Arbovirus Surveillance: Present and Future

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Global Resurgence of Epidemic Arboviral Disease

BF - Barmah Forest
CE - California Encephalitis
Chik - Chikungunya
CCHF - Congo-Crimean Hemorrhagic Fever
DEN - Dengue
EEE - Eastern Equine Encephalitis
JE - Japanese Encephalitis
KFD - Kyasanur Forest Disease
LAC - LaCrosse Encephalitis
MAY - Mayaro
MVE - Murray Valley Encephalitis
ONN – O’nyong-nyong
ORO - Oropouche
RVF - Rift Valley Fever
RR - Ross River
SLE - St. Louis Encephalitis
SIN - Sinbis
TBE- Tick-Borne Encephalitis

VEE - Venezuelan Equine Encephalitis
WEE - Western Equine Encephalitis
WN - West Nile
WSL - Wesselsbron
YF - Yellow Fever
ZIK - Zika

Severe Febrile Thrombocytopenia Syndrome
Bourbon
Major Infectious Disease Epidemics, 1990-2018

- Dengue, 1990-2018
- Venezuelan equine encephalitis, 1992
- Pneumonic plague, 1994
- Avian influenza, 1997-2010
- Rift Valley Fever, 1998
- Nipah encephalitis, 1998-1999
- West Nile, 1999-2005
- SARS, 2003
- Zika, 2007-2016
- Swine origin H1N1 influenza, 2009-2010
- MERS-CoV, 2012-2018
- Chikungunya, 2014-2015
- Ebola, 2014
- Yellow fever, 2016-2018

We Live in a New Era
Principal Clinical Syndromes Caused by Arboviruses

- Systemic Febrile Illness
- Hemorrhagic Fever
- Meningoencephalitis
Challenges of Arboviral Disease Surveillance

• Differential diagnosis
• Laboratory Diagnosis
• Unpredictable epidemics
• Physicians low index of suspicion
  – Inter-epidemic period
• Mild Illness/Self Treatment
• No early warning system
Surveillance for Arboviral Diseases

• Disease Surveillance

• Entomologic Surveillance
Surveillance for Arboviral Diseases

Entomologic Surveillance

- Species
- Geographic distribution
- Larval habitats
- Adult behavior
- Seasonal distribution
- Insecticide resistance
- Infection rate
Surveillance for Arboviral Diseases

Entomologic Surveillance

- Can use entomologic surveillance data for multiple diseases, depending on geographic area
  - Dengue
  - Yellow fever
  - Zika
  - Chikungunya
  - Epidemic polyarthritis
  - Others
Disease Surveillance for Arboviral Diseases

Passive

Active
Disease Surveillance for Arboviral Diseases

Passive Surveillance

- Physician Reporting
- Case Definitions
- Mandated by Law
- Monitor Secular Trends
- Sensitivity
Hypothetical Dengue Fever Epidemic Curve

% of Patients With Fever vs Week

Week: 0  5  10  15  20  25  30  35  40  45  50  52

10  20  30  40  50  60  70

1  2  3  4  5
Problems with Passive Surveillance Systems

- Does not exist for most arboviruses
- Low Index of Suspicion
  - Inter-epidemic period, silent
- Misdiagnosis by physician
- Mild Illness/Self Treatment
- Insensitive
Active Surveillance for Arboviral Diseases

ACTIVELY MONITOR INFECTIOUS DISEASE TRANSMISSION IN CATCHMENT AREA

Time
Location
Etiology
Disease Severity
Inter-epidemic Period
Early Warning Surveillance for Arboviral Diseases

- Passive syndromic surveillance
  - Dengue fever-like disease
  - All hemorrhagic disease
  - All neurologic disease
  - Case definitions

- Active/proactive surveillance
  - Laboratory-based sentinel system
  - Algorithm on testing priorities/sequence
  - National Laboratories for QC

- Regional Reference Laboratories for QC
Components of Laboratory-Based, Active Surveillance for Arboviral Diseases with Emphasis on the Inter-epidemic Periods*

<table>
<thead>
<tr>
<th>TYPE OF SURVEILLANCE</th>
<th>SAMPLES**</th>
<th>APPROACH</th>
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<tbody>
<tr>
<td>Sentinel Clinic/Physician</td>
<td>Clinical samples from representative cases of viral syndrome, taken 3-15 days of onset of illness</td>
<td>Representative samples taken year round and processed weekly for serology, virus isolation, and PCR**</td>
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<tr>
<td>Fever Alert</td>
<td>Clinical samples from representative cases during outbreaks of febrile illness</td>
<td>Increased febrile illness in community is investigated immediately</td>
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<tr>
<td>Sentinel Hospital</td>
<td>Clinical and tissue samples taken during hospitalization and/or at death</td>
<td>All hemorrhagic disease, neurologic disease, and viral syndrome with fatal outcome are investigated immediately***</td>
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* During an epidemic, after the etiology is known, the case definition should be more specific and surveillance focused on severe disease.

**All samples are processed weekly for serology and virology

***Serology, virus isolation, PCR and immuno-histochemistry on appropriate samples

Adapted from Gubler, 1998
Proactive Early Warning Surveillance Algorithm for Arboviral Diseases

Active, Laboratory-Based Syndromic Surveillance

Test for common pathogens

Positive → Virology

Negative → Other pathogens; virology
Need a Comprehensive Early Warning Arboviral Disease Surveillance Program

• Link clinical and epidemiologic disease detection networks to state-of-the-art basic research and diagnostics laboratory

• Regional Program
  ▪ Country specific
  ▪ Good lab & epidemiologic capacity
  ▪ Communications
  ▪ Leadership
What is Needed for Arboviral Diseases Surveillance?

• Investment in sustainable country programs
• Regional reference laboratories
• Standardized Reporting Requirements
  – Global
  – Regional
  – National
• Outreach Programs to Medical Community
• Regional Coordination of Surveillance Data
Comprehensive EID Surveillance
No disease was ever controlled by surveillance