Overview

• Introduction and outbreak overview
• Enteric disease outbreaks
• Tuberculosis outbreaks
• Zoonotic and vector-borne disease outbreaks
• Vaccine-preventable disease outbreaks
Introduction and Outbreak Overview

Shawn Pence, Outbreak Supervisor
Epidemiology Resource Center

Indiana State Department of Health
Enteric Disease Outbreaks

Hailey Vest, Enteric Epidemiologist
Epidemiology Resource Center
On July 11, 2018, the Indiana State Department of Health was notified of an outbreak of gastrointestinal illness following a wedding ceremony that took place on June 23, 2018.

It was reported that more than 100 people attended the wedding.
Outbreak Investigation Steps

1. Verify diagnosis
2. Search for additional cases
3. Develop a case definition
4. Generate a hypothesis
Verify Diagnosis: Collecting Samples for Testing

- WE WANT THE POOP!
- Is anyone still symptomatic and willing to submit a stool specimen?
  - Note: 2 positives are needed to confirmed etiology
- Outbreak situations: 3–5 specimens per outbreak
Search for Additional Cases

- Foodborne Illness Questionnaire
  - Survey Monkey with electronic link
  - Fast, efficient way to collect epidemiological data
- 72 hour food history
- Menus help!
ISDH worked with the county health department to disseminate foodborne illness surveys to all wedding attendees with available contact information. ISDH received surveys from 90 wedding attendees; 49 individuals reported illness. The diagram shows the outbreak of acute GI illness from June 23, 2018, with an average incubation period of 8.92 days.
63.3% of cases were female
• Cases range in age from 16 to 72
• Reported symptoms include abdominal cramps, diarrhea, watery stool, nausea, vomiting, fever, weight loss, and fatigue
• Dates of onset of watery stool ranged from 6/28/18-7/11/18.
Epidemiological evidence can allow us to hypothesize etiology

- **Symptom description:** watery stool, loss of appetite, nausea, fatigue
- **Incubation period:** Approximately one week

**Cyclosporiasis**

*Two specimens tested positive for cyclosporiasis; outbreak etiology was confirmed*
Looking for the Vehicle

• What kind of study do we perform?
  • Cohort Study

• What kind of analysis?
  • Risk Ratios/Relative Risk
Calculating Risk Ratios

<table>
<thead>
<tr>
<th>Consumed Pork</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>31</td>
<td>24</td>
<td>55</td>
</tr>
<tr>
<td>No</td>
<td>18</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>41</td>
<td></td>
</tr>
</tbody>
</table>

- Cumulative Incidence exposed group
  - \( \frac{31}{55} \times 100 = 56.4\% \)
- Cumulative incidence unexposed group
  - \( \frac{18}{35} \times 100 = 51.4\% \)

\[
\frac{CI_e}{CI_u} = \frac{56.4}{51.4} = 1.10
\]

Confidence Interval Calculation

\[
\ln(RR) \pm z \sqrt{\frac{(n_1-x_1)/x_1}{n_1} + \frac{(n_2-x_2)/x_2}{n_2}}
\]
# Cohort Study

<table>
<thead>
<tr>
<th>Menu Item</th>
<th>Risk Ratio</th>
<th>95% CI (Lower Limit)</th>
<th>95% CI (Upper Limit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pork</td>
<td>1.10</td>
<td>0.74</td>
<td>1.63</td>
</tr>
<tr>
<td>Beef</td>
<td>0.80</td>
<td>0.49</td>
<td>1.31</td>
</tr>
<tr>
<td>Chicken</td>
<td>1.84</td>
<td>0.93</td>
<td>3.62</td>
</tr>
<tr>
<td>Tortillas</td>
<td>1.17</td>
<td>0.43</td>
<td>3.23</td>
</tr>
<tr>
<td>Chips</td>
<td>2.21</td>
<td>0.67</td>
<td>7.31</td>
</tr>
<tr>
<td>Salsa</td>
<td>1.57</td>
<td>0.71</td>
<td>3.50</td>
</tr>
<tr>
<td>Rice</td>
<td>1.38</td>
<td>0.63</td>
<td>2.99</td>
</tr>
<tr>
<td>Beans</td>
<td>1.23</td>
<td>0.68</td>
<td>2.22</td>
</tr>
<tr>
<td><strong>Cilantro</strong></td>
<td><strong>5.11</strong></td>
<td><strong>1.80</strong></td>
<td><strong>14.53</strong></td>
</tr>
<tr>
<td>Lettuce</td>
<td>0.97</td>
<td>0.58</td>
<td>1.62</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>1.64</td>
<td>0.91</td>
<td>2.96</td>
</tr>
<tr>
<td>Onions</td>
<td>2.10</td>
<td>0.99</td>
<td>4.46</td>
</tr>
<tr>
<td>Red Sauce</td>
<td>0.74</td>
<td>0.40</td>
<td>1.35</td>
</tr>
<tr>
<td>Green Sauce</td>
<td>1.29</td>
<td>0.79</td>
<td>2.10</td>
</tr>
<tr>
<td>Cheese</td>
<td>0.60</td>
<td>0.35</td>
<td>1.02</td>
</tr>
<tr>
<td>Watermelon</td>
<td>1.17</td>
<td>0.71</td>
<td>1.94</td>
</tr>
<tr>
<td>Musk Melon</td>
<td>0.73</td>
<td>0.33</td>
<td>1.58</td>
</tr>
<tr>
<td><strong>Grapes</strong></td>
<td><strong>1.71</strong></td>
<td><strong>1.08</strong></td>
<td><strong>2.71</strong></td>
</tr>
<tr>
<td>Wedding Cake</td>
<td>0.72</td>
<td>0.42</td>
<td>1.26</td>
</tr>
</tbody>
</table>
Epi analysis informs food testing: This analysis yielded a strongly significant relationship between cilantro consumption and illness onset

- Food samples were collected by environmental health staff
- Environmental assessment was conducted at the facility
- ISDH Food Protection Program traced the cilantro served at the wedding event back to a farm in Puebla, Mexico, which had an outbreak alert by the FDA
Tuberculosis Outbreaks

Kelly White, MPH, CPH, Director
TB/Refugee Health

Nov. 21, 2019
TB Outbreaks

• TB disease outbreaks are difficult to define based on traditional methods
• TB cases as a result of transmission can take years, even decades, to appear
• Focus outbreak designation on TB clusters where ongoing transmission is suspected
  • Direct action to stop transmission
TB Genotyping

• All culture confirmed TB cases are genotyped by CDC
• Traditional genotyping includes three sections (Spoligotype, MIRU, MIRU2)
• Each strain given a PCRTYPE and GenType designation based on three sections
  • PCRTYPE and GENType are consistent between every state and represent unique combinations
TB Clusters

• If genotypes match, they are given a cluster designation
  • IN_0001 for partial cluster (PCR Type)
  • IN_0001_001 for full clusters (GENType)
• Clusters only apply to cases within each state
• Don’t always indicate recent transmission
  • Similar strains, but not exact
  • Ex. Same country of birth
TB Whole Genome Sequencing

• Clustered cases receive WGS from CDC
• More specific than traditional methods
• Can show relationships within designated clusters
  • Help include/exclude cases when identifying possible transmission sites/routes
• States receive results in a phylogenetic tree
G07471 in Indiana
Results received 5/28/2019
WGS results for G07925 nationally — by state and year

Node A
2007 (6 from OH)
2008 (0 from OH, 2 from IN)
2009 (2 from OH, 1 from IN)
2010 (7 from OH, 1 from IN, 1 from KY)
2011 (2 from OH, 1 from IN)
2012 (1 from OH, 1 from IN)
2013 (1 from OH, 5 from IN)
2014 (1 from OH, 2 from IN)
2015 (1 from OH)
2016 (2 from OH, 1 from IN)

Node B
2012 (3)
2013 (1)
2014 (1 from OH, 2 from IN)
2015 (1 from OH)
2016 (2 from OH, 1 from IN)

MRCA

WGS Example 2
WGS Example 3

G05480 in the United States
Results received 6/13/2019
Should we Investigate?

• Is it a common cluster?
• Are the cases in the same county or area?
• How far apart in time are the cases?
• Do the cases share a common country of birth?
• Have we identified epi-links in this cluster before?
• How many cases are involved?
TB Cluster/Outbreak Response

- Review case information and confirm known epi-links
- Re-interview cases, as needed
  - Ask about newly identified epi-links or locations
- Evaluate contact investigations
  - Rate of positivity?
  - Secondary cases?
  - Missed contacts?
TB Cluster/Outbreak Response

- Re-open or expand contact investigations
  - Additional testing on known contacts
  - New sites of transmission
- Implement infection control measures
  - Ensure isolation of infectious patients
  - Additional environmental controls, if needed
- Education/awareness of cases to partners
  - Work with jails, homeless shelters, hospitals, etc.
  - Remind providers to “Think TB”
Contact Information

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317-233-7548
KeWhite@isdh.in.gov
Zoonotic and Vector-borne Disease (ZVBD) Outbreak Investigations

Ali Bianco, MPH, Zoonotic and Vector-borne Epidemiologist
ZVBD Outbreaks: How They Differ from Other Diseases

• Human to human transmission is not always a primary concern
• Often affect other animal species as well
• Ecologic activity can play a large role in the public health response
  • Season, weather patterns, vector and host populations
ZVBD Outbreaks: How They Differ from Other Diseases

Pathogen Detection
- May be a new or reemerging pathogen
- May be detected in humans, animals, or vectors first

Ongoing Surveillance
- Looking for human or animal cases or an increase in the number of cases that are typically seen
- Vector/host surveillance

Control Measures
- Possible control of pathogen in population or environment
- Educating the public
ZVBD Outbreaks: How They Differ from Other Diseases

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2019 Eastern Equine Encephalitis Virus Outbreak

Eastern Equine Encephalitis (EEE) virus
- Mosquito-borne alphavirus
- Endemic in the eastern United States
- Rare cause of severe illness in humans, horses
Last EEE virus detection by species, prior to 2019

- Last human case, 1998
- Last positive mosquito pool, 2010
- Last equine case, 2018 (2 total)
Last EEE virus detection by species, into late August 2019

- Last human case, 1998
- Last positive mosquito pool, 2010
- Last equine case, 2018 (2 total)

3 equine cases and one positive mosquito pool detected in Elkhart County in late August, 2019
ZVBD Outbreaks: How They Differ from Other Diseases

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Control Measures
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Ongoing EEE Virus Surveillance During Outbreak

- Mosquito surveillance in high risk areas
- Veterinary surveillance of animals, especially horses
- Human surveillance
  - Outreach to hospitals in areas with EEEV activity
  - Looking for patients with unexplained neurologic symptoms without another, more plausible diagnosis
  - Arranging testing for suspect cases
Disease cases
Reported to CDC ArboNET by county of residence

- Human disease cases
- Non-human infections reported

CDC ArboNET data as of 11/4/19
ZVBD Outbreaks: How They Differ from Other Diseases

Pathogen Detection
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Ongoing Surveillance
- Looking for human or animal cases or an increase in the number of cases that are typically seen
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Control Measures
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- Educating the public
EEE Spray Areas and Areas Surrounding Equine Cases and Mosquito Pools

5 Mile Radius Around EEE Sites Detected Before Spraying

Spray Areas

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia © OpenStreetMap contributors, and the GIS User Community
Both Elkhart and LaGrange Counties had evidence of EEEV transmission in 2019.

<table>
<thead>
<tr>
<th></th>
<th>Elkhart County</th>
<th>LaGrange County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human cases</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Equine cases</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Infected mosquito pools</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
There was an EEEV epidemic in the United States in 2019.
Challenges with ZVBD Outbreaks

- Pathogens have complex transmission cycles influenced by multiple factors
- Testing capabilities may be lacking
- May not have disease specific treatments, prophylaxis or vaccines available
- Emergence of new pathogens
- Each disease is different and can require a different response
Contact Information

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Vaccine-Preventable Disease (VPD) Outbreaks

Lauren Milroy, MPH
Vaccine-preventable Disease Epidemiologist
14 Diseases You Almost Forgot About (Thanks to Vaccines)

- Measles
- Mumps
- Rubella
- Polio
- Hib
- Chickenpox
- Diphtheria
- Whooping Cough (Pertussis)
- Influenza (Flu)
- Hepatitis B
- Pneumococcal Disease
- Rotavirus
- Tetanus
- Hepatitis A

Image source: Centers for Disease Control and Prevention (CDC).
14 Diseases You Almost Forgot About (Thanks to Vaccines)

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Image source: Centers for Disease Control and Prevention (CDC).
VPD Outbreak Investigation

Case & Outbreak Confirmation → Outbreak Declaration → Control Measures → Ongoing Surveillance → Outbreak End
VPD Outbreak Investigation

Case & Outbreak Confirmation

Outbreak Declaration

Control Measures

Ongoing Surveillance

Outbreak End
## Is it an outbreak?

<table>
<thead>
<tr>
<th>Disease</th>
<th>Outbreak Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varicella (Chickenpox)</td>
<td>Cases &lt;13 years: 5 epi-linked cases</td>
</tr>
<tr>
<td></td>
<td>Cases ≥13 years: 3 epi-linked cases</td>
</tr>
<tr>
<td></td>
<td>*Must reside in two separate households.</td>
</tr>
<tr>
<td>Mumps</td>
<td>3 epi-linked cases</td>
</tr>
<tr>
<td></td>
<td>(with at least 1 lab confirmed case)</td>
</tr>
<tr>
<td>Pertussis</td>
<td>No specific threshold</td>
</tr>
<tr>
<td>Measles</td>
<td>1 case</td>
</tr>
</tbody>
</table>

*Outbreaks are declared by the local health department.*
VPD Outbreak Investigation

1. Case & Outbreak Confirmation
2. Outbreak Declaration
3. Control Measures
   • Exclusions
   • Post-exposure prophylaxis
   • Vaccination clinics
4. Ongoing Surveillance
5. Outbreak End
Exclusions

• Required for susceptible, exposed contacts in outbreaks of:
  • Varicella
  • Mumps
  • Measles
• May return if receive vaccination or present appropriate documentation of immunity
• Exclusions maintained for one incubation period from last exposure
# Exclusion Periods

<table>
<thead>
<tr>
<th>Condition</th>
<th>Exclusion Period for Susceptible Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>21 days from last exposure</td>
</tr>
<tr>
<td>Mumps</td>
<td>Days 9 – 25 from last exposure</td>
</tr>
<tr>
<td>Pertussis</td>
<td>No exclusions required if asymptomatic</td>
</tr>
<tr>
<td>Varicella</td>
<td>21 days from last exposure</td>
</tr>
</tbody>
</table>

**May be extended if additional cases are identified.**
## Post-Exposure Prophylaxis (PEP)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prophylaxis Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>- MMR vaccine within 72 hours of exposure <strong>OR</strong> &lt;br&gt;  - IG with 6 days of exposure</td>
</tr>
<tr>
<td>Mumps</td>
<td>No effective PEP available</td>
</tr>
<tr>
<td>Pertussis</td>
<td>Targeted antibiotics for close contacts</td>
</tr>
<tr>
<td>Varicella</td>
<td>- Varicella vaccine within 5 days of exposure <strong>OR</strong> &lt;br&gt;  - Varicella Immune Globulin (VariZIG) within 10 days (ideally 96 hours) of exposure</td>
</tr>
</tbody>
</table>
Vaccination Clinics

• May be implemented for outbreak control
• Often most effective when:
  • Well-defined at-risk population
  • Large number of susceptible people at risk
  • Re-vaccination may provide additional protection (e.g., third mumps dose)
VPD Outbreak Investigation

- Case & Outbreak Confirmation
- Outbreak Declaration
- Control Measures
- Ongoing Surveillance
- Outbreak End

After 2 incubation periods since last case onset
## Outbreak End Dates

<table>
<thead>
<tr>
<th>Condition</th>
<th>Outbreak End (From Last Case Onset)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>42 days</td>
</tr>
<tr>
<td>Mumps</td>
<td>50 days</td>
</tr>
<tr>
<td>Pertussis</td>
<td>42 days</td>
</tr>
<tr>
<td>Varicella</td>
<td>42 days</td>
</tr>
</tbody>
</table>
Impact of Vaccine Hesitancy on VPD Outbreaks
Number of Measles Cases Reported by Year

2010-2019** (as of October 3, 2019)

Source: Centers for Disease Control and Prevention
93% - Related to outbreaks

Number of Measles Cases Reported by Year

2010-2019** (as of October 3, 2019)

Source: Centers for Disease Control and Prevention
85% - Related to outbreaks in close-knit, under-vaccinated communities
Number of Measles Cases Reported by Year

2010-2019** (as of October 3, 2019)

75% - Related to outbreaks in NYC and NY State

Source: Centers for Disease Control and Prevention
Contact Information

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