Spatial Analysis of West Nile Virus in Maryland, 2000-2005

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Overview

- Goals
- Background on West Nile Virus (WNV)
- Maryland WNV Results- Spatial Analysis and Indicators of Human Disease
- Discussion and Public Health Impact
- Limitations
- Future Questions
Project Goals

- Complete 2004 annual arbovirus report
- Describe experience of WNV in Maryland and do preliminary analysis:
  - Map location of positive mosquito pools and human disease.
  - Detect clusters of human cases.
  - Explore indicators of human disease.
WNV Background

- **Agent:** arbovirus
- **Vector:** mosquito (multiple species can carry WNV; such as *Culex spp.*)
- **Reservoir host:** avian
- **Emerging disease:** First seen in U.S. in 1999
- **Maryland:**
  - First detected in dead crow in 1999 (Baltimore City)
  - First human case in 2001
Maryland Agency Acronyms

- DHMH = Maryland Department of Health and Mental Hygiene
  - CVPH = Center for Veterinary Public Health
- MDA = Maryland Department of Agriculture
- DNR = Maryland Department of Natural Resources
Maryland WNV Surveillance: A Multi-Agency Effort

- Human and Non-Human Surveillance
  - Enhanced Human Surveillance: DHMH
  - Equine & small mammal surveillance: DHMH/CVPH
  - Human Pesticide Illness Monitoring: DHMH Office of Environmental Health

- Mosquito surveillance (collection and speciation): MDA

- Mosquito control: MDA

- Wildlife: DNR (live birds and mammals)
Human WNV Cases

Case definition
- West Nile encephalitis
- West Nile aseptic meningitis
- West Nile Fever

Reported cases in Maryland
- 136 total (90 severe)
- Peak: 73 cases in 2003
- Most recent year: 5 in 2005
Overall Incidence Rate, Severe WNV Disease
Maryland 2001-2005

Legend
Detection rate/100,000
- No cases
- 0.1 - 1.1
- 1.2 - 2.3
- 2.4 - 6.9

Map showing the overall incidence rate of severe WNV disease in Maryland from 2001 to 2005.
Severe WNV Human Incidence Rates and Positive Mosquito Pools, 2002

Legend
Detection Rate/100,000
- 0.00
- 0.01 - 0.50
- 0.51 - 1.50
% WNV positive mosquito pools

Legend
Detection Rate/100,000
- 0.00
- 0.01 - 0.50
- 0.51 - 1.50
% WNV positive mosquito pools
Severe WNV Human Incidence Rates and Positive Mosquito Pools, 2003

Legend
Detection Rate/100,000

- 0
- 0.01 - 1.5
- 1.51 - 7

% WNV positive mosquito pools
Severe WNV Human Incidence Rates and Positive Mosquito Pools, 2004

Legend
Detection rate/100,000

- 0
- 0.01 - 1.5
- 1.51 - 6.5

% WNV positive mosquito pools 2004
Severe WNV Human Incidence Rates and Positive Mosquito Pools, 2005

Legend
Incidence Rate/100,000
- 0.0
- 0.1 - 0.2
- 0.3 - 0.7
- WNV positive mosquito pools

0 12.5 25 50 Miles
Cluster Analysis

- **Method:** Cluster scan analysis (Poisson model) of incidence rates by ZCTA’s.

- **Results:**
  - Primary cluster in Baltimore City/County (12 km diameter), $p = .001$
  - One secondary cluster in Prince George’s County (1 ZCTA), $p = .067$
Maryland ZCTAs and Hot Spots for Severe WNV Disease Based on Cluster Scan Analysis
Indicator Variables

- Determine if correlated with incidence of severe WNV disease by jurisdiction:
  - Surveillance indicators
    - Mosquito detection (any)
    - Years in which WNV-positive mosquitoes reported
    - % dead crows identified in 2002
  - Demographic indicators
    - % population >50 years of age
    - Population density
## Categorical Univariate Results

<table>
<thead>
<tr>
<th></th>
<th>Jurisdictions with Severe Disease (n=14)</th>
<th>Jurisdictions with no Severe Disease (n=10)</th>
<th>p-value (Fisher’s Exact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WNV+ Mosquito pool (any year)</td>
<td>11 (85%)</td>
<td>8 (80%)</td>
<td>1</td>
</tr>
<tr>
<td>&gt;1 year with + mosquito pool</td>
<td>8 (62%)</td>
<td>2 (20%)</td>
<td>0.22</td>
</tr>
<tr>
<td>&gt;2.3% of dead crows 2002</td>
<td>10 (71%)</td>
<td>2 (20%)</td>
<td>0.04</td>
</tr>
<tr>
<td>&gt;28% of population &gt;50</td>
<td>5 (36%)</td>
<td>7 (70%)</td>
<td>0.21</td>
</tr>
<tr>
<td>Population density &gt; 300 people/sq mi.</td>
<td>9 (64%)</td>
<td>1 (10%)</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Discussion

- Maps suggest early, sustained incidence in urban East-Central region and later higher incidence in Central Eastern Shore (nearly all resolved).
- Clusters detected in Baltimore City, Baltimore County, and Prince George’s County
- Dead crows, population density were indicators of severe human WNV; mosquitoes detected almost everywhere
Limitations

- No control group for comparison (either spatial or individual)
- Passive surveillance
- Couldn’t obtain all surveillance data
Future Questions

- How good is the passive human surveillance?
- What are the effects of spraying and other mosquito control efforts on human WNV incidence?
- Temporality (testing result of cases or cases after positive mosquitoes detected)?
- Why do we see WNV-positive mosquitoes and no cases?