
- Spring and summer
- Incubation period: ~ 7 days (2-14)
- Abrupt onset severe HA, F/C, prostration, myalgias, nonproductive cough (later)
- GI manifestations very common
- CNS: meningitis, meningoencephalitis
- Death: 1-2 weeks after symptom onset in 4-8% (untreated)

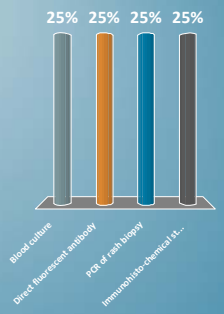
RASH

- **Macular rash develops day 2-6 (90%): wrists, ankles, palms, & soles then centrally**
- **Lesions become petechial, hemorrhagic**



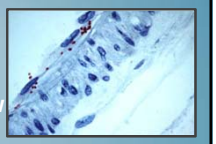
WHAT IS THE PREFERRED METHOD TO DIAGNOSE RMSF IN THE LAB?

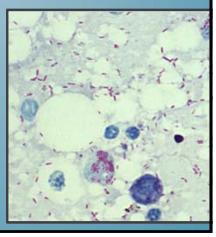
A. Blood culture
B. Direct fluorescent antibody
C. PCR of rash biopsy
D. Immunohisto-chemical staining of blood



DIAGNOSIS

- **Clinical & epidemiologic**
- **Nonspecific lab findings:**
  - **anemia, hyponatremia, low plts, ↑AST**
- **RMSF PCR from rash site is now preferred**
- **IFA: IgM +: 1-2 w but may be false +**
- **IgG +: 4-6 w**
- **Immunostaining: skin biopsy prior to therapy**





RICKETTSIA PARKERI

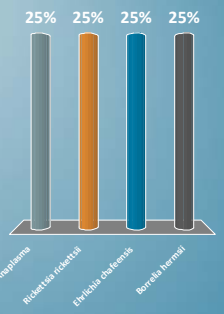
- Mild form of RMSF
- Confirmed 2002
- *Amblyomma maculatum* tick
- Cattle on Gulf Coast of Texas
- Virginia
- Antibodies cross react with RMSF

CASE 3

- Healthy 2 y.o. female southeast Missouri
- Fever 104°F, vomitting and diarrhea
- Red maculopapular rash that blanched began on cheek
- 4.9 x 10^9 WBC, 10.9 g/dL Hgb, 102 x 10^9 plt
- Hyponatremia and mildly elevated liver enzymes
- Inclusion bodies in cytoplasm of monocytes
- PCR confirmed diagnosis

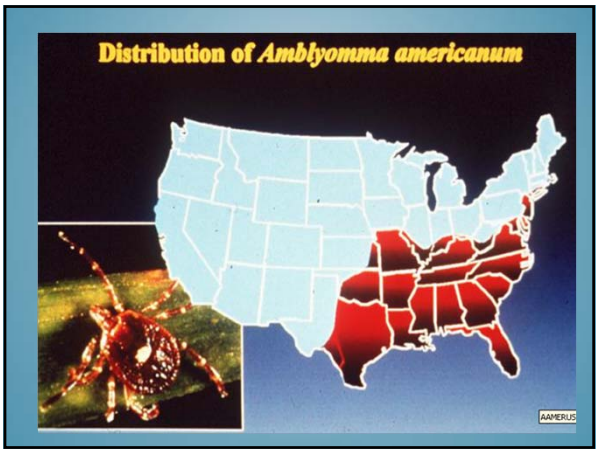
WHAT IS THE SUSPECTED PATHOGEN IN THIS CASE?

A. Anaplasma
B. Rickettsia rickettsii
C. Ehrlichia chafeensis
D. Borrelia hermsii



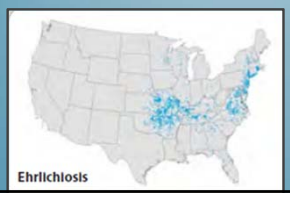
EHRLICHIOSIS

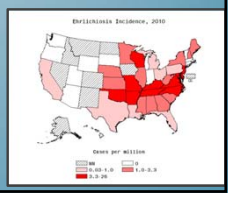
- **Obligate intracellular bacteria form distinct microcolonies called morulae**
- **Diseases:**
- **Human Monocytotropic Ehrlichiosis**
- **Human Granulotropic Anaplasmosis**
- ***E. ewingii***
- **"Rocky Mountain Spotless Fever"**
- *Ehrlichia muris*-like (EML)—MN & **WI**

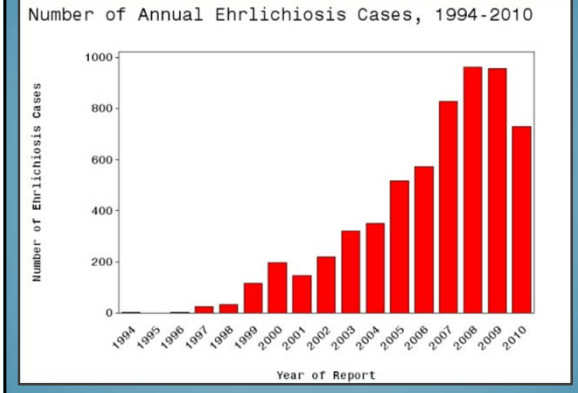


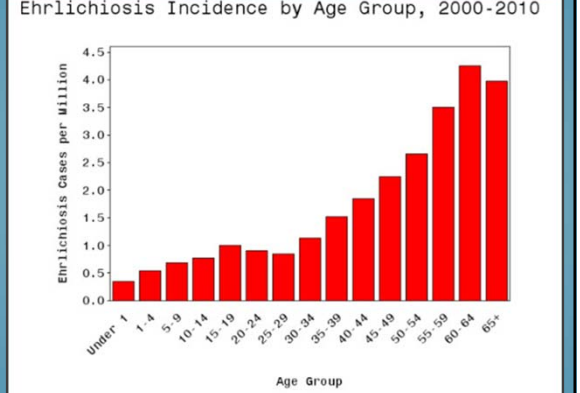
EHRLICHIOSIS

- Southeastern and south-central US
- Lone star tick
- OK, MO, AR 35% cases
- *Ehrlichia* muris-like in upper midwest
- 966 reported case in 2014









SIGNS AND SYMPTOMS

- Fever, headache
- Chills, malaise
- Muscle pain
- Nausea, diarrhea, anorexia
- Confusion
- Conjuctival injection
- Rash—more common in children

BLOOD TRANFUSION AND ORGAN TRANSPLANTATION

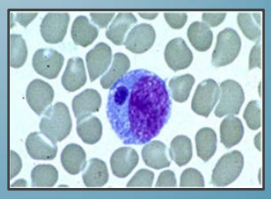
- Survive for > 1week in refrigerated blood
- Leukoreduced blood
- Infected within 1 mo
- No cases confirmed by organ transplantation

GENERAL LAB FINDINGS

- **Anemia**
- **Leukopenia**
- **Thrombocytopenia**
- **Elevated AST**
- **Elevated ALT**
- **Morulae detected in 20%**

LABORATORY DIAGNOSIS

- **Serology (IFA)**
  - **Negative in first 7-10 days**
  - **Minimum peak of 1:80**
  - **Fourfold change**
  - **Positive: week 3**
  - **Peak: week 6**
  - **Cross-reactivity**
- **PCR**



LABORATORY DIAGNOSIS

- Antibody titer to *Ehrlichia chaffeensis* antigen by IFA in paired serum samples
- PCR
- Identification of morulae in leukocytes and a positive IFA titer
- Immunostaining of *E. chaffeensis* antigen in a biopsy or autopsy sample
- Culture from a clinical specimen

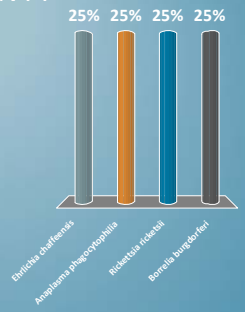
IF MORULAE WERE SEEN IN SEGMENTED NEUTROPHILS, WHAT WOULD BE THE AGENT?

A. Ehrlichia chaffeensis

B. Anaplasma phagocytophilia

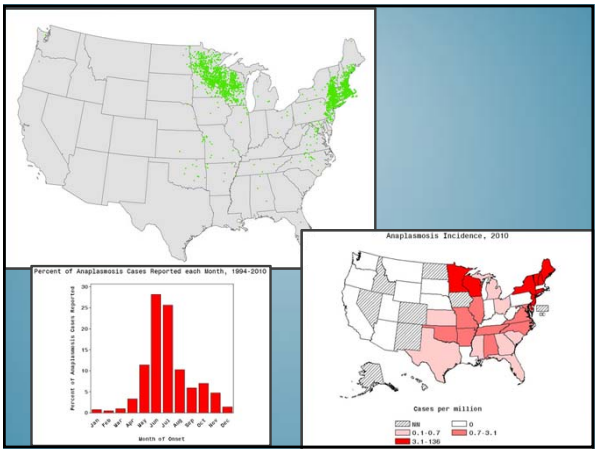
C. Rickettsia ricketsii

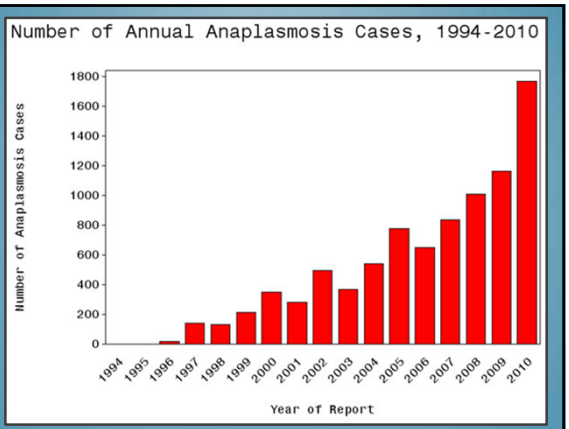
D. Borrelia burgdorferi

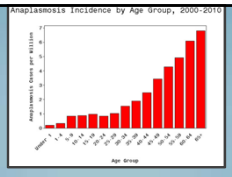


ANAPLASMA PHAGOCYTOPHILUM

- Human granulocytotropic ehrlichiosis
- Fever, shaking chills
- Severe headache
- Malaise, myalgia
- Nausea, vomiting, diarrhea, anorexia
- Cough
- Mild self-limiting in most
- Fatal if advanced age or immunosuppressed, malignancy or chronic inflammatory
- Rash 60% children; 30% adults
- More likely to have morulae







- Persons aged >70 and 60–69 years
- <1% fatality
- *Ixodes scapularis* and *Ixodes pacificus* (blacklegged ticks)
- New England, North Central and Pacific states

LABORATORY DIAGNOSIS

- IgG antibody titer by IFA in paired serum samples (first week and 2-4 weeks later)
- Positive PCR whole blood in 1st week and confirmation
- Identification of morulae in leukocytes and a positive IFA titer
- Immunostaining in a biopsy or autopsy sample
- Culture of *A. phagocytophilum* from a clinical specimen in HL60 cells
- Consider coinfection with *Babesia* or *B. burgdorferi*

EHRLICHIA EWINGII

- Canine granulocytotropic ehrlichiosis
- 20 human cases
- Vector: *A. americanum*
- First 4 cases of human infection reported July, 1999
- Immunocompromised patients from Missouri, Oklahoma, and Tennessee
- Antigenic similarity to *E. chaffeensis and E. canis*
- Infects granulocytes

EHRLICHIA MURIS-LIKE OR EML

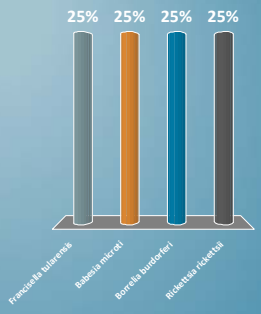
- *Ixodes scapularis ?*
- 1-2 weeks after bite
- Minnesota, Wisconsin
- Fever, malaise, headache, lymphopenia
- Thrombocytopenia, ↑ liver enzymes
- *E. muris* Japan and Russia
- PCR test of choice

CASE 4

- In June, woman attempted to take dead rabbit from her dog
- Her thumb had a splinter and became infected
- Lesion developed
- In 7 days
  - Fever of 104ºF

THE MOST LIKELY PATHOGEN IN THIS CASE IS:

A. Francisella tularensis
B. Babesia microti
C. Borrelia burdorferi
D. Rickettsia rickettsii

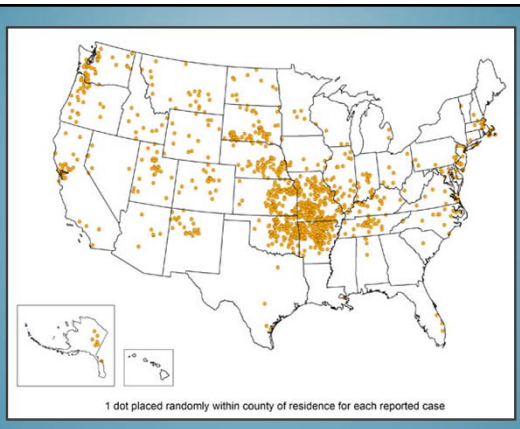


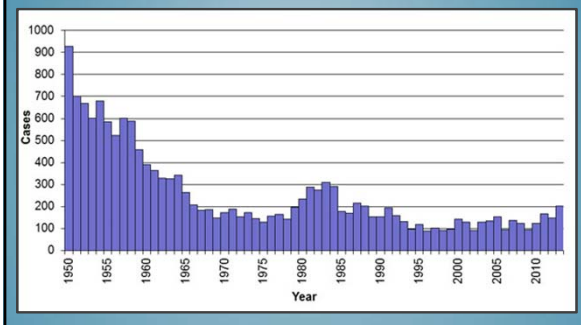
TULAREMIA

- **Causative agent: *Francisella tularensis***
- **Small, gram-negative coccobacillus**
- **Tick bites account for > 50% cases**

VECTORS

- > 12 tick species
  - *A. americanum, D. variabilis, D. andersoni*
- Deer flies
- Skin contact with infected animals
- Drinking contaminated water
- Aerosol
- No person to person
- June-September and December





CLINICAL MANIFESTATIONS

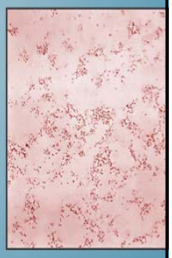
- Depends on route of infection
- Ulceroglandular—most common
  - Skin ulcer at entry site
  - Enlarged lymph glands armpit or groin
- Glandular—like ulceroglandular without the ulcer
- Oculoglandular—enter eye
- Oropharyngeal—eating or drinking contaminated food or water
- Pneumonic—most serious from aerosols

GENERAL LABORATORY FINDINGS

- **Leukocytosis**
- **Thrombocytopenia**
- **Elevated sedimentation rate**
- **Elevated ALT/AST**
- **Sterile pyuria in 20-35%**

LABORATORY DIAGNOSIS

- Alert laboratory—potential for lab exposure
- Culture
  - Skin lesions, lymph node aspirates, pharyngeal washings, sputum
- DFA
- PCR
- Immunohistochemical staining



CASE 5

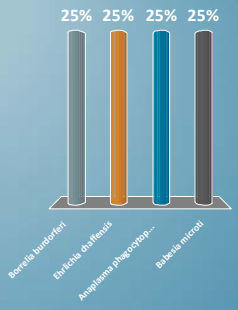
- I mo. old infant from Massachusettes
- Fussy, pale, warm skin, and vomiting
- 38.6ºC; tachycardia
- Poor perfusion
- Splenomegaly
- Pulmonary edema

LABORATORY STUDIES

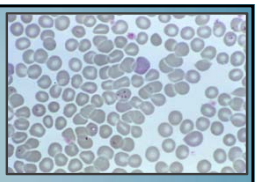
- Hemolytic anemia, thrombocytopenia, ↑ALT
- Other chemistry tests normal
- UA- dark red, cloudy, pH of 7.0, specific gravity of 1.015, a large amount of blood, 100 mg per deciliter of protein, and trace leukocyte esterase
- Microscopic 0 to 5 red cells and white cells/HPF,15 to 20 granular casts/LPF
- Normal CSF

AFTER RULING OUT A BACTERIAL INFECTION, WHAT IS THE CAUSE?

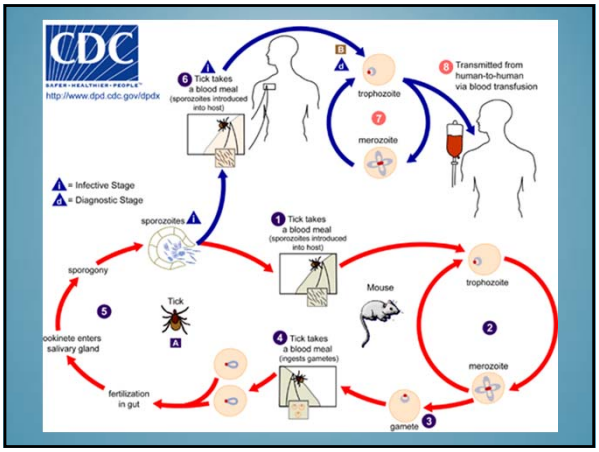
A. Borrelia burdorferi
B. Ehrlichia chaffensis
C. Anaplasma phagocytophilum
D. Babesia microti



BABESIOSIS



- Intraerythrocytic parasite
- *Babesia microti* transmitted by *I. scapularis*
- *B. divergens*—splenectomized Europe
- *B. duncani*—WA, CA
- Currently unnamed strain designated MO-1--Missouri

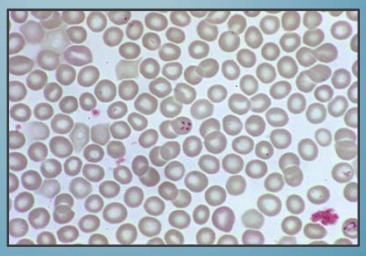


CLINICAL MANIFESTATIONS

- Asymptomatic 25-50%
- Fatal
- Fever, chills, sweats, myalgia, arthralgia
- Anorexia, nausea, vomiting
- Fatigue
- Splenomegaly, hepatomegaly, jaundice

AT RISK

- Asplenic
- Malignancy
- HIV
- >50 y.o.



SEVERE CASES

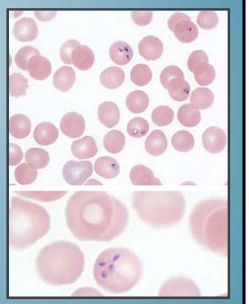
- Marked thrombocytopenia
- DIC
- Hemodynamic instability
- Renal failure
- Compromised liver
- Acute respiratory failure
- Altered mental status
- Coma
- Death

COINFECTION

- Lyme disease
- Anaplasmosis
- Ehrlichiosis
- RMSF
- Infected by tickbite or congenitally
- Mother visited island off coast of MA and incidence is 100 times higher than mainland

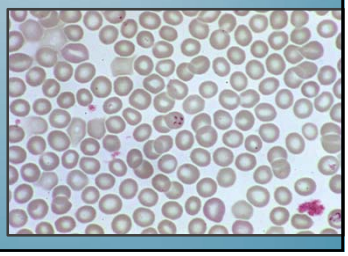
LABORATORY

- Hemolytic anemia ↑ retic
- Thrombocytemia
- Proteinuria
- ↑ liver enzymes, BUN, Creatinine
- Parasitemia of 10%



LABORATORY DIAGNOSIS

- ID on Giemsa stained blood smears
  - Multiple smears
  - Multiple rings
  - Maltese cross
- IgG IFA
- PCR



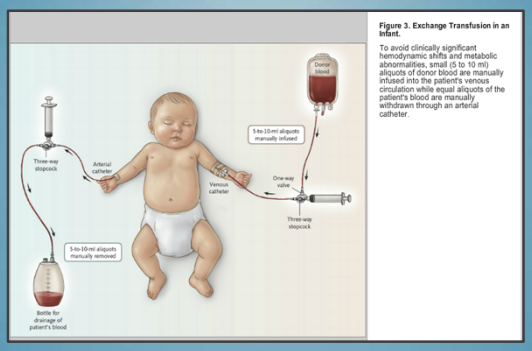


Figure 3. Exchange Transfusion in an Infant.

To avoid clinically significant hemodynamic shifts and metabolic abnormalities, small (5 to 10 ml) aliquots of donor blood are manually infused into the patient's venous circulation while equal aliquots of the patient's blood are manually withdrawn through an arterial catheter.

CONGENITAL BABESIOSIS

- Rare: 5 infants
- Mother may be asymptomatic but have high titer
- Symptoms begin 19-41 days after birth
- Parasitemia of 2-15%
- All received transfusion for anemia

Table 2. Additional Test Results.*

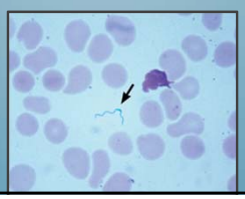
Sample	Test	Result
Patient		
Blood collected after partial exchange transfusion	*Babesia microti* antibody titer	Positive at 1:1024
Blood	PCR for *Anaplasma phagocytophilum*	Negative
Blood	PCR for ehrlichia	Negative
Blood	IgM and IgG antibodies against borrelia	Negative
Dried blood spot collected at birth	PCR for babesia	Negative
Placental tissue collected at birth	Immunohistochemical staining for babesia	Negative
Placental tissue collected at birth	PCR for babesia	Negative
Patient's twin		
Blood	*B. microti* antibody titer	Positive at 1:4096
Blood collected at the time of the patient's diagnosis	PCR for babesia	Negative
Dried blood spot collected at birth	PCR for babesia	Negative
Patient's mother		
Blood	*B. microti* antibody titer	Positive at 1:4096
Blood collected at the time of the patient's diagnosis	PCR for babesia	Negative

CASE 6

- 60 y. o. man Boise, ID
- 1 month history of intermittent fevers and headache
- 105ºF with 3 –day headache
- 2nd fever 13 days later lasted 2 days
- 3rd fever 26 days later
- Camped in Bear Valley region of Idaho

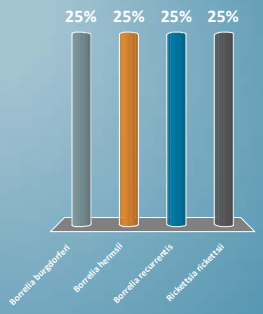
CASE 6 CONTINUED

- CBC normal with 81% segs, 6% lymphs, 3.37% retics
- UA: protein 1+
- ↑ bilirubin
- Giemsa-stained blood smear



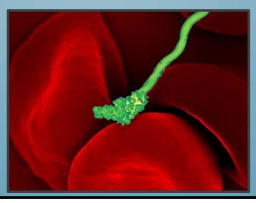
WHAT IS THE MOST LIKELY PATHOGEN INFECTING THIS MAN?

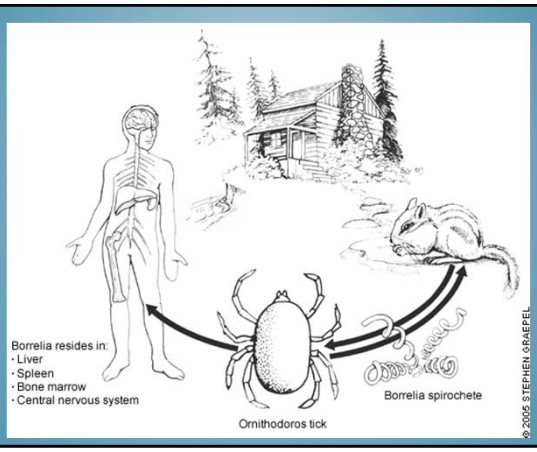
A. Borrelia burgdorferi
B. Borrelia hermsii
C. Borrelia recurrentis
D. Rickettsia rickettsii



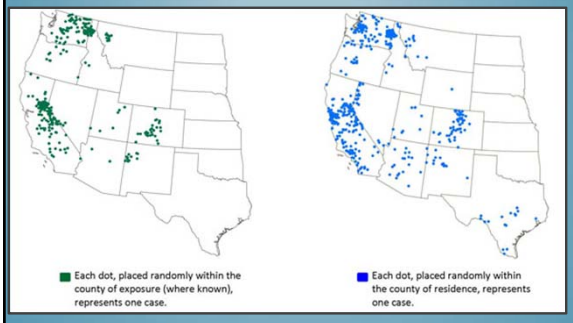
TICKBORNE RELAPSING FEVER

- *B. hermsii* most common cause
- Soft tick: *Onithodoros hermsi*
- Transmission brief nighttime feed
- Overnight stay in rodent infected dwellings >2000 feet elevation





1990-2011



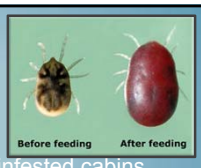
County of Exposure

County of residence

TBRF

- *Ornithodoros hermsi* prefers coniferous forests at altitudes of 1500 to 8000 feet
- Feeds on tree squirrels and chipmunks
- *O. turicata,* found at lower altitudes in Southwest
  - cattle, rodents, pigs, snakes, tortoises, and possibly coyotes

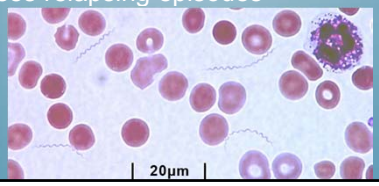
TBRF



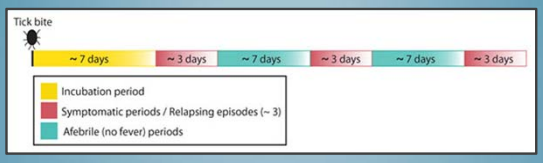
- Most cases in summer
- Vacationers sleep in rodent-infested cabins
- Fires to warm cabins sufficient to activate ticks in winter
- 70% of all reported TBRF cases (CA 33%, WA 25%, and CO 11%)
- Bite of soft ticks brief, < 30 min.
- Soft ticks do not search for prey in tall grass or brush
- Live within rodent burrows or cabins
- Painless so unaware of being bitten

TICK BORNE *BORRELIA*

- DNA rearrangement
- Periodically change molecules on their outer surface--antigenic variation
- Allows evasion of host immune system
- Causes relapsing episodes



SYMPTOMS



- Fever lasting several days
- Interval without fever
- Episode of fever
- 1-4 times
- Body, muscle, joint and headache
- Nausea, vomiting, anorexia

GENERAL LABORATORY VALUES

- Mild leukocytosis
- Elevated erythrocyte sedimentation rate
- Anemia
- Thrombocytopenia (i.e., ≥ 50,000 platelets per mm^3)
- ↑ serum unconjugated bilirubin levels
- ↑ aminotransferase levels
- Prolonged PT and PTT
- Proteinuria
- Microhematuria

LABORATORY DIAGNOSIS

- Observation of spirochetes in a blood smear taken during a febrile episode
- Stained with Wright-Giemsa stain or examined with dark field microscopy
- Testing for serum antibodies not valuable in acute setting
- IFA might be useful for convalescent patients
- PCR

BORRELIA MIYAMOTOI SENSU LATO

- Relapsing fever Borrelia sp.
- Same ticks (*I. scapularis*) that transmit *B. burgdorferi* and occurs in all Lyme disease-endemic areas of U.S.
- Common in Southern New England
- Northern California--prevalence of B. miyamotoi sensu lato in ticks equals or exceeds the prevalence of B. burgdorferi
- 1/3 of the cases of Lyme Disease

B. MIYAMOTOI SENSU LATO

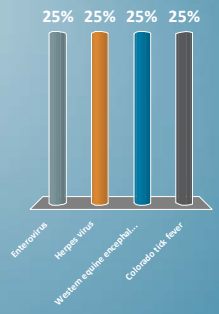
- Of 5 patients testing positive, 4 were co-infected with Lyme disease
- 1 also co-infected with babesiosis
- All 5 patients had fever, but no relapsing fever pattern
- *52 residents residing in southern New England or New York State during 1991– 2012tested positive*

CASE 7

- Healthy 49-year-old man from Manhattan with fever and malaise
- 3 days after returning from horseback trip on Western slope of Rocky Mountains
- Removed 4 ticks from his body
- Reported chills, fever and severe myalgias
- Symptoms resolved but recurred 2 days later
- 38.1°C, conjunctivitis and sore throat
- 2.0 x 10^9 WBC
- Neutralizing antibody undetectable in acute serum but 1:40 in convalescent serum

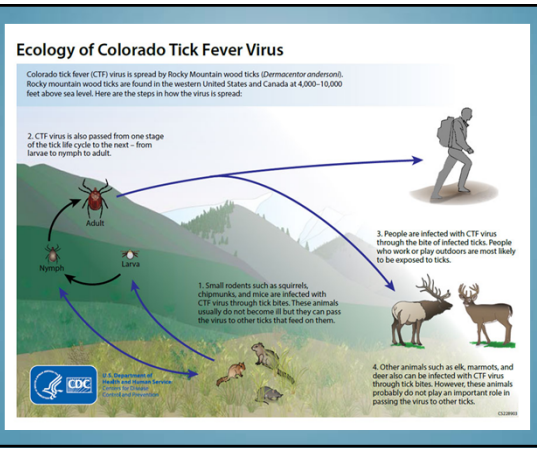
IF THIS IS A VIRAL ILLNESS, WHAT VIRUS IS IT LIKELY TO BE?

A. Enterovirus
B. Herpes virus
C. Western equine encephalitis
D. Colorado tick fever

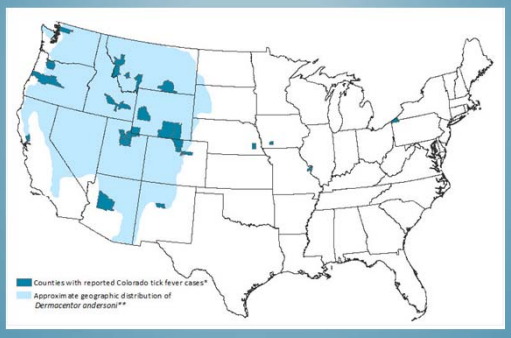


COLORADO TICK FEVER

- Vector: *Dermacentor andersoni*-- Rocky mountain wood tick
- RNA Coltivirus intraerythrocytic orbivirus
- Reservoirs: small mammals
- Western U.S. 4,000-10,500 feet
- 83 cases reported 2002-2012 but only 6 states require reporting—voluntary in others



COLORADO TICK FEVER



COLORADO TICK FEVER

- 3-4 days and up to 2 weeks after tick bite
- Typical flu-like illness
  - Sore throat
  - Vomiting
  - Lymphadenopathy
  - 5-16% rash
- Biphasic especially in adult > 30 years
  - Remit after 2-4 days and reoccur 1-3 days later
- Prolonged convalescence
- Rarely death or menigoencephalitis in children

LABORATORY FINDINGS

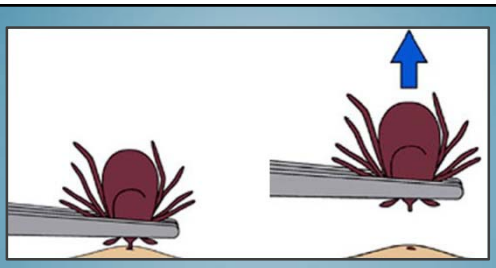
- Leukopenia with relative lymphocytosis (2000-4000)
  - Atypical lymphs
- Thrombocytopenia (20,000-60,000)
- Viral culture of blood
- IgM IFA of peripheral blood
- Neutralizing antibodies
- RT-PCR
- State Health Departments

PREVENTION OF TICK BITES

- Avoid wooded and brushy areas with high grass and leaf litter.
- Walk in the center of trails.
- Use repellents that contain 20 to 30% DEET (N, N-diethyl-m-toluamide) on exposed skin and clothing
- Permethrin on clothing--treat clothing and gear, such as boots, pants, socks and tents with products containing 0.5% permethrin
  - It remains protective through several washings
  - Pre-treated clothing is available and may be protective longer

FIND AND REMOVE TICKS

- Bathe or shower as soon as possible (preferably within two hours) to wash off and find ticks
- Conduct a full-body tick check using a hand-held or full-length
- Parents should check children for ticks under the arms, in and around the ears, inside the belly button, behind the knees, between the legs, around the waist, and especially in their hair.
- Examine gear and pets
- Tumble clothes in a dryer on high heat for an hour



- Use fine-tipped tweezers to grasp the tick as close to the skin's surface as possible
- Pull upward with steady, even pressure
- Don't twist or jerk the tick

HOW TO REMOVE A TICK

- Thoroughly clean bite area and your hands with rubbing alcohol, iodine scrub, or soap and water
- Dispose of a live tick by submersing it in alcohol, placing it in a sealed bag/container, wrapping it tightly in tape, or flushing it down the toilet
- Never crush a tick with your fingers