Dengue in the Southeastern United States

Gary G. Clark, Ph.D.
Mosquito and Fly Research Unit
CMAVE, ARS, USDA
Gainesville, Florida
Dengue

• Among the most important re-emerging infectious diseases in the world
  • 50 to 100 million cases annually
  • 500,000 hospitalizations
  • 22,000 deaths (mostly children); therapy has greatly reduced case-fatality rates
  • Occurs in explosive epidemics that paralyze communities and nations

• Most important arboviral disease of humans
World distribution of dengue 2009

- Areas infested with *Aedes aegypti*
- Areas with *Ae. aegypti* and recent dengue epidemics
Dengue virus

- Arbovirus; transmitted by mosquitoes
- Four virus serotypes (DEN-1, 2, 3, 4)
- Causes **dengue** (headache, fever, joint/retroorbital pain, rash, bleeding) and **dengue hemorrhagic fever (DHF)** (severe abdominal pain; bleeding from the nose, mouth, and gums; frequent vomiting; black stools; excessive thirst; and pale, cold skin)
Dengue viruses

- Each serotype provides specific lifetime immunity but only short-term cross-immunity
- All serotypes can cause severe and fatal disease
- Genetic variation within serotypes; some appear to be more virulent or have greater epidemic potential
Transmission of dengue virus by *Aedes aegypti*

- **Viremia**
  - Mosquito feeds / acquires virus
  - Extrinsic incubation period
  - Illness

  **Human #1**

- **Viremia**
  - Mosquito refeeds / transmits virus
  - Intrinsic incubation period

  **Human #2**

  **Illness**
Dengue in the Americas 1980 – 2009*

* Source: PAHO (Dec. 15, 2009)
Dengue hemorrhagic fever (DHF) in the Americas, 1980 – 2009*

* Source: PAHO (Dec. 15, 2009)
Why has dengue incidence increased in Latin America?

- Reinfestation of the region by *Aedes aegypti* mosquitoes
- Ineffective mosquito control programs
- Uncontrolled population growth and unplanned urbanization
- Increased air travel by humans
- Deteriorated public health infrastructure
Critical factors needed for local transmission of dengue in the US

• Presence of a competent vector (*Aedes aegypti* and/or *Aedes albopictus*)
• Frequent introductions of dengue viruses (in humans) during periods when vectors are active and abundant
Aedes aegypti
Aedes aegypti

- Lives around human habitations in urban areas
- Lays eggs and produces larvae preferentially in artificial containers
- Strong preference for human blood; primarily a daytime feeder; often found indoors
- Most important vector of dengue viruses in the world
Reported distribution of *Aedes aegypti* in the U.S. in 2009

Courtesy: Dr. Chester Moore
Aedes albopictus

Photograph: Courtesy Susan Ellis
*Aedes albopictus*

- Lives near human habitations in suburban/rural areas
- Lays eggs and produces larvae in natural or artificial containers
- Female regarded as “catholic” feeder
- An aggressive, daytime feeder in outdoor areas
- Very competent vector of dengue viruses in the laboratory
Reported distribution of *Aedes albopictus* in the U.S. in 2009

Courtesy: Dr. Chester Moore
Factors favoring dengue transmission in the US

- Good vectors (*Aedes aegypti* and *Ae. albopictus*) are widely distributed in domestic environment
- Human population is highly susceptible
- Frequent vector-viremic host contact
- “Nearby” endemic/epidemic activity in Mexico, Caribbean, and Central/South America.
- Absence of clinical diagnosis
Dengue cases reported in the U.S. through 2008

- Dengue epidemics occurred in the U.S. in the 1800s and the first half of the 1900s.
- Last epidemic in Florida - 1934-35 in Tampa and Miami
- Since 1945: 63 indigenous cases; all in Texas
  - 1980: 23 cases
  - 1986: 9 cases
  - 1995: 7 cases
  - 1997: 3 cases
  - 1998: 1 case
  - 1999: 18 cases
  - 2005: 2 cases (1 DHF)
Dengue in Texas and Mexico 1980-1999*

3 states = 62,514

Texas = 64

* Source: CDC
Origin of imported dengue cases, Florida, 1986 – 2008*

- 41- Puerto Rico
- 21- Dominican Republic \( \text{n} = 168 \)
- 13- Haiti
- 9- Nicaragua
- 8- Costa Rica
- 7- Brazil
- 6- Trinidad/Tobago, Bali, Venezuela
- 5- Virgin Islands, Barbados, Ecuador
- 4- Honduras
- 3- Bahamas, Cuba, Mexico, Guatemala, Jamaica
- 2- El Salvador, Philippines
- 1- Panama, Peru, Vietnam, India, Ghana, Asia, Thailand, Malaysia, Curacao, St. Thomas, St. Barts, unknown

* Source: CDC and Florida DOH
Imported dengue in Florida
1986 – 2008*

* Source: Florida DOH

* Source: Florida DOH
Imported dengue in Arizona 1998 - 2009*

* Source: Craig Levy, AZ Dept of Health (n = 46)
Factors mitigating dengue transmission in the US

- Relatively short viremia (ave. 5-7 days) in an infected person
- Housing conditions and lifestyles minimize vector-human contact
- Vector distribution is variable and uneven
- Critical vector density needed for secondary transmission may not exist
Worst case (human)/best case (virus) scenario leading to dengue transmission in the US

- Several viremic travelers arrive in an area without mosquito control
- One or both dengue vectors are present
- Housing conditions/lifestyles permit ready access to viremic and later to susceptible hosts
- Initial infections are inapparent or are not promptly diagnosed clinically
Recommendations for detecting local transmission in the US

- State and national public health officials are aware of dengue activity in American tropics
- Physicians in travel clinics and potential foci of introduction:
  - can clinically diagnose (and treat) dengue
  - know procedures for collecting specimens for laboratory diagnosis
- A laboratory is available to provide prompt, accurate testing services
- Monitor/control distribution, density, and behavior of dengue vectors
Conclusions

• Under certain local circumstances (i.e., a vector species has frequent contact with humans and numerous virus introductions are occurring) dengue virus transmission may appear in focal areas of the southern US, as has been seen in southern Texas during the last 25 years.

• While dengue transmission has occurred in the US, large-scale outbreaks are unlikely.
What happened in 2009?
Dengue Fever in Key West, Florida 2009

Public health information- Elizabeth Radke, FDOH
Outbreak identification

- **September 1** - Monroe County Health Department was notified about a New York resident who had been diagnosed with dengue fever after travel to Key West.

- A press release was issued to the public and area physicians were notified of the potential for local transmission of dengue viruses.

- The **Florida Keys Mosquito Control District** implemented enhanced trapping and spraying for *Aedes aegypti*. 
Mosquito control efforts

- An increase in the *Aedes aegypti* population was observed in July after increased rainfall.
- Nightly truck spray missions and weekly aerial spray missions were implemented.

Mosquito control information courtesy Andrea Leal, Florida Keys Mosquito Control District.
Increased control

- Truck spray missions focused on area surrounding the guest house
- Every other morning, helicopter spray missions were implemented
Sweep (field survey) of guest house where the first case stayed

On-site
• Metal container
• Pond with fish (no larvae)

Neighboring residences
• Abandoned swimming pool
• Plant trivets
• Bromeliads
• Plastic containers
New suspect case

Sweep of area

- Rooftop next door
- Fountain
- Birdbath
- Light fixture
- Bromeliads

Implemented domestic sweep of entire island

- Recorded whether larvae were present or inspectors could not enter property
More cases

• Due to public notification, additional case was identified; Key West resident with no travel history
• Wife became ill 2 weeks later and dengue infection was confirmed
  • Indicated ongoing transmission, multiple generations of mosquitoes
• Household had ample vegetation, numerous containers
• Key West Cemetery was nearby; many vases had immature mosquitoes
First sweep by mosquito control staff
September 16-30

Infestation rate (IR) (house/premise index) = 20%
Second sweep (Sep. 24 – Oct. 6; IR= 19%)
third sweep (Sep. 30- Oct. 8; IR= 32%)
Control/surveillance procedures

• All containers holding water were destroyed or treated with Altosid (methoprene) or Golden Bear (oil).
• Hand fogger (P-1) used to apply permethrin (Biomist 30:30) outside and under houses.
• All properties were visited 3 times.
• Aedes aegypti (no Ae. albopictus) present in Key West; B-G Sentinel trap used to collect adults.
Medical Record Search

- Lower Keys Medical Center and two primary care physicians had “urgent care” case loads higher than usual.
- Pulled records based on discharge diagnoses for international classification of disease (ICD) codes consistent with dengue illness.
- Records were checked for likelihood of dengue infection and “suspect” patients were asked to provide a blood sample for dengue laboratory testing.
Seroprevalence survey

- Case interviews suggested that initial infections were acquired at the guest house and married couple’s home
- Drew 1,000 meter radiuses around the cases; took a random sample of houses
- Desired sample size was 328 based on assumptions from previous outbreaks
- Generated list of 730 households, later added another 180 due to low occupancy rates (240 samples obtained)
Households sampled in serosurvey
Key West, Florida (Sep. 23-27, 2009)

Households sampled (N= 170)
Residences of dengue cases in Key West, Florida, 2009 (DEN-1 virus isolated from humans and mosquitoes)

- Physician/record review case (n=14)
- Serosurvey confirmed case (n=8)
- Positive mosquito pool
Dengue in Key West, Florida
July 26 - Oct. 24, 2009*

* Source: Florida DOH

N = 22
Where are we now?

With physician-submitted samples, medical record review, and the serosurvey, 22 laboratory-confirmed cases of dengue were detected in Key West, Florida in 2009.

These were the first locally-acquired dengue infections detected in Florida in 75 years.
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