The PulseNet Cost Benefit Study and Beyond: What We Have Learned & Where We Are Headed for Molecular Enteric Surveillance

Craig Hedberg, PhD
University of Minnesota
Our mission is to identify and evaluate best practices for foodborne disease surveillance and outbreak investigation, and share this knowledge with others.

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An Economic Evaluation of PulseNet, a Network for Foodborne Disease Surveillance

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The PulseNet Benefit-Cost Analysis

Goal:
To assess the benefits and costs of PulseNet

Benefits:
Focus on reduced foodborne illness
  – from faster recalls
  – from process change brought about by industry accountability

Costs:
Focus on costs to the public health system
A Model of Benefits from Process Change

State level data (1994-2009)

Reported NNDSS illnesses modeled as a function of:
- PulseNet presence (d.v.)
- Isolates tested
- Population
- Year

Linear Regression Models
### Estimated Numbers of Cases Prevented by Outbreak-Associated Recalls of E. coli O157:H7 and Salmonella Infections, 2007–2008

<table>
<thead>
<tr>
<th>Agent</th>
<th>Vehicle</th>
<th>No. outbreaks</th>
<th>No. outbreak cases reported</th>
<th>No. reportable cases prevented</th>
<th>90% credible interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em> O157:H7</td>
<td>Ground beef</td>
<td>15</td>
<td>276</td>
<td>108</td>
<td>95, 266</td>
</tr>
<tr>
<td><em>Salmonella</em> outbreaks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wandsworth, Typhimurium</td>
<td>Veggie Booty</td>
<td>1</td>
<td>87</td>
<td>49</td>
<td>32, 67</td>
</tr>
<tr>
<td>I 4,[5],12:i:-</td>
<td>Pot pies</td>
<td>1</td>
<td>401</td>
<td>72</td>
<td>19, 132</td>
</tr>
<tr>
<td>Litchfield</td>
<td>Cantaloupe</td>
<td>1</td>
<td>51</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>St. Paul</td>
<td>Jalapeno, serrano peppers</td>
<td>1</td>
<td>1,500</td>
<td>345</td>
<td>50, 714</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>Peanut butter, products</td>
<td>1</td>
<td>714</td>
<td>114</td>
<td>27, 214</td>
</tr>
</tbody>
</table>
## Alternative Illness Reduction Estimates

<table>
<thead>
<tr>
<th></th>
<th>Salmonella</th>
<th>E Coli</th>
<th>Listeria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random effects</td>
<td>15,784**</td>
<td>310</td>
<td>113**</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td>19,758**</td>
<td>489*</td>
<td>113*</td>
</tr>
<tr>
<td>Poisson</td>
<td>9,096**</td>
<td>364**</td>
<td>27</td>
</tr>
<tr>
<td><strong>Spillover Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random effects</td>
<td>21,249**</td>
<td>2,673**</td>
<td>151**</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td>25,181**</td>
<td>1,597**</td>
<td>75</td>
</tr>
<tr>
<td>Poisson</td>
<td>11,291**</td>
<td>670**</td>
<td>73</td>
</tr>
</tbody>
</table>

** significant at 1%
* significant at 5%
# The Cost Per Case of FBI ($)

@Risk Used to Perform Monte Carlo Simulations

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Mean</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td><em>E Coli O157:H7</em></td>
<td>2,154</td>
<td>1,464</td>
</tr>
<tr>
<td><em>Listeria m.</em></td>
<td>156,019</td>
<td>81,003</td>
</tr>
<tr>
<td><em>Salmonella (non-typh)</em></td>
<td>1,792</td>
<td>1,461</td>
</tr>
</tbody>
</table>
Are the Costs of PulseNet Justified?

Annual **Cost:**

$7.3 million

Annual **Benefits:**

$21 million to $654 million
$1.3 to $36.5 million related to improved recalls

**Conclusion:** PulseNet improves social welfare
The Cycle of Public Health Prevention

*Humans are the ultimate bioassay for the food supply*

Provide feedback on effectiveness of food safety systems

Prevention measures

Surveillance

Epidemiological, laboratory and environmental investigation

Identify new hazards

Applied targeted research
Connecting Dots and Tying up Loose Ends

Increasing the specificity of food exposure information provided by case-patients is as important as increasing the specificity of the case definition.

Tracing the distribution pathway of suspect food items to production source may be the only way to obtain the food exposure specificity necessary to identify the outbreak vehicle.
**Listeria Whole Genome Sequencing Project**

- “Solving outbreaks caused by *Listeria* and other germs will improve with continued efforts to obtain important epidemiologic data, and to strengthen the link between epidemiologic and whole genome sequencing data.”

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**CIFOR Target Range:**

**Cluster investigation interval**

- Preferable: < 7 days
- Acceptable: 7-21 days
Minnesota
Salmonella Clusters, 2001-2012

If WGS results in detection of many smaller outbreaks, is our surveillance system ready?

CIFOR Target Range:
Cluster source identification
Preferable: >20% of clusters with > 5 cases
Acceptable: 10-20% of clusters with >5 cases
Relative Sensitivity and Specificity of Foodborne Illness/Outbreak Detection Tools

- Culture > PFGE
- Culture > WGS
- CIDT
- Complaint
- The future
The Most Important Foodborne Disease Epidemiology Tool Developed in My Lifetime

CIFOR Target Range:
PFGE subtyping of isolates (Salmonella, STEC, Listeria separate)

Preferable: >90% of isolates
Acceptable: 60-90% of isolates