The Spread of Vector-Borne Diseases – Our Responsibility

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Spread of VBDs in the Modern World

Drivers of global change and their potential relation to VBD spread

Humans are primarily responsible for these changes

The 3rd Plague Pandemic
- An Early “Modern” Example of VBD Spread -

- Extremely virulent, frequently fatal flea-borne disease
- Two previous historically important pandemics
- Began with outbreaks in SW China in 1850s
- Reached Chinese coast in 1894
- Plague carried aboard rat-infested ships
- Spread to world’s ports over next three decades
- Caused millions of deaths in India and hundreds of thousands elsewhere
- Post-World War II advances in vector control and antibiotic therapy provided means for control
- No commercially available vaccine
The 3rd Plague Pandemic - An Early “Modern” Example of VBD Spread -

- The disease spread to many areas that were previously plague-free
- Some areas had susceptible rodent and competent vectors
- Establishment of new plague foci that persisted
- Ongoing sources of human infection (example, Algeria)
- Risks worst in poverty stricken, rat-infested rural areas

Achtman, et. al., 1999. PNAS 96:14043-14048
Current Status of Plague

- Currently endemic in Asia, Africa, and the Americas
- Surveillance is poor and cases are underreported
- 3,248 cases reported from 2010-2015 with 584 deaths
- Significant outbreaks still occur in developing countries with endemic foci
- 96% of cases reported to WHO from 2010-2015 were from Africa
- Re-emergence from old foci
- Poverty and rat infestations
Regional Spread of Vector-Borne Diseases
- Many Examples -

- Tick-borne diseases
  - Lyme disease
  - Ehrlichiosis
  - Anaplasmosis
  - Babesiosis
  - Tick-borne encephalitis
- Malaria
- Japanese Encephalitis
- Crimean Congo Hemorrhagic Fever

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Regional Spread of VBDs
- Diseases transmitted by *Ixodes scapularis*

- Lyme disease
- Anaplasmosis
- Babesiosis
- TBDs associated with blacklegged ticks increasingly noticed in 1970s, 80s and 90s
- Humans largely responsible for this re-emergence
Regional Spread of VBDs  
- *I. scapularis*-transmitted diseases -

- Linked to reforestation of abandoned farm lands
- Deer populations recover and provide hosts for adult ticks
- Human homes spread throughout reforested areas
- Deer populations very high in suburban areas
- Densities of questing infected nymphs also high in these areas

**County status for *Ixodes scapularis***

- Established
- Reported
- No records

Up to 1996 (Dennis et al. 1998)

Up to 2015 (RJ Eisen et al. 2016)
Prevention and Control of TBDs

- Human vaccines (None)
- Rapid diagnosis and treatment of cases
- Surveillance
- Personal protective measures
  - Avoid tick-infested areas if possible
  - Repellents
  - Permethrin-treated clothing
  - Tick checks

Risk of human infection greatest in late spring and summer
Prevention and Control of TBDs

- Landscape management
  - Remove tall grass and brush near homes
  - Woodchip barriers
  - Plant deer resistant plants
- Acaricides
  - Host-targeted
  - Area-wide acaricide treatments
  - Treating adult deer
- Vaccination of reservoir hosts

Spread of Mosquito-Borne Diseases
- Arboviral Diseases -

- Zoonotic mosquito-borne diseases
  - West Nile Virus – related illnesses
  - SLE, WEE, EEE

- Arboviral diseases with humans as major hosts
  - Malaria
  - Dengue
  - Chikungunya
  - Zika

Aedes aegypti
Aedes albopictus
Spread of WNV in U.S.

- First appeared in Western Hemisphere in New York in 1999
- Thousands of cases
- Spread to Latin American Countries but similar outbreaks did not occur
- Birds are important amplifying host and quickly spread infection
- Culex mosquitoes are the major vectors
- No vaccine; neurological disease can be severe
Spread of WNV in U.S.

Primary WNV Vectors by Region

North – Culex pipiens

West – Culex tarsalis

South – Culex quinquefasciatus
Dengue

- Emerging/Re-emerging disease
- Caused sporadic outbreaks in the tropics in 1800s
- 30-fold increase in cases over past 30 years
- World’s most important mosquito-borne viral disease
Dengue

- 50 million infections annually
- 500,000 cases of DHF
- 22,000 deaths
- Estimated 2.5 billion at risk

Laboratory-Confirmed DHF in the Americas
Prior to 1981 vs. 1981-2003

Source: WHO, PAHO, CDC
Countries and Territories Reporting Chikungunya Cases (Oct. 20, 2015)

Cases did not appear in the Americas until late 2013
Zika Virus

- First discovered in Uganda’s Zika Forest in 1947
- Prior to 2015 outbreaks had occurred in areas of Africa, SE Asia and some Pacific Islands

Known Zika Outbreaks: 1947-2007

2009 Uganda Site Visit for CDC/DVBD and UVRI Collaborative Studies
Zika Outbreak in the Americas

- In May 2015 PAHO issues alert of Zika infections in Brazil
- Outbreaks underway in many western hemisphere countries
- Will continue to spread but the final extent of the Zika invasion is difficult to predict
- Humans responsible for this spread
  - Urbanization
  - Poverty
  - Lack of vector control
Aedes aegypti

Vector of viruses causing dengue, yellow fever, chikungunya and Zika virus disease

Wide distribution in subtropics and tropics

Unique biology – Unique control challenges & opportunities
• Close association with humans and human dwellings
• Females often rest and feed indoors (Day biter)
• Container breeding mosquito

http://gamapserver.who.int/mapLibrary/Files/Maps/Global_DengueTransmission_ITHRiskMap.png
PAHO’s/Soper’s campaign against Aedes aegypti in the Americas

The campaign (1940’s-1960’s)
- Paramilitary, vertical campaign
- House-to-house inspection
- Strong focus on larviciding and source reduction
- Ultimate lack of sustainability

Could it work broadly again today for Ae. aegypti in the Americas?
- Uncontrolled urbanization with poor sanitation services
- Greater diversity of container habitats in today’s throw-away society
- Insecticide resistance
- Political will & Public acceptance
- Work intensive, costly and intrusive
Control and Prevention of Aedes aegypti-borne Diseases

Recently in the American Tropics?

Mosquitoes spread Dengue, Chikungunya, Zika, and other diseases.

Watch for fever with, muscle, or eye pain, or a rash in the next 2 weeks.

If you get sick, see a doctor. Tell the doctor where you traveled.

No vaccines available.

For more information, visit www.cdc.gov/travel
Control and Prevention of Aedes aegypti-borne Diseases

GOING TO THE AMERICAN TROPICS?

MOSQUITOES spread DENGUE, CHIKUNGUNYA, ZIKA, and other diseases

Mosquitoes bite day and night. Prevent mosquito bites:
- Use insect repellent
- Use air conditioning or window/door screens
- Wear long-sleeved shirts and long pants

DON’T LET MOSQUITOES RUIN YOUR TRIP

For more information, visit www.cdc.gov/travel
Integrated Vector Management - Aedes aegypti -

- Source reduction (Eliminate container breeding sites)
- Indoor Sprays to kill adults
- Bednets to prevent mosquitoes acquiring infections from sick patients
- Ultra-low volume fogging to kill adults (Early morning to late evening)
- Larvicides if source reduction inadequate
- Other control methods (Wolhlabachia, etc.
- Monitor resistance
Conclusions

- VBDs are rapidly emerging and can cause severe illness
- Vaccines rarely available
- Human activities contribute to VBD spread
- Trade and travel move vectors, hosts and pathogens
- Land use changes, agricultural practices, urbanization, climate change, etc. contribute to spread
- The above factors can create suitable environments for vectors and non-human hosts of disease vectors
- Drought, famine, political unrest, economic opportunities can bring susceptible people into contact with VBDs
- VBD programs can be expensive and hard to sustain in non-outbreak periods