THE MENTOR INITIATIVE

DEVO TED TO REDUCING MALARIA DEATHS & SUFFERING IN HUMANITARIAN CRises
Ticks as Vectors
and
African Tick Bite Fever

Alex Heaney
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Lesson Summary

1. Ticks as Disease Vectors

2. African Tick Bite Fever
Ticks

- Arthropoda
  - 2 types of ticks that are vectors for human disease
    - Hard ticks (Ixodidae class)
    - soft ticks (Argasidae class)

Picture Credit: www.floridahealth.com
Connecting to a Host

- Questing: ticks feed by perching in low vegetation and waiting for a mammal to walk by

Photo Credit: Local Public Health Institute of Massachusetts
http://www.masslocalinstitute.org
Connecting to a Host

- Questing
- Ticks use chemical stimuli, airborne vibrations, and body temperatures to locate mammals

Photo Credit: Local Public Health Institute of Massachusetts
http://www.masslocalinstitute.org
Ticks as Disease Vectors

- transmit a greater variety of pathogenic microorganisms than any other arthropod vector group

- Bacteria/virus/protozoa in saliva of tick
  - Injected during a blood meal

Photo Credit: Lyme Disease Action
http://www.lymediseaseaction.org.uk/about-ticks/tick-animation/
Ticks as Disease Vectors

- Hypostoma attaches to the host’s skin using hooks

Photo by Larisa Vredevoe, UC. Davis

Picture from (Parola, 2001)
Ticks as Disease Vectors

Substances secreted into skin

- Cementing substance
  - Glues the hypostoma in place
- Immunosuppressive, Anti-inflammatory chemicals
  - Helps the tick go unnoticed by the host
- Anticoagulant
  - Allows blood to go where it needs to go in the body

All help the pathogen to establish a foothold in the host
Epidemiology of Tick Borne Diseases

Ticks are second only to mosquitoes as vectors of human infectious disease throughout the world.
Epidemiology of Tick Borne Diseases in US

- Recent dramatic increase in prevalence

![Disease Comparisons - GIDEON](image_url)
Epidemiology of Tick Borne Diseases in US

- Recent dramatic increase in prevalence
- Prevalence varies within differing populations

**FIGURE 3** Annual incidence rates of Rocky Mountain spotted fever, per 1 million population, among American Indians, and the total U.S. population, 1992-2005 (Holman et al., 2009).
Epidemiology of Tick Borne Diseases in US

• Possible explanations of increase in prevalence:
  – warming temperatures/increasing humidity
  – residential development in preferred tick ecosystems
  – Increased contact between ticks and humans
  – more competent tick vectors
  – international trade and travel distributing tick vectors and their preferred animal hosts
FIGURE 6 Hypothetical explanation for the usurge in cases of tick-borne encephalitis in Estonia, Latvia, and Lithuania, following the end of Soviet rule (Šumilo et al., 2007)
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# Diseases Carried by Ticks

## Diseases:
- Anaplasmosis
- Ehrlichiosis
- Lyme Disease
- Rickettsiosis
- Rocky Mountain Spotted Fever
- Southern Tick-Associated Rash Illness
- Tickborne relapsing fever
- Tularemia
- African Tick Bite Fever
- 364D Rickettsiosis
- Meningoencephalitis
- Colorado tick fever
- Crimean
- Congo hemorrhagic fever
- Babesiosis
- Cytauxziinosis

## Bacteria
- Anaplasma phagocytophilum
- Ehrlichia
- Borrelia burgdorferi
- Rickettsiae
- Borellia
- spirochetes
- Francisella tularensis

## Virus
- TBEV virus
- CTF virus
- CCHF virus

## Protozoa
- Babesia microti
- C. Felis
Diseases Carried by Ticks

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**Bacteria**
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- *Francisella tularensis*

**Virus**
- *TBEV virus*
- *CTF virus*
- *CCHF virus*

**Protozoa**
- *Babesia microti*
- *C. Felis*
African Tick Bite Fever

- **Vector:** *Amblyomma hebraeum* and *A. variegatum* ticks
- **Bacteria:** *Rickettsia africae* and *Rickettsia parkeri*
  - Thrive in tick salivary glands
  - Multiply in tick salivary glands and ovaries of tick
  - Once injected in host, initially spread via lymphatics, then travels to vascular endothelial lining cells of CNS, lungs, and myocardium
Epidemiology *Amblyomma hebraeum*

Endemic African Countries

Prevalence of *A. hebraeum* Tick

*THE MENTOR initiative*

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Epidemiology

• Not many cases reported within endemic countries
  – People in endemic countries are infected at a younger age
    • At this age, disease is not serious enough to warrant medical attention
  – Misdiagnosed as malaria

Photo credit: http://www.grida.no/publications/vg/africa/page/3119.aspx
A Case Study (France)

- Patient: 69 year old white man
- History: had just returned from a 6 day trip to Zimbabwe
  - Had visited farms and other rural areas
- Admitted with a fever
- Signs/Symptoms:
  - multiple eschars on the right leg
  - headaches, dry cough, nausea, chills, back pain, dysphagia
  - lymphangitis and edema of the right leg
Clinical Presentation

- Symptoms start 1-2 weeks after infection
- Rash and/or eschar at site of tick bite
  - Rash starts on wrists/ankles and spreads to the limbs
- Enlarged lymph nodes near eschar

Photo by Mark Wise, Travel Clinic
Clinical Presentation

• fever, headache, nausea, malaise, vomiting, abdominal pain

• Severe problems
  – Vascular epithelial cell damage by microbial replication
  – Vascular inflammation
  – Pulmonary edema
  – Distal, digital skin necrosis
Diagnostic Challenges

• Clinical Presentation similar for many different *rickettsiae* infections
  – tick bites, eschars, rash, painful regional lymphadenopathy

• Antibody-based laboratory techniques are not sufficient
  – *Rickettsiae* bacteria all cause similar immune responses in humans

• Can be misdiagnosed as Malaria
Preferred Diagnostic Techniques

Sample: Swab or skin biopsy from rash or eschar

• PCR test
  – Also possible with blood sample

• Immunohistochemical detection

• Culture isolation
Treatment

- Doxycycline
  - 200 mg/day
  - 3-14 days
Personal Methods of Prevention

• Body be checked every few hours for ticks

• diethyl-3-methylbenzamide (DEET) and KBR 3023 lotions
Large Scale Preventative Strategies

• Deforestation or agricultural activities disrupt tick lifecycle

• Insecticides
  – Negative impact on environment
  – Ex. Amitraz, Decamethrin

• Tail tags

Picture credits: UC Davis Veterinary School (top) and http://www.agric.wa.gov.au/PC_93608.html (bottom)
Ticks as Disease Vectors Summary

- Anthropoda phyla of animal parasites
  - hard ticks and soft ticks transmit human diseases
- Hard tick life cycles can include 1-3 feeding hosts, and humans are at risk of becoming an "accidental host" during feeding periods in the lifecycle
- Ticks use methods such as questing, chemical stimuli, and summoning signals to find a host
- Ticks transmit Bacteria/virus/protozoa during blood meals by secreting saliva (containing the pathogen) into the host
- Increasing reports of occurrence in tick borne diseases are due to changing environmental factors and growing disease recognition
African Tick Bite Fever Summary (1 of 2)

- **Vector:** *Amblyomma hebraeum* and *A. variegatum* ticks
- **Bacteria:** *Rickettsia africae* and *Rickettsia parkeri*
- **Epidemiology**
  - Mainly endemic to Sub-Saharan Africa, but some endemicity in Caribbean and Americas
  - Mainly a "traveler disease" - few reported cases in endemic countries
- **Clinical Presentation**
  - Rash, eschar, lymphangitis, fever, rare severe complications
- **Diagnosis**
  - Challenges in distinguishing it from other Rickettsial and febrile diseases
  - Use PCR, Immunohistochemical detection, culture isolation on skin biopsy
• Treatment
  – Doxycycline

• Control Methods
  – Mainly personal prevention like DEET/KBR lotions
  – Some larger interventions like deforestation, insecticides, and tail tags

• If epidemic were to occur, obstacles for control would be lack of diagnostic tools and lack of large scale control methods
Questions??
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